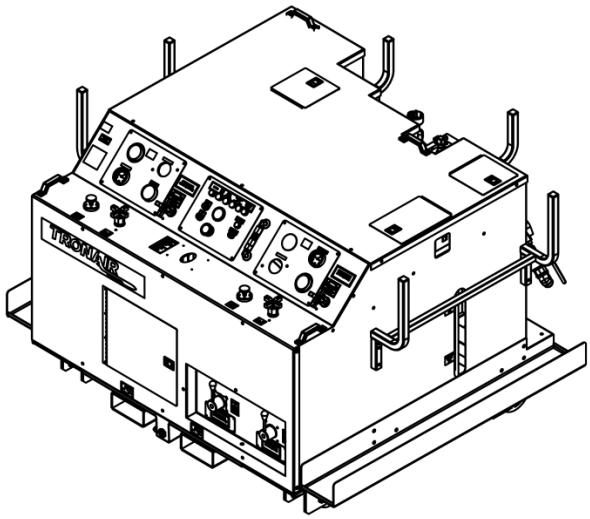
OPERATION & SERVICE MANUAL



Model: TADHPU-5FJ
Dual Hydraulic Power Unit

CE

07/2022 – Rev. 06

For Spare Parts, Operations & Service Manuals or Service Needs
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REVISION	DATE	TEXT AFFECTED
01	12/2017	Original release
02	07/2018	Added 5.7 Self Circulation Kit & 5.8 Contamination Monitor Controls
04	08/2021	Added section 5.13 Infrequent HPU Use and updated 9.0 Maintenance
05	01/2022	Modified 9.5.6 Return Filter Assembly, 9.6 Hydraulic Hoses, 9.10 Electrical Components, and Appendices
06	07/2022	Modified 9.3.1 Hydraulic Pump Replacment Parts and 9.5.6 Return Filter Assembly

TABLE OF CONTENTS

PAGE

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1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Hydraulic Power Unit
Model Number.....TADHPU-5FJ
Fluid Type MIL-PRF-5606

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit.

1.3 MANUFACTURER

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1.4 FUNCTION

The Dual Hydraulic Power Unit (HPU) provides a source of clean, pressurized hydraulic fluid for performing required aircraft maintenance. An electric motor drives tandem pressure compensated piston pumps. Filters are provided on the pressure and return systems. Bypass (dump) valves allow 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 section for proper sizing of electrical supply and protection equipment in the facility.

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

The HPU provides pressurized hydraulic fluid for performing aircraft maintenance.

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

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

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

2.2 EXPLANATION OF WARNING & DANGER SIGNS

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

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

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

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

2.3 COMPONENT SAFETY FEATURES

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

2.4 FUNCTIONAL SAFETY FEATURES

- Emergency shut off switch
- Floor lock
- 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 - 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 valves must be in the "Open" position when starting or stopping the HPU.
- Electrical power must be disconnected from the HPU and the bypass valves must be in the "Open" position before servicing the HPU. (Reference Technical Manual for details on servicing the HPU.)

2.7 GENERAL COMMENT

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

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

3.0 PREPARATION PRIOR TO FIRST USE

3.1 GENERAL

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

3.2 SERVICING RESERVOIR

Fill the reservoir with the correct fluid (see label next to reservoir fill for correct type of fluid) until fluid level is above the minimum fluid level mark but below the maximum fluid level. See ***5.3.1 Front Panel Controls*** for reservoir fill location.

3.3 CONNECTING ELECTRICAL LEADS

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

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

WARNING!

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

Voltage unbalanced between phases occurs when the voltages differ from one another.
Some reasons for imbalance are:

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

A voltage monitor is installed on this machine to prevent motor damage.

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

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

4.2 TRAINING PROGRAM

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

4.3 OPERATOR TRAINING

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

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

5.0 OPERATION

5.1 OPERATING PARAMETERS

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

ELECTRICAL POWER AND PROTECTION REQUIREMENTS

Voltage	60Hz/480 V	60Hz/380 V	50 Hz/380-440 V	60Hz/575 V
Full Load Amps	92	103.8	105	73.6
Locked Rotor Amps	543	543	528	413
Recommended Fuse Size	125	150	125	90
Maximum Fuse Size	125	150	150	100

5.2 NUMERICAL VALUES

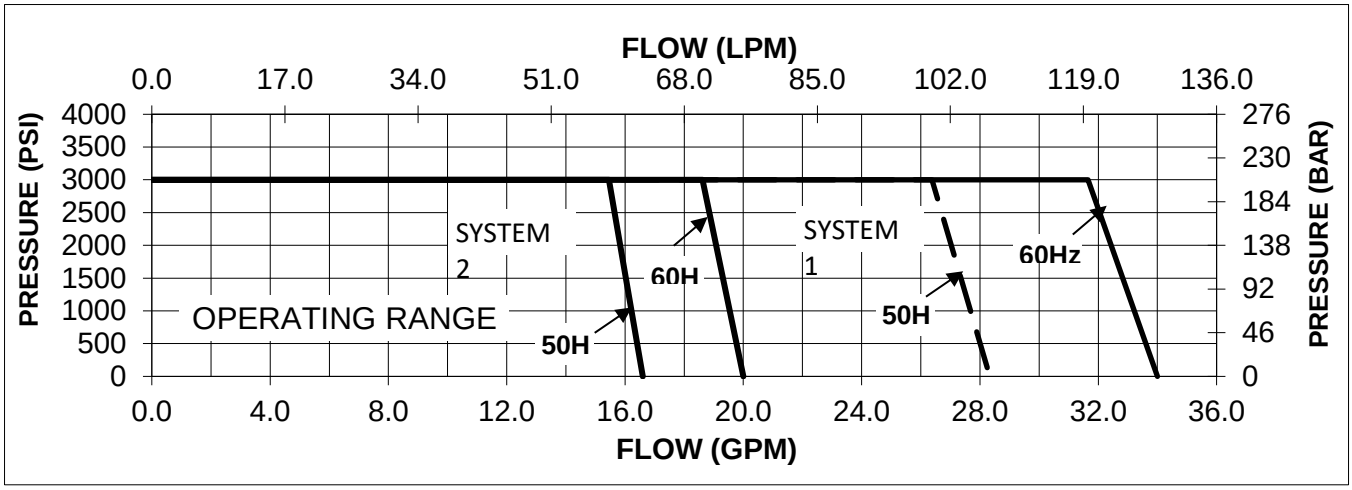
5.2.1 Model

Model Number: TADHPU-5FJ
Fluid Type: MIL-PRF-5606

5.2.2 Physical

- Weight (Dry) ..... 5,000 lbs (2,268 kg)
- Dimensions**:**
  - Width..... 90 in (162 cm)
  - Height ..... 58 in (147 cm)
  - Depth ..... 76 in (193 cm)
- Power Cord ..... 50 ft (15.24 m) long
- Electric Fill Pump Hose ..... 25 ft (7.62 m)..... Standard Length
  -6 (3/8 in, 9.53 mm)..... Working Diameter
- Pressure Hoses..... 25 ft (7.62 m)..... Standard Length
  -12 (¾ in, 19 mm)..... Working Diameter
- Return Hoses ..... 25 ft (7.62 m)..... Standard Length
  -16 (1 in, 25.4 mm)..... Working Diameter

5.2.3 Hydraulic Pump



SYSTEM 1:

- A pressure compensated, adjustable maximum volume piston pump, split into two sets of hoses
- Maximum flow at 60 Hz..... 34 gpm (129 lpm)
- Maximum flow at 50 Hz..... 28 gpm (107 lpm)
- Maximum operating pressure at 50 Hz and 60 Hz ..... 3,000 psi (207 bar)
- System pressure relief valve setting..... 3,250 psi (224 bar)
- Performance Curve for 50 Hz and 60 Hz

SYSTEM 2:

- A pressure compensated, adjustable maximum volume piston pump
- Maximum flow at 60 Hz..... 20 gpm (95 lpm)
- Maximum flow at 50 Hz..... 17 gpm (76 lpm)
- Maximum operating pressure at 50 Hz and 60 Hz ..... 3,000 psi (64 bar)
- System pressure relief valve setting..... 3,250 psi (224 bar)
- Performance Curve for 50 Hz and 60 Hz

5.2.4 Electric Motor

A 75 horsepower, TEFC electric motor is the prime mover for the HPU. This is attached to the tandem hydraulic pumps using a pump/motor adapter and a spider/coupling rotating interface.

MOTOR POWER REQUIREMENTS

Voltage	60Hz/480 V	60Hz/380 V	50 Hz/380-440 V	60Hz/575 V
Full Load Amps	92	104	105	74
Locked Rotor Amps	543	543	528	413

5.2.5 Filters

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

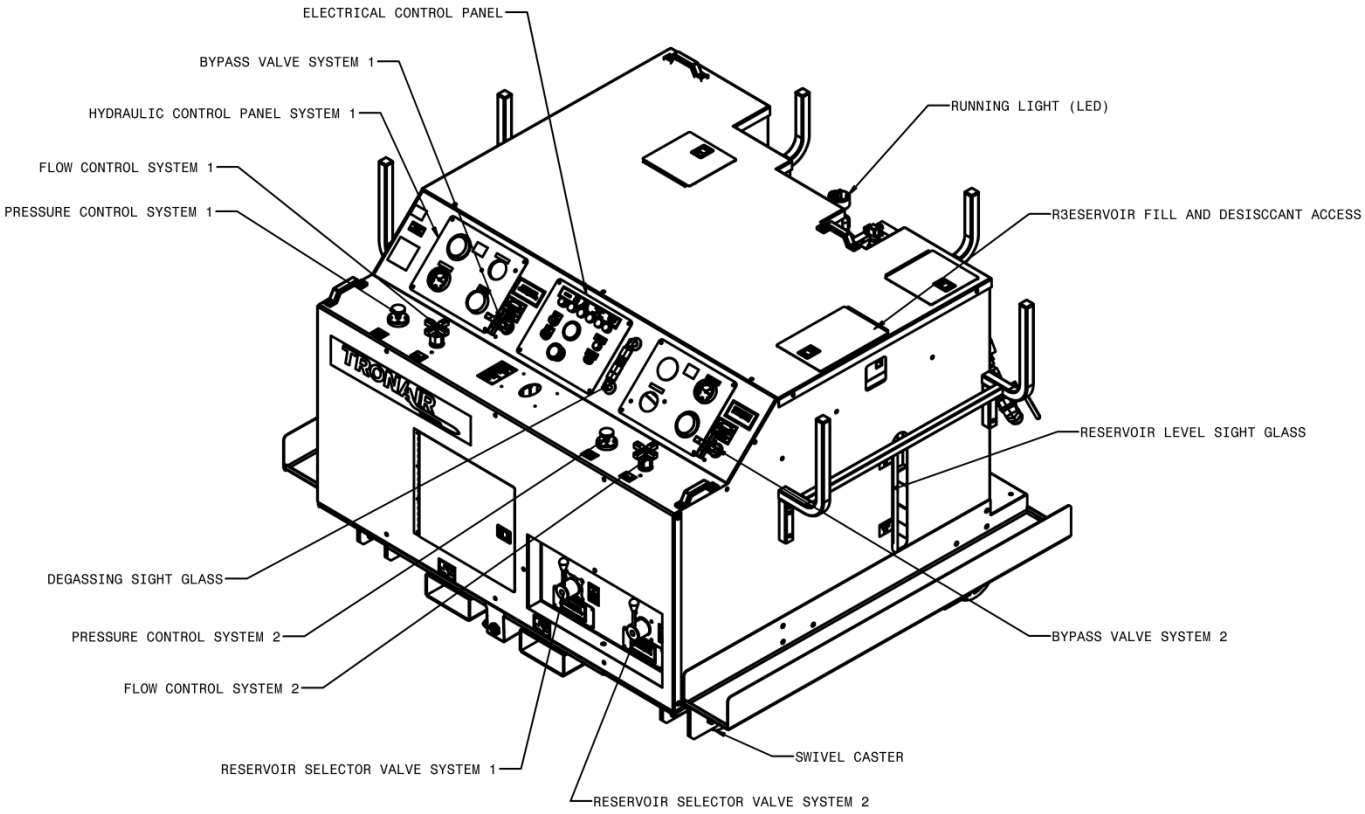
5.2.6 Electric Fill Pump

A ½ HP electric motor drives a vane pump to supply pressurized fluid for servicing aircraft reservoirs.

- Flow ..... 1 gpm (4 lpm)
- Pressure..... 65 psi (4.5 bar)
- Pressure Relief..... 70 psi (4.8 bar)

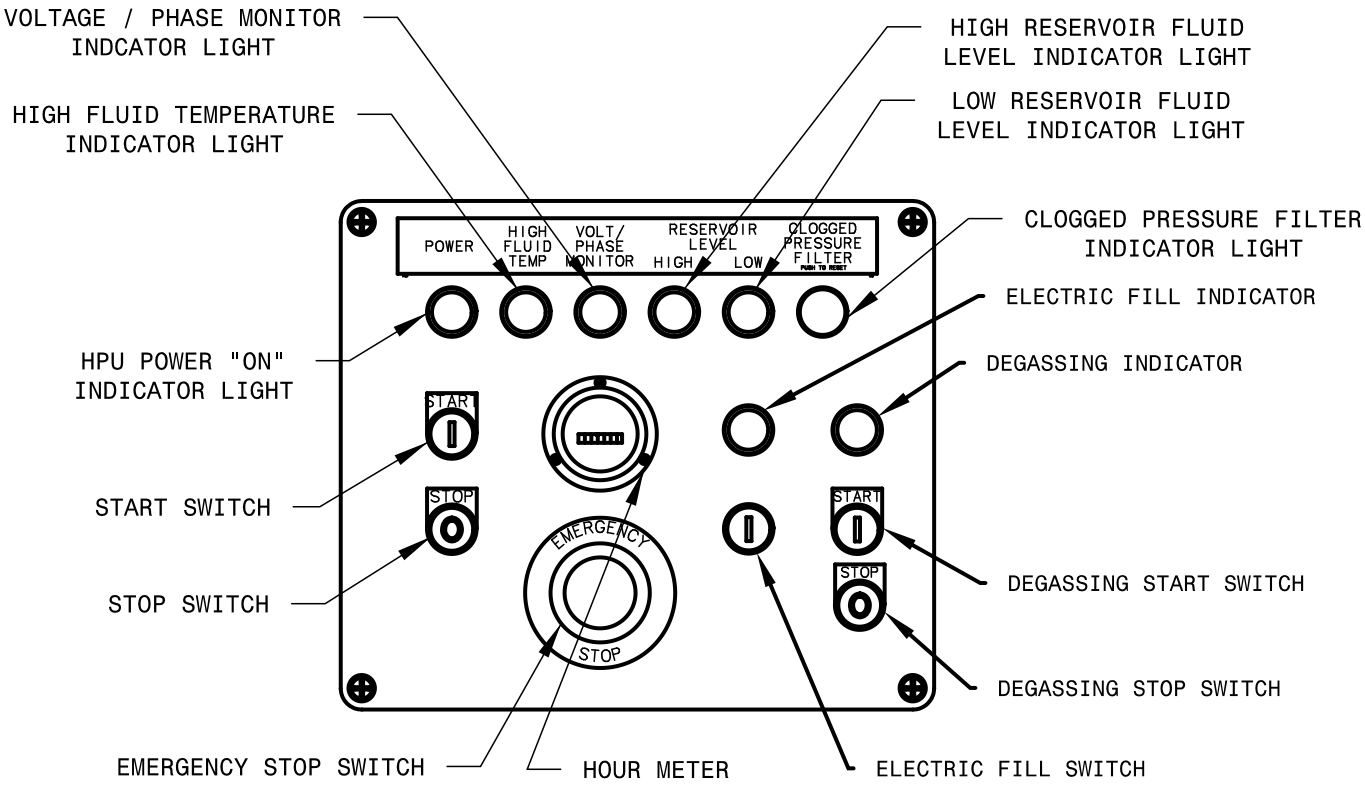
5.3 LOCATION & LAYOUT OF CONTROLS

5.3.1 Front Panel Controls



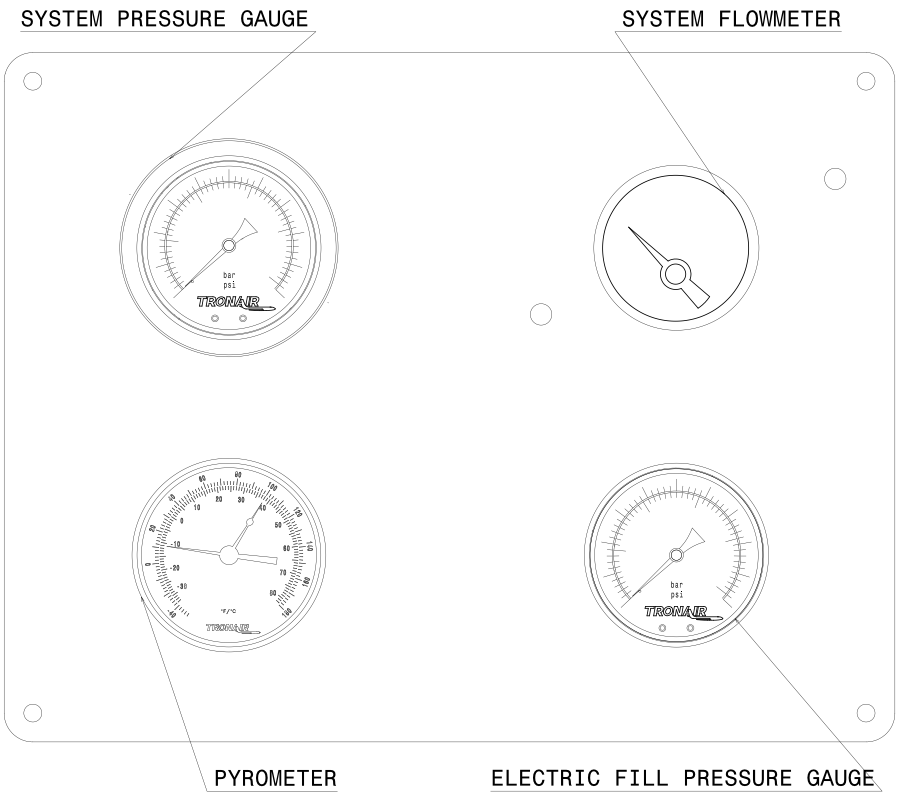
Electrical Control Panel	See Section 5.3.2
Hydraulic Control Panel	See Section 5.3.3
Bypass Valve	For loading and unloading the motor driven hydraulic pump
Flow Control	For setting the maximum flow required from the system
Pressure Control	For setting the system pressure of the HPU during operation
Reservoir 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
Locking Swivel Caster	Locking/unlocking, foot actuated and released locking caster
Running Light	Illuminated green LED light when unit is running
Degassing Sightglass	Fluid sightglass to observe air bubbles

5.3.2 Electrical Control Panel



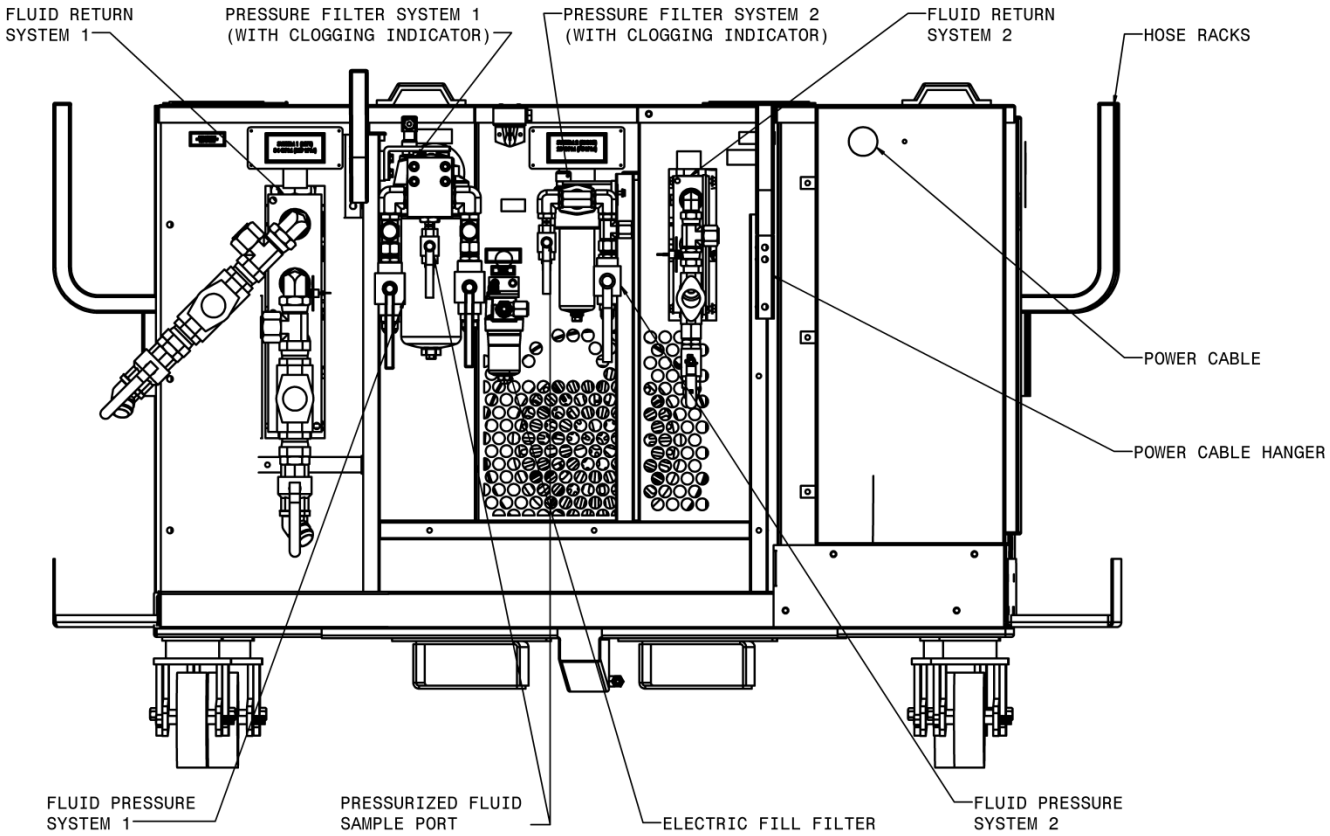
Emergency Stop	Removes power to all electrical devices, must turn to reset
Stop Switch	Turns off the electric motors driving the hydraulic pump and cooling fan
Start Switch	Turns on the electric motors driving the hydraulic pump and cooling fan
HPU Power "On" Indicator Light	Light is illuminated when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

5.3.3 Hydraulic Control Panel



System Pressure Gauge	Displays the system pressure on an analog fluid dampened gauge
Pyrometer	Displays the fluid temperature in the return system on an analog gauge. A warning indicator preset to 160° F (71° C) warns of high operating temperature
Electric Pump Pressure Gauge	Displays the hand pump system pressure on an analog fluid dampened gauge
System Flowmeter	Displays the system flow on an analog fluid dampen gauge

5.3.4 Rear Panel Controls



Fluid Pressure System	The source of pressurized fluid from the HPU that flows to the aircraft pressure system through the pressure hose
Fluid Return System	Fluid returning to the HPU from the aircraft that flows through the return hoses
Pressure Fluid Filter	Filters the pressurized fluid before it flows to the aircraft pressure system
Return Fluid Filter	Filters the fluid returning from the aircraft before it enters the HPU
Pressurized Fluid Sample Port	A sample valve is provided to obtain a fluid sample for analysis. In order to obtain a representative sample
Electric Fill Pump Pressure Filter	Filters the pressurized fluid before it flows to the aircraft system
Hose Racks	Location for storing the pressure and return hoses when not in use
Power Cord Hanger	Location for storing the power cord and electric fill hose when not in use

5.4 START UP PROCEDURES

5.4.1 Procedure for First Time or Different Electrical Supply ONLY

Phase Monitor: Check that the phase monitor light on the instrument panel is not illuminated. If the light is illuminated, change any two of the three input leads at the plug. Verify that the correct voltage is connected; make sure all three phases are connected. Once the phase monitor light is not illuminated with power attached unit will start.

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.

5.4.2 Initial Start Up of the HPU

a. Unit must be prepared per section *3.0 Preparation Prior to First Use* and section *5.4.1 First Time or Different Electrical Supply ONLY* before starting the HPU.
b. Operator must be familiar with this manual and be properly trained prior to starting the HPU.
c. Close all pressure and return valves on the back of the unit.
d. Place both reservoir selector valves in "HPU Reservoir" position.
e. Place the bypass valves in the "Open" position.
f. Press the start switch and adjust the flow control on System 1 until approximately 10 - 12 gpm (38 - 45 lpm) is displayed on the flowmeter. (If no flow displays on the flowmeter after adjusting the flow control, reference *Trouble Shooting 8.2 No Flow*). Immediately repeat for System 2.
g. Allow to run for two to five minutes until flow is steady and no hammering sounds.
h. Close the bypass valve; adjust the pressure control on System 1until 3,000 psi (206.84 bar) is displayed on the pressure gauge. (If no pressure displays on the system pressure gauge after adjusting the pressure control, reference *Trouble Shooting 8.4 No Pressure or Reduced Pressure)*. Repeat for System 2.
i. Open the bypass valve on System 1 and System 2.
j. Press the stop switch.

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

WARNING!

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

WARNING!

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

5.5 PRELIMINARY ADJUSTMENTS FOR OPERATION

The following are basic to the operation of the HPU and should be thoroughly understood.

5.5.1 Flow Control Adjustment

a. Open bypass valve.
b. Select "Hydraulic Power Unit" position with reservoir selector valve.
c. Start HPU.
d. Adjust flow control on System 1 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. (Pressure may need to be increased to reach higher valve flows.)
e. Repeat for System 2.

5.5.2 Pressure Control Adjustment

a. Make sure all pressure ball valves on the back of the HPU are closed.
b. Open bypass valve.
c. Select "Hydraulic Power Unit" position with reservoir selector valve.
d. Start HPU.
e. Close bypass valve System 1.
f. Adjust pressure control for desired pressure; observing the system pressure gauge, read in psi (bar). Be sure the control shaft lock nut is loose during adjustment. Tighten after adjustment to maintain setting.
g. Repeat for System 2.

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

k. Open the bypass valve on System 1 and System 2.
l. Shut off HPU.

5.5.3 Reservoir Selector Valve Operation

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

CAUTION!

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

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

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

Since the HPU reservoir is vented to atmosphere and the aircraft is at a higher level, it is normal for the aircraft reservoir to drain into the HPU reservoir. It is, therefore, necessary to be sure that sufficient room is available in the HPU reservoir to accommodate the additional fluid. The aircraft reservoir will probably need to be serviced after using the HPU in “HPU Reservoir” position.

CAUTION!

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

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

5.5.4 Bypass Valve Operation

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

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

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

CAUTION!

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

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

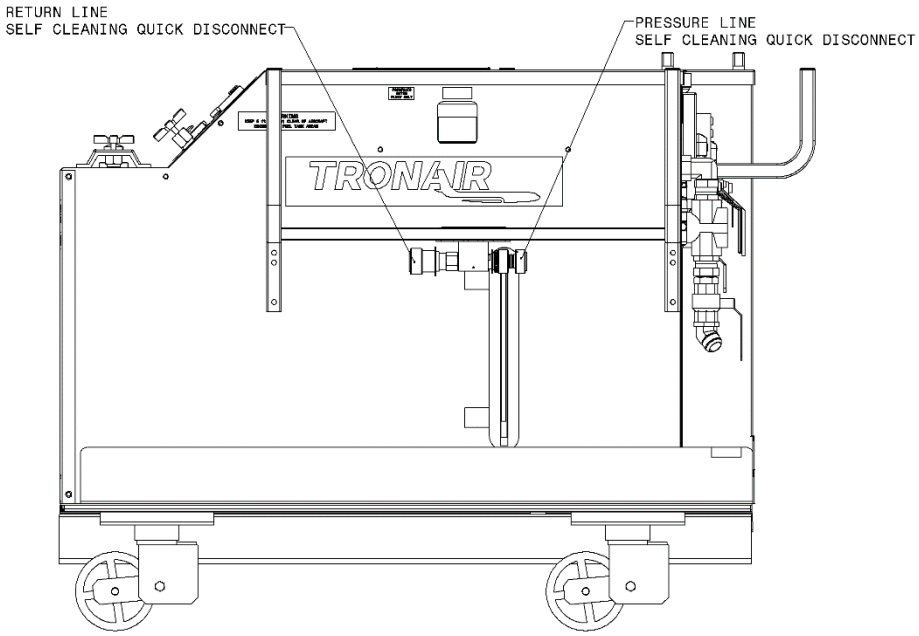
5.6 BLEEDING AIR FROM SYSTEM

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

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

5.6.1 To Easily Purge the Unit of Air

a. Fill reservoir to recommended level.
b. Connect pressure and return hoses to optional quick disconnect self-cleaning coupling kit, both systems.



c. Open all pressure and return ball valves on the back of the unit.
d. Open bypass valve.
e. Place reservoir selector valves in “Hydraulic Power Unit” position.
f. Start unit and adjust flow controls to maximum position.
g. Slowly close the bypass valves (pressure should never exceed 200 psi).

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

h. Run unit for ten (10) minutes.
i. Open bypass valves.
j. Shut off HPU.

WARNING!

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

5.6.2 Operating One System Only

When only operating one system it is important to set the unused system correctly. Setting the unused system correctly will assure that the pump still receives proper lubrication and cooling.

Setting Unused System:

Reservoir Selector Valve..... HPU position
Both pressure and return ball valves on the back of the unit..... Closed position
Bypass valve ..... Fully open
Flow control..... Set to ½ max
(ex. System 1 at 17 gpm, System 2 at 10 gpm)

5.7 SELF CIRCULATION KIT OPTION

To operate the self-circulation kit:

- Connect all sets of pressure and return hoses to the self-circulation kit using the quick disconnect couplings.
- Open all pressure and return ball valves
- Set the reservoir selector valve to HPU mode

WARNING!

Failure to open return ball valves may over pressurize return system

- Start unit, set each system to desired flow rate, and close bypass valves to circulate fluid through the pressure and return filters on each system

5.8 CONTAMINATION MONITOR CONTROLS OPTION

To operate the contamination monitor:

- Connect all sets of pressure and return hoses to the self-circulation kit using the quick disconnect couplings.
- Open all pressure and return ball valves
- Set the reservoir selector valve to HPU mode

WARNING!

Failure to open return ball valves may over pressurize return system

- Start unit, set each system to desired flow rate, and close bypass valves to circulate fluid through each pressure and return systems
- The contamination monitor can be connected to quick disconnect fittings on each pressure and return system to monitor contamination in each system
- The contamination monitor will take live readings and report in NAS or ISO codes to the front panel
- For accurate readings annual calibration is required.
  To calibrate the contamination monitor:
  1. Disconnect power cable and secure to unit
  2. Disconnect hoses, cap and secure to unit
  3. Remove contamination monitor from the unit for calibration
  4. The unit is still fully operable without the contamination monitor, follow standard operation procedures

5.9 ELECTRIC FILL PUMP OPERATION

The Electric Fill and Degassing Pump allows for filling the aircraft reservoir. The electric fill and degassing pump circuit is separate from the main hydraulic system; a separate filter and hose are attached to the back panel of the HPU.

To operate the pump, connect the external hose to the aircraft reservoir fill port, and hold down the electric fill pump switch located on the center electrical control panel. An indicating light will illuminate if the fill pump motor is running. Observe the fill system pressure on the fill pump pressure gauge.

To operate the degassing pump system push the degassing On switch and observe flow through the sightglass.

5.10 SAMPLE VALVE

A sample valve is provided on the rear of the unit for each system to obtain a fluid sample for analysis or inspection.

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

5.11 EMERGENCY SHUT DOWN PROCEDURE

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

5.12 DESCRIPTION OF ALARM SYSTEMS

Reference *5.3.2 – Electrical Control Panel*.

5.12.1 High Fluid Temperature Indicator

The indicator light for high fluid temperature of either system 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 ***8.0 Trouble Shooting***.

5.12.2 Voltage/Phase Monitor Indicator

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

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

5.12.3 High and Low Reservoir Level Indicator

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

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

5.12.4 Clogged Filter Indicator Light

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

If the clogged filter indicator light is illuminated, the pressure filter element requires changing. Reference *9.13.11 Electric Filter Clogging Indicator for maintenance procedure*. Pressing the clogging filter indicator light will reset the light and the light will turn off.

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

5.13 INFREQUENT HPU USE

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

5.13.1 Infrequent HPU Use Start Up Procedure

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

6.0 PACKAGING AND STORAGE

6.1 PACKAGING REQUIREMENTS

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

NOTE: Use at least four (4) straps with a minimum 5,500 lb (2,495 kg) capacity each.

6.2 HANDLING

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

NOTE: Be sure the forks are long enough to reach the frame cross members for stability during lifting. Reference Figure 7.0 – HPU on Forklift.

6.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required.

6.4 LABELING OF PACKAGING

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

6.5 STORAGE COMPATIBILITY

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

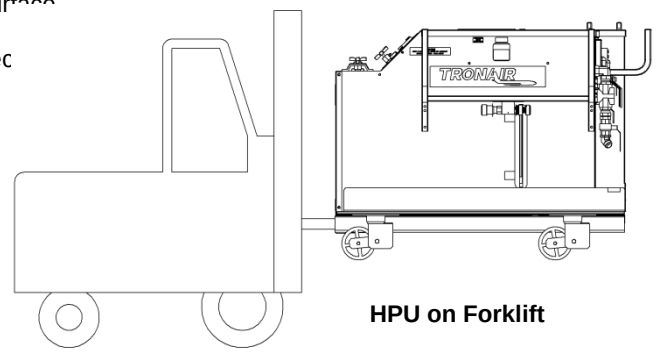
6.6 STORAGE ENVIRONMENT

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

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

6.7 STORAGE SPACE AND HANDLING FACILITIES

- Weight (Dry): 5,000 lbs (2,268 kg)
- Dimensions: Width 90 in (229 cm)
  Height 58 in (147 cm)
  Depth 76 in (193 cm)



HPU on Forklift

7.0 TRANSPORTATION

1. Do not stack Hydraulic Power Units.
2. The unit can be lifted by means of a fork truck from the front 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 – HPU on Forklift.

8.0 TROUBLE SHOOTING

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

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

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

8.1 HPU WILL NOT START

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

NOTE: Using the bypass valve to meter flow or pressure will increase the motor load and may cause the thermal overload device to trip. Refer to 5.5.4 Bypass Valve Operation for proper use of the bypass valve.

8.2 NO FLOW

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

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

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

8.3 REDUCED FLOW

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

8.4 NO PRESSURE or REDUCED PRESSURE

Possible Cause	Solution
Pressure adjustment is set too low	Increase pressure adjustment
Motor is “Single Phasing”	Motor is not getting power on all three phase legs. Check across-the-line voltage on all three phase legs
Pump inlet is not receiving enough fluid (cavitation)	Follow the procedure for “Air in pump inlet lines” in 8.2 No Flow
Flow path is open	Pressure is resistance to flow. The HPU will reach full pressure as flow paths (such as moving actuators and open valves) are closed

8.5 FLUID OVERHEATS

Possible Cause	Solution
Fan is not functioning properly	Check the cooler fan output. Forced air should be easily detected at the left hand side of the HPU. Check the fuses for the fan motor and the motor overloads (See Appendices – Electrical Schematic INS-2314, INS-2375)
Bypass valve or rear ball valve is being used in a partially closed position	The bypass valve and all ball valves must be used in a fully open or fully closed position. These valves are not intended for metering flow. All flow adjustments must be made using the pump flow control

8.6 ELECTRIC PUMP IS NOT PUMPING FLUID

Possible Cause	Solution
No flow	Check fuses and motor overload on the fill pump motor
Not filling reservoir	Observe the electric fill pressure gauge. If pressure is above 65 psi check the coupling connection or remove aircraft reservoir pressure
Low flow	Change the electric fill filter element

9.0 MAINTENANCE

If the unit is not used frequently Tronair recommends operating the unit monthly. Operating regularly assures that the seals are kept lubricated, eliminates air pockets in the system, reduces moisture in the fluid and helps extend the hose life. If the unit is not used frequently see 5.13 Infrequent Use Procedure.

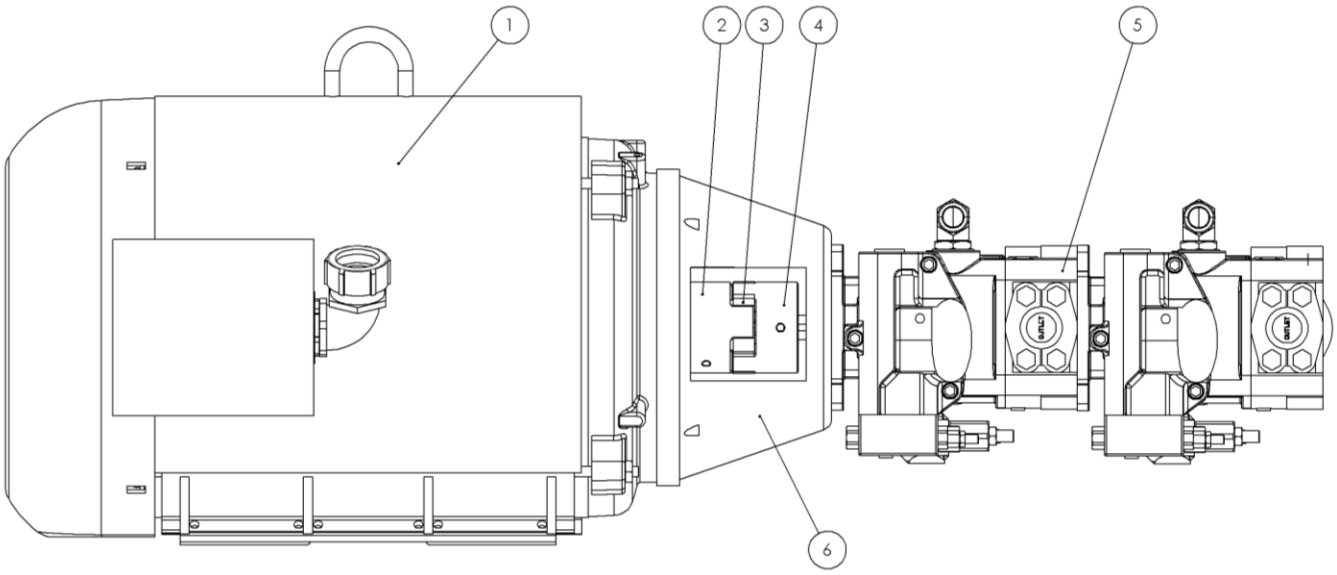
9.1 GENERAL

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

Reference Sections **9.2 – 9.14** for Parts Lists, Descriptions and Illustrations.

9.2 ELECTRIC MOTOR

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



Parts List

Item	Part Number	Description	Qty
1	See table below	Electric Motor	1
2	H-2223-03	Coupling (Motor Half)	1
3	H-2229	Spider (Hytrel)	1
4	H-2226-14	Coupling (Pump Half)	1
5	Reference 9.3 and 9.3.1	Tandem Hydraulic Pump	1
6	HC-1427-02	Pump/Motor Adapter	1

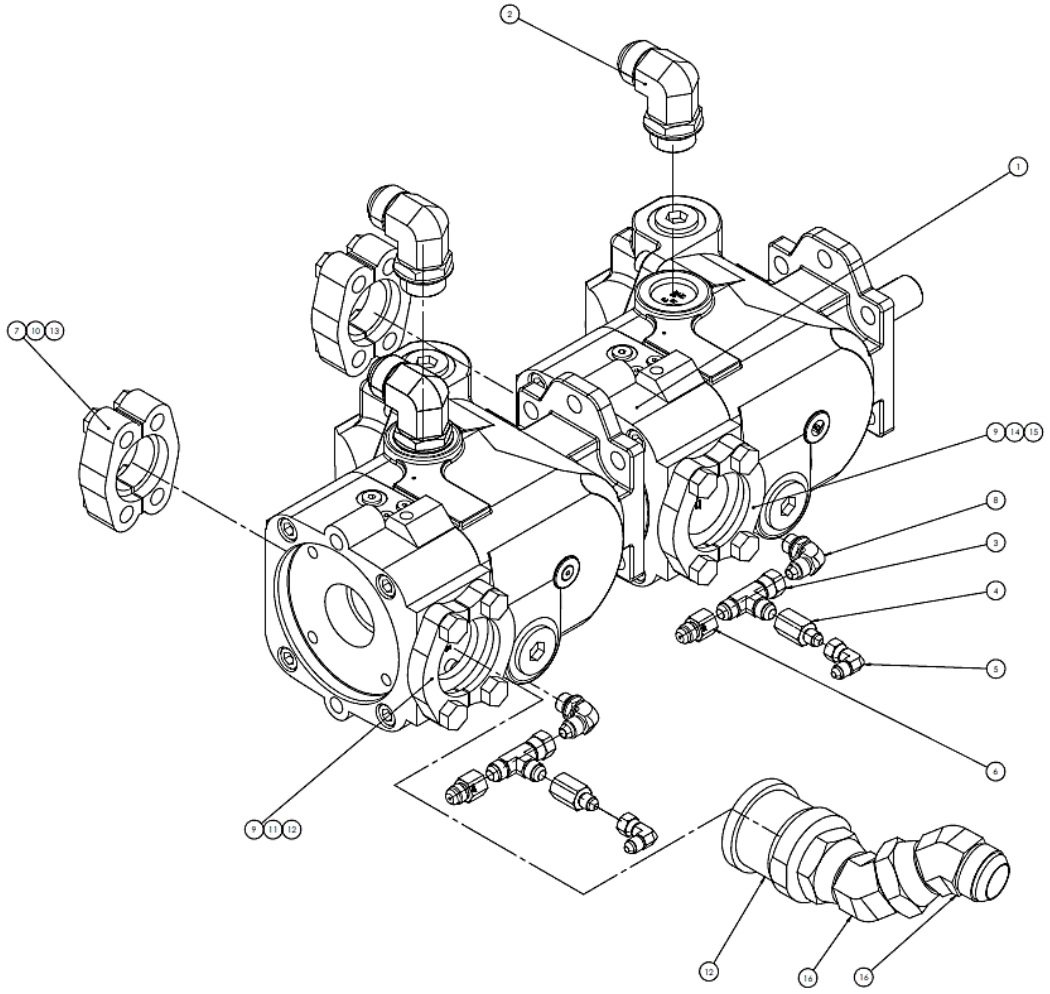
60 Hz Applications	
Voltage	**Part Number**
380	EC-1224-13
480	EC-1224-14
575	EC-1224-15

50 Hz Applications	
Voltage	**Part Number**
380	EC-1224-14
415	EC-1224-14
440	EC-1224-14

9.3 HYDRAULIC PUMP

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

9.3.1 Hydraulic Pump Replacement Parts



Parts List

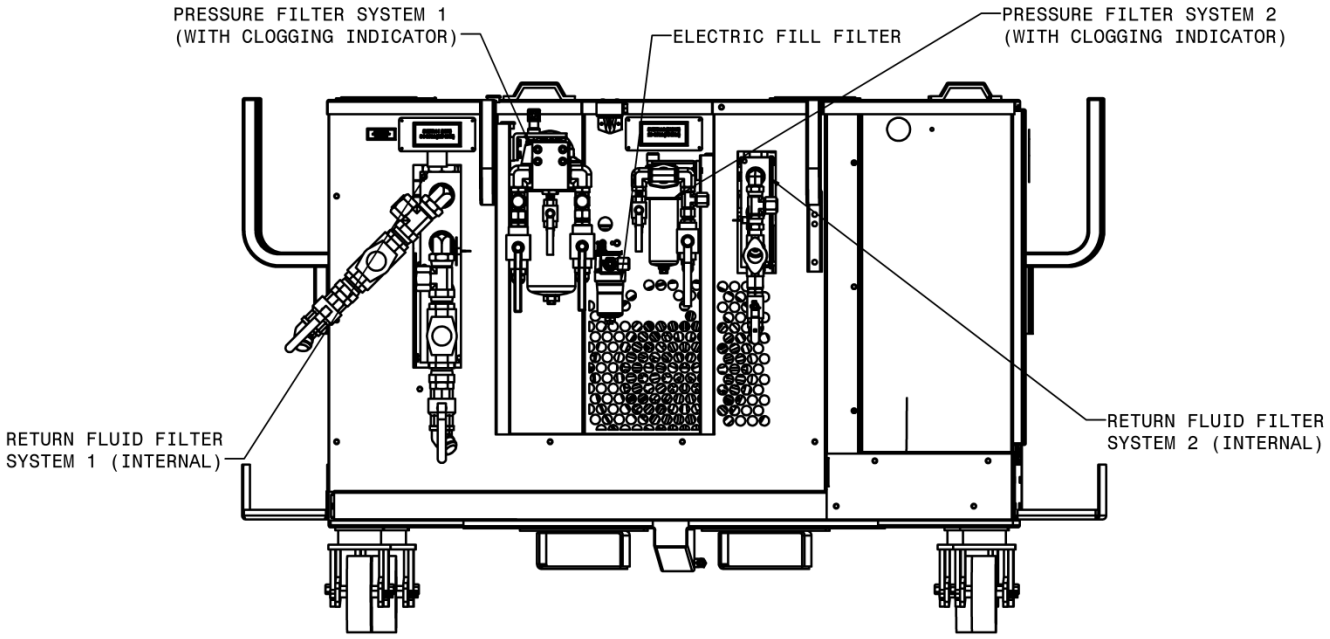
Item	Part Number	Description	Qty
1	HC-2679-00	TANDEM PUMP, HYDRAULIC	1
2	N-2001-24-S-B	CONNECTOR, STR THD, #16 SAE X #16 JIC	2
3	N-2016-05-S	TEE, RUN SWIVEL NUT	2
4	N-2055-01-S	REDUCER, TUBE (6-4)	2
5	N-2002-03-S	ELBOW, SWIVEL NUT	2
6	N-2924	CONNECTOR, IN-LINE ORFICE	2
7	N-2664-03-S-B	KIT, FLANGE	2
8	N-2001-08-S-B	ELBOW, STR THD (-16)	2
9	N-2545-06-S-B	KIT, FLANGE	2
10	HC-2000-222	O-RING SERIES 2	2
11	HC-2000-228	O-RING SERIES 2	2
12	N-2993-06-S-B	FLANGE, CODE 61 CONNECTOR	1
13	N-2932-05-S-B	FLANGE, CODE 62 CONNECTOR	2
14	N-2078-11	FLANGE, 90º ELBOW	1
15	N-2063-05	ELBOW, BENT SWIVEL NUT	1
16	N-2081-09-S	ELBOW, 45º SWIVEL, #20 JIC	2

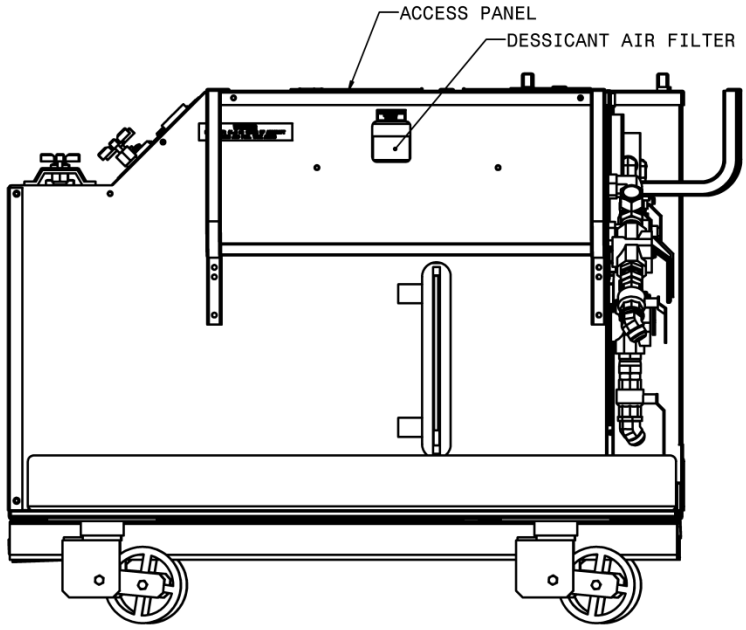
9.4 HYDRAULIC FLUID

Any time an unusual color, smell or visual indicator is noticed with the hydraulic fluid, a sample analysis should be performed to determine the condition of the fluid. (See ***5.8 – Sample Valve Operation***)

Refer to the manufacturer of the specific fluid for your unit to obtain additional information:
Model Number: TADHPU-5FJ
Fluid Type: MIL-PRF-5606

9.5 FILTERS



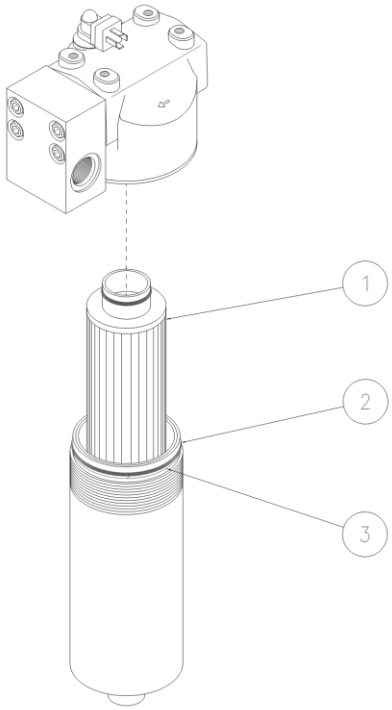


9.5.1 Pressure Filter Element

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

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

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



System 1 - Parts List

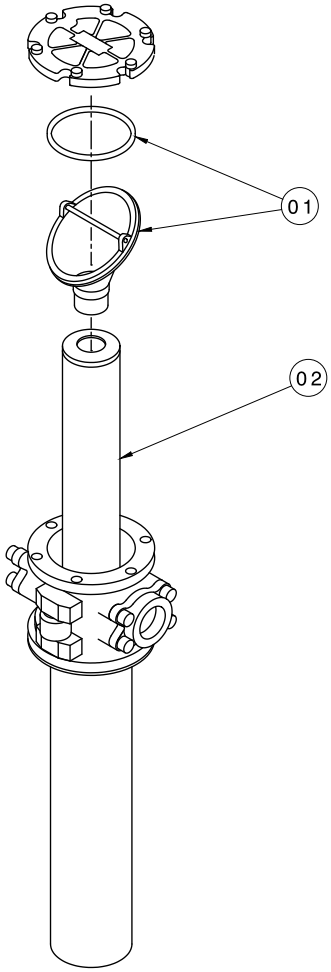
Item	Part Number	Description	Qty
1, 2, 3	K-5244	Kit, Replacement Filter Element	1
2, 3	TBD	O-ring & Backup Ring	1

System 2 - Parts List

Item	Part Number	Description	Qty
1, 2, 3	K-5243	Kit, Replacement Filter Element	1
2, 3	TBD	O-ring & Backup Ring	1

9.5.2 Return Filter Element

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



System 1 - Parts List

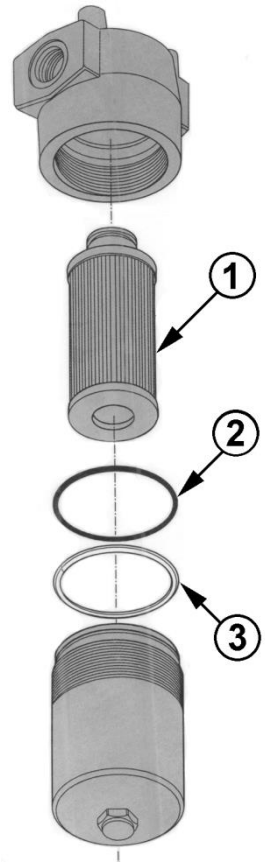
Item	Part Number	Description	Qty
1, 2	K-3615	Kit, Replacement Filter Element	1
1	HC-2000-350	O-ring	2

System 2 - Parts List

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

9.5.3 Electric Fill Pump 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.

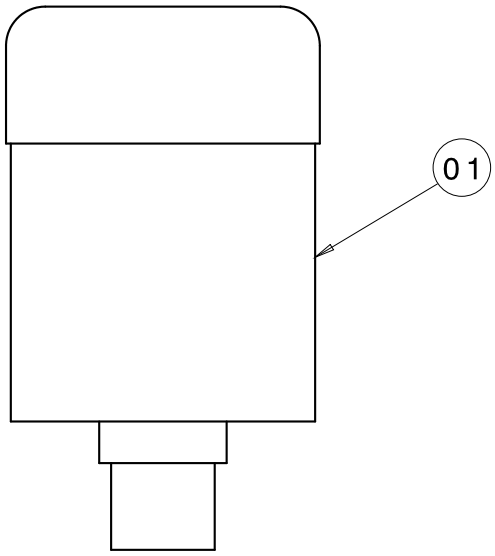


Parts List

Item	Part Number	Description	Qty
1, 2, 3	936698Q	Kit, Replacement Filter Element	1

9.5.4 Desiccant Air Filter

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



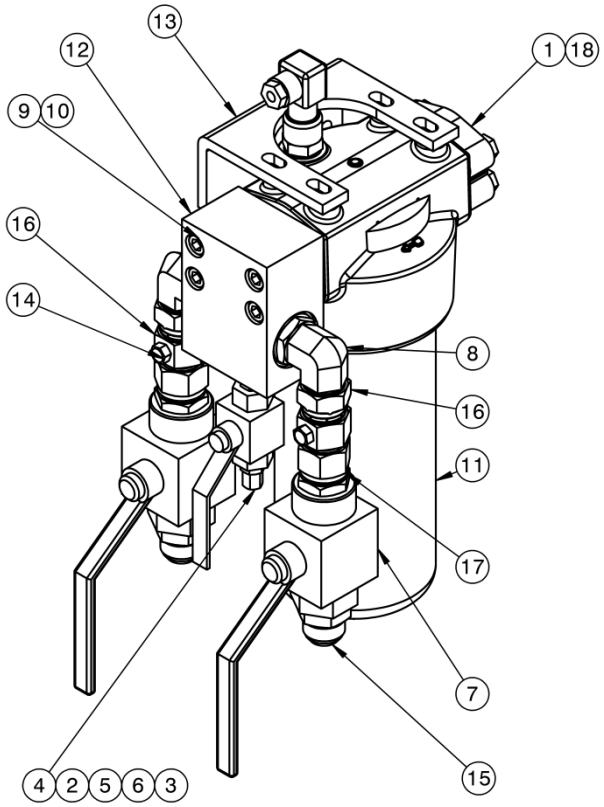
Parts List

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

9.5.5 Pressure Filter Assembly with Electric Filter Clogging Indicator

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

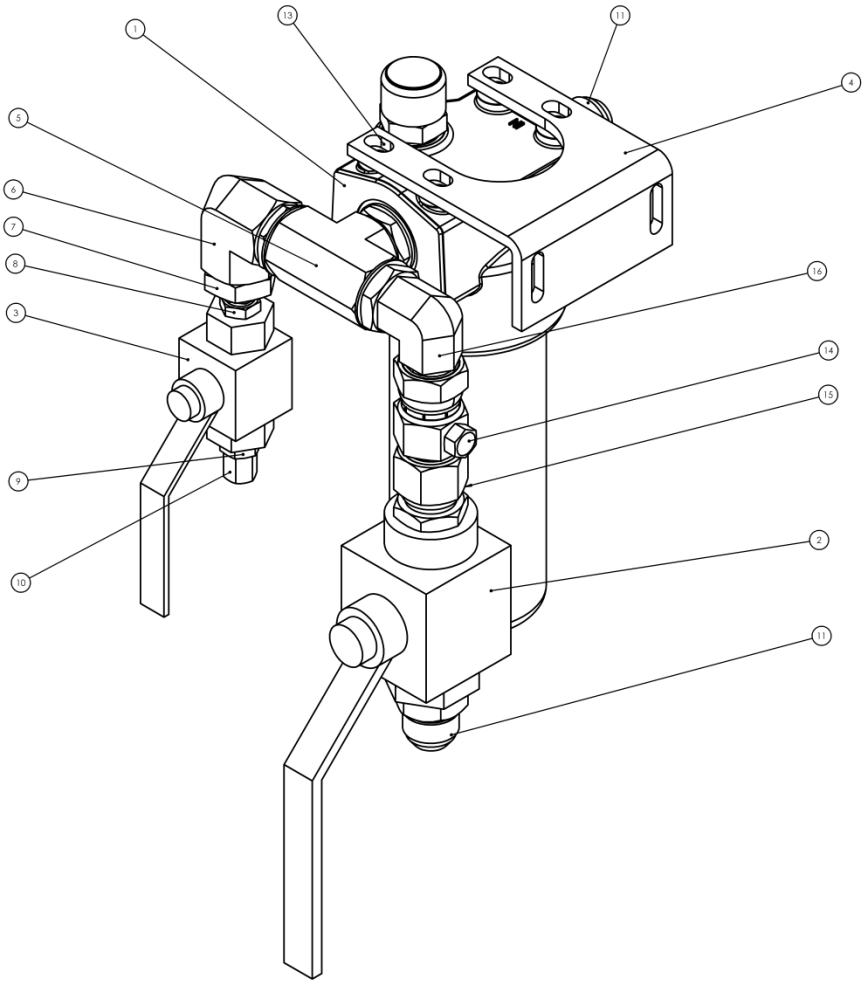
NOTE: Higher flow rates will result in higher differential pressures. (Example: The clogging indicator may sense a 98 psi differential pressure at a flow rate of 34 gpm but not show a clogged condition when the flow rate is reduced to 10 gpm.



System 1 - Parts List

Item	Part Number	Description	Qty
1	N-2664-03-S-B	KIT, FLANGE	1
2	HC-2206-02	VALVE, BALL	1
3	N-2007-05-S-B	CONNECTOR, STR THD	1
4	N-2008-03-S	CAP, 1/4	1
5	N-2464-05-S-B	UNION, #6 STRAIGHT THREAD	1
6	N-2463-31-S-B	FITTING, REDUCER/EXPANDER	1
7	HC-2206-05	VALVE, BALL	2
8	N-2001-24-S-B	ELBOW, STRAIGHT THREAD	2
9	G-1151-109224	SCR, 1/2-13 HEX SOC HD CAP	4
10	G-1251-1090HC	LOCKWASHER, HELICAL SPRING	4
11	HC-2798	FILTER, PRESSURE	1
12	H-2584	FLANGE, SAE ADAPTER	1
13	H-3865-00	BRACKET, FILTER (P)	1
14	N-2053-03-S-B	PLUG, HEX. HD W/ O-RING	2
15	N-2007-24-S-B	CONNECTOR, STR THD	2
16	N-3023-06	TEE, GAUGE PORT	2
17	N-2036-10-S-B	SWIVEL, 37 DEG FEMALE	2
18	HC-2000-222	O-RING, SERIES 2	1

9.5.5 Pressure Filter Assembly with Electric Filter Clogging Indicator *(continued)*



System 2 - Parts List

Item	Part Number	Description	Qty
1	HC-2796	FILTER, PRESSURE	1
2	HC-2206-04	VALVE, BALL	1
3	HC-2206-02	VALVE, BALL	1
4	Z-5093-01	BRACKET, FILTER	1
5	N-2740-12-S-B	TEE, STR THD BRANCH	1
6	N-2661-05-S-B	ELBOW, STRAIGHT THREAD	1
7	N-2463-35-S-B	FITTING, REDUCER/EXPANDER	1
8	N-2464-05-S-B	UNION, #6 STRAIGHT THREAD	1
9	N-2007-05-S-B	CONNECTOR, STR THD	1
10	N-2008-03-S	CAP, 1/4	1
11	N-2007-18-S-B	CONNECTOR, STR THD	2
12	G-1114-080016	BOLT, METRIC M8 HEX HD	4
13	N-3023-05	TEE, GAUGE PORT	1
14	N-2053-03-S-B	PLUG, HEX. HD W/ O-RING	REF
15	N-2036-08-S-B	SWIVEL, 37° FEMALE	1
16	N-2001-18-S-B	ELBOW, STRAIGHT THREAD	1

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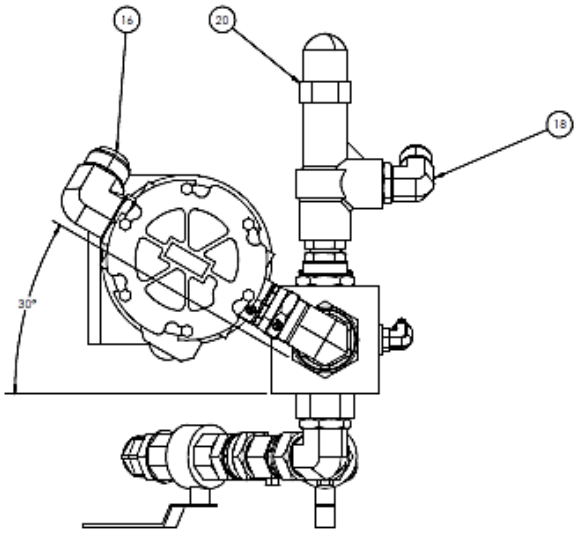
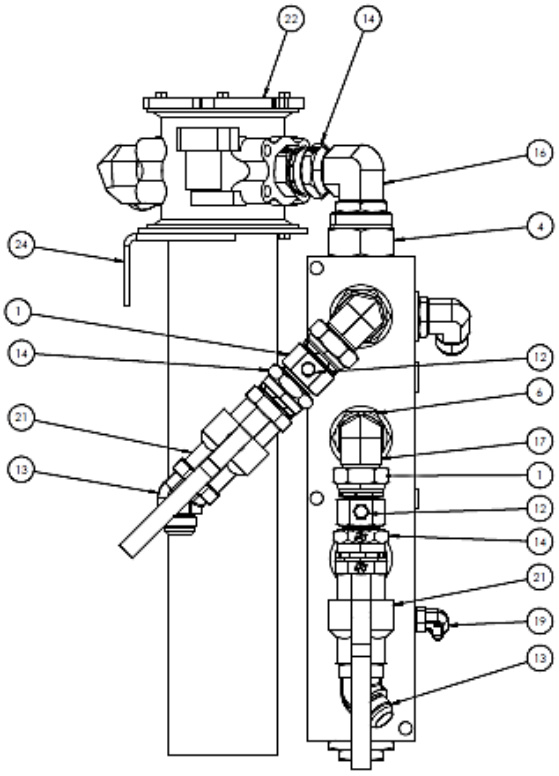
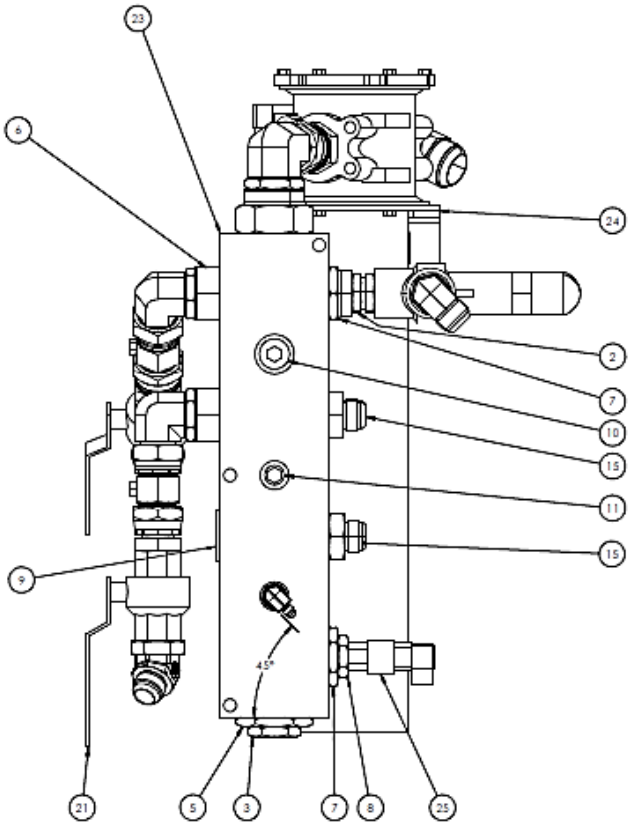
9.5.6 Return Filter Assembly





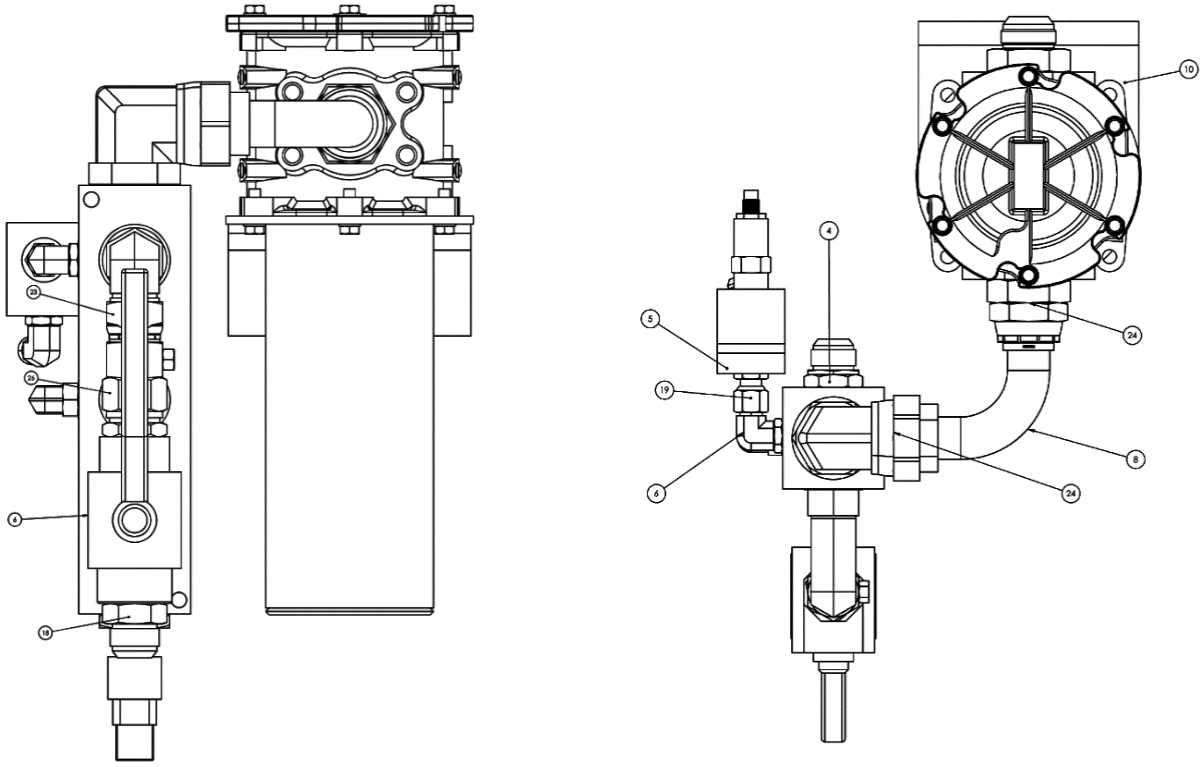


9.5.6 Return Filter Assembly *(continued)*

System 1 - Parts List

Item	Part Number	Description	Qty
1	N-3023-07	TEE, GAUGE PORT	2
2	N-2464-10-S-B	UNION, #16 STRAIGHT THREAD	1
3	N-2463-40-S-B	FITTING, REDUCER/EXPANDER	1
4	N-2463-28-S-B	FITTING, REDUCER/EXPANDER	1
5	N-2463-27-S-B	FITTING, REDUCER/EXPANDER	1
9	N-2463-25-S-B	ADAPTOR, FEM PIPE/STR THD	2
7	N-2463-24-S-B	FITTING, REDUCER/EXPANDER	2
8	N-2463-16-S-B	FITTING, REDUCER/EXPANDER	1
9	N-2066-24-S-B	PLUG, O-RING HEX	1
10	N-2066-12-S-B	PLUG, O-RING HEX	1
11	N-2066-08-S-B	PLUG, O-RING HEX	1
12	N-2053-03-S-B	PLUG, HEX. HD W/ O-RING	2
13	N-2042-25-S-B	ELBOW. 45 DEG STR THD (20-24)	2
14	N-2036-12-S-B	SWIVEL, 37 DEG FEMALE	3
15	N-2007-34-S-B	CONNECTOR, STR THD	2
16	N-2001-31-S-B	ELBOW, STRAIGHT THREAD	2
17	N-2001-28-S-B	ELBOW, MALE	2
18	N-2001-24-S-B	ELBOW, STRAIGHT THREAD	1
19	N-2001-06-S-B	ELBOW, STRAIGHT THREAD	1
20	HC-2201	VALVE, PRE-SET PRESS RELIEF	1
21	HC-2058-01	VALVE, BALL (6000 PSI)	2
22	HC-2045-01	FILTER, RETURN	1
23	HC-2043	MANIFOLD, RETURN	1
24	H-3864-00	BRACKET, FILTER	1
25	EC-1782-01	SWITCH, TEMPERATURE	1

9.5.6 Return Filter Assembly *(continued)*

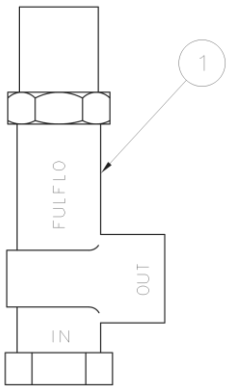


System 2 - Parts List

Item	Part Number	Description	Qty
1	HC-1906-01	FILTER, RETURN	1
2	HC-2205	MANIFOLD, RETURN	1
3	N-2007-21-S-B	CONNECTOR, STR THD	1
4	N-2463-16-S-B	FITTING, REDUCER/EXPANDER	1
5	HC-2199	VALVE, PRESS RELIEF	1
6	HC-2058-02	VALVE, BALL	1
7	N-2063-04	ELBOW, BENT SWIVEL NUT	1
8	N-2001-11-S-B	ELBOW, STRAIGHT THREAD	2
9	N-2007-30-S-B	CONNECTOR, STRAIGHT THREAD	2
11	N-2007-24-S-B	CONNECTOR, STR. THD.	1
13	N-2706-06-S-B	ELBOW, LONG STR THD	1
14	N-2001-06-S-B	ELBOW, STRAIGHT THREAD	1
15	EC-1782-01	SWITCH, TEMPERATURE	1
16	N-2463-40-S-B	FITTING, REDUCER/EXPANDER	1
17	N-2066-16-S-B	PLUG, O-RING HEX	2
18	N-2007-34-S-B	CONNECTOR, STR THD	2
19	N-2049-20-S-B	ELBOW, 90 DEG SWIVEL	1
20	N-2053-03-S-B	PLUG, HEX. HD W/ O-RING	1
21	H-3863-01	BRACKET, FILTER (P)	1
22	N-2036-05-S-B	SWIVEL, 37 DEG FEMALE	1
23	N-3023-06	TEE, GAUGE PORT	1
24	HC-1951-20	SEAL, CONICAL (-20)	1
26	N-2036-10-S-B	SWIVEL, 37~ FEMALE	1
27	N-2463-24-S-B	FITTING REDUCER/EXPANDER	1

9.5.6 Return Filter Assembly *(continued)*

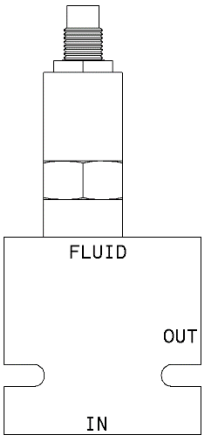
The Return System Pressure Relief Valve can be purchased as a preset assembly. If the relief valve is serviced by the end user, the valve must be set to crack at 150+/-7 psig **before** being re-installed on the HPU.



System 1 - Parts List

Item	Part Number	Description	Qty
1	HC-2201	Valve, Pressure Relief (*Pre-set*)	1
Not Shown	♦ HC-2000-220	O-ring, Series 2	1

♦ ***Included with Item 1***

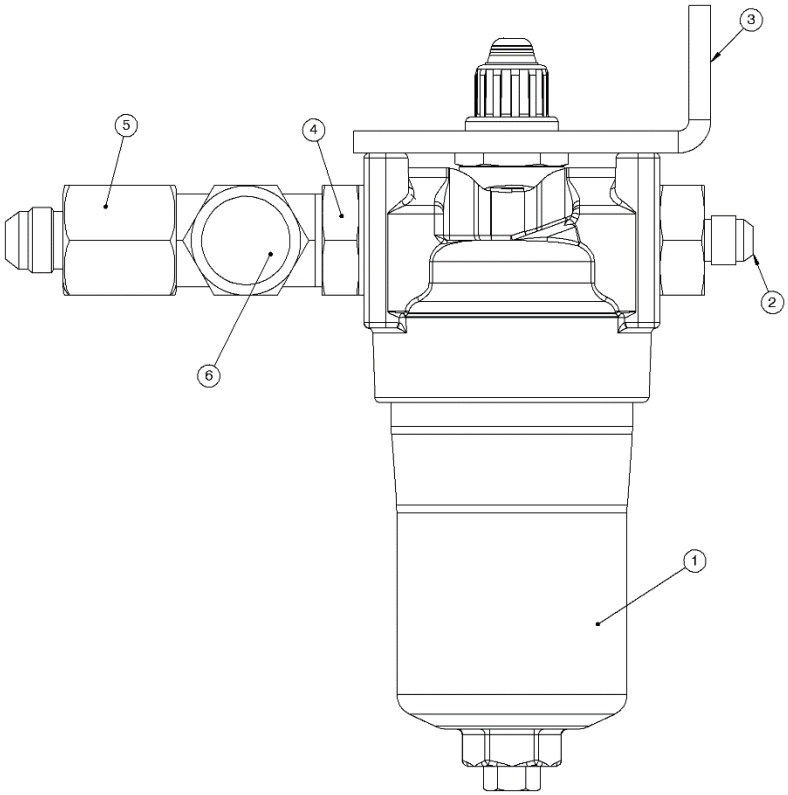


System 2 - Parts List

Item	Part Number	Description	Qty
1	HC-2201	Valve, Pressure Relief (*Pre-set*)	1

♦ ***Included with Item 1***

9.5.7 Electric Fill filter



Parts List

Item	Part Number	Description	Qty
1	HC-2800	ASSEMBLY, FILTER 15CN 2 MICRON (PE)	1
2	N-2007-46-S-B	CONNECTOR, STRAIGHT THREAD	1
3	J-6203	BRACKET, FILTER MOUNTING	1
4	N-2008-08-S	CAP, 3/4"	1
5	N-2015-18-S-B	TEE, RUN, STR THD	1
6	N-2055-09	REDUCER, TUBE	1

9.6 HYDRAULIC HOSES

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

System 1 - Parts List

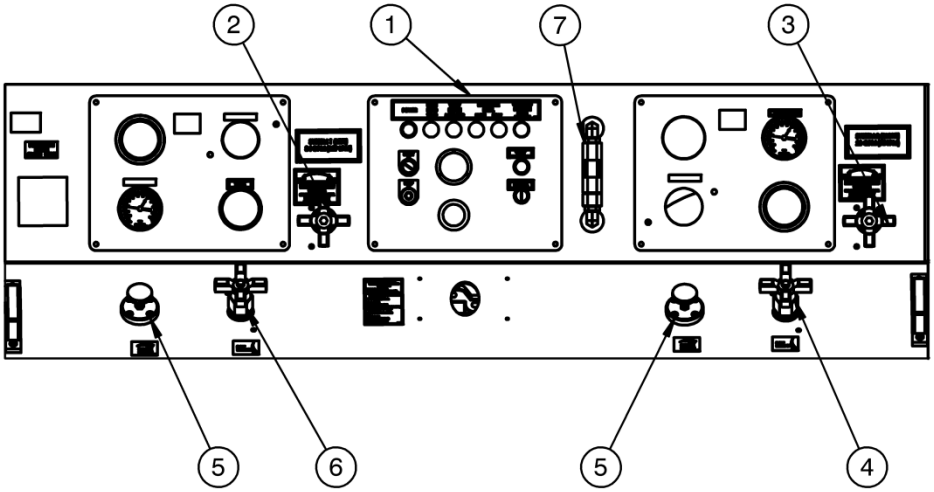
Item	Hose Size	End Size	Part Number	From	To	Qty
1	-24	-24	TF-1117-40-53.4	Selector Valve	Pump Inlet	1
2	-16	-16	TF-1038-47-31.4	Pump Outlet	Flow Control	1
3	-16	-16	TF-1038-44-23.1	Flow Control	Flowmeter	1
4	-16	-16	TF-1038-46-48.0	Manifold	Pressure Filter	1
5	-16	-16	TF-1039-37-64.8	Manifold	Return Manifold	1
6	-16	-16	TF-1039-02-15.8	Pump Case	Heat Exchanger Bottom	1
7	-6	-6	TF-1038-42-45.1	Flow Control Sense	Orifice Fitting	1
8	-4	-4	TF-1038-16-44.4	Pressure Control	Pump Load Sense	1
9	-4	-4	TF-1038-14-116	Pressure Control	Return Manifold	1
10	-16	-16	TF-1039-37-47.5	Heat Exchanger Top	Return Manifold	1
11	-16	-16	TF-1039-09-27.0	Return PRV	Reservoir	1
12	-24	-24	TF-1039-12-49.8	Return Filter	JIC Union	1
13	-24	-24	TF-1039-13-17.0	JIC Union	Selector Valve	1

System 2 - Parts List

Item	Hose Size	End Size	Part Number	From	To	Qty
16	-20	-20	TF-1117-39.18.6	Selector Valve	Pump Inlet	1
17	-12	-12	TF-1038-5-44.4	Pump Outlet	Flow Control	1
18	-12	-12	TF-1038-33-25.1	Flow Control	Flowmeter	1
19	-12	-12	TF-1038-10-54.6	Manifold	Pressure Filter	1
20	-12	-12	TF-1039-36-62.9	Manifold	Return Manifold	1
21	-16	-16	TF-1039-02-52.6	Pump Case	Heat Exchanger Bottom	1
22	-6	-6	TF-1038-42-44.6	Flow Control Sense	Orifice Fitting	1
23	-4	-4	TF-1037-03-35.8	Pressure Control	Pump Load Sense	1
24	-4	-4	TF-1038-14-126	Pressure Control	Return Manifold	1
25	-16	-16	TF-1039-02-60.3	Heat Exchanger Top	Return Manifold	1
26	-8	-8	TF-1038-12-40.4	Return PRV	Reservoir	1
27	-20	-20	TF-1039-35-61.8	Return Filter	JIC Union	1
28	-20	-20	TF-1039-08-16.5	JIC Union	Selector Valve	1

9.7 INSTRUMENT PANEL

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

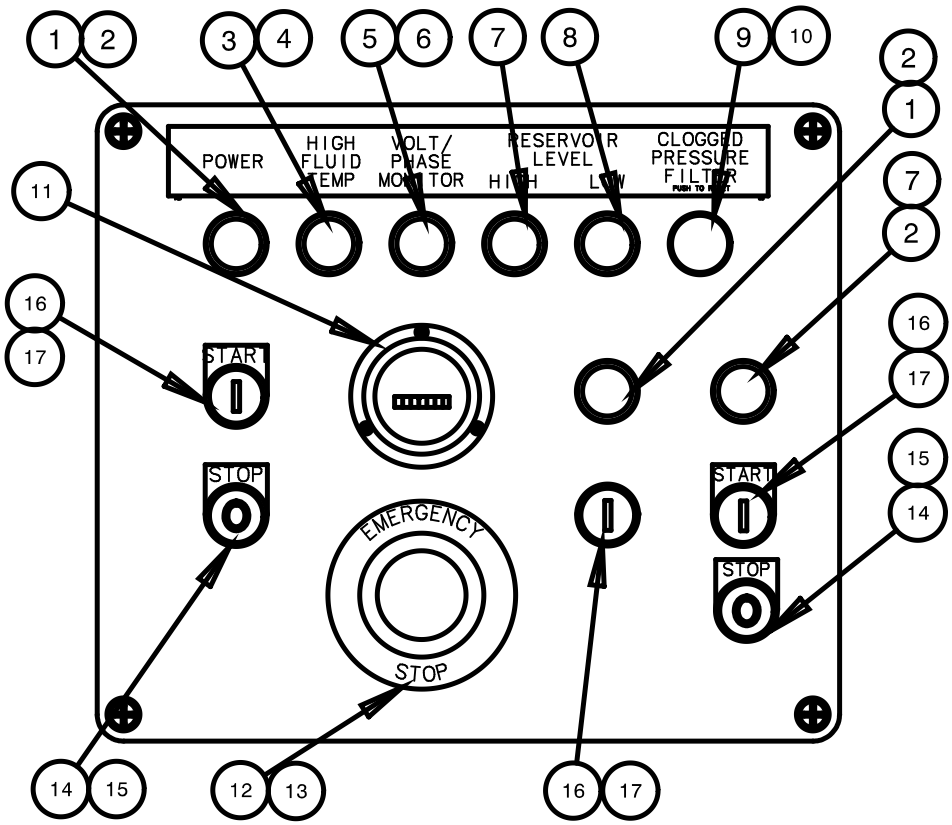


Parts List

Item	Part Number	Description	Qty
1	*See Page 35*	Electric Panel	1
2	*See Page 38*	Assembly, System 1 Pressure Manifold	1
3	*See Page 38*	Assembly, System 2 Pressure Manifold	1
4	*See Page 37*	Assembly, System 2 Flow Control Manifold	1
5	HC-2108-02	Valve, Pressure Control	1
6	*See Page 37*	Assembly, System 1 Flow Control Manifold	1
7	*See Page 32*	Assembly, Degassing Sightglass	1

9.7.1 Electric Panel

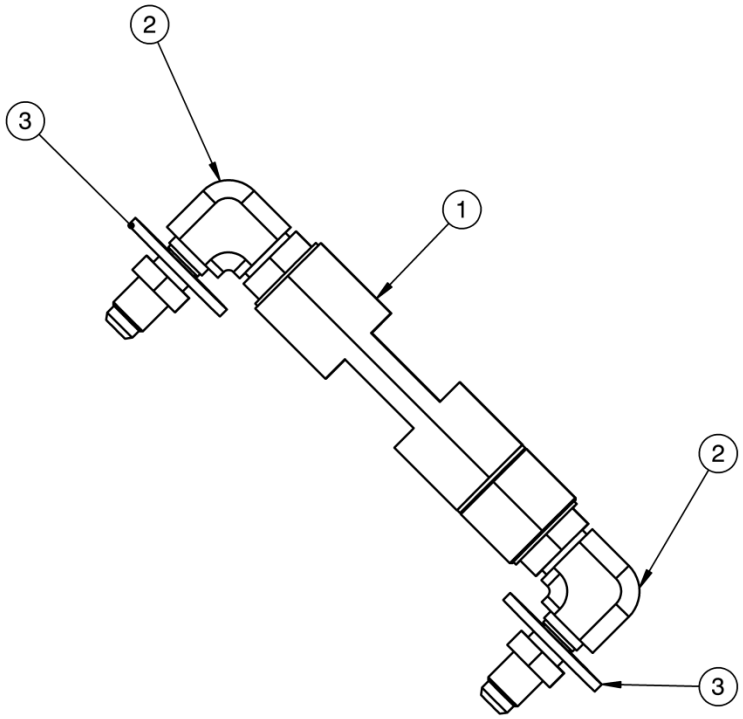
The Electric Panel does not require regular general maintenance.



Parts List

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

9.7.2 Degassing Sightglass

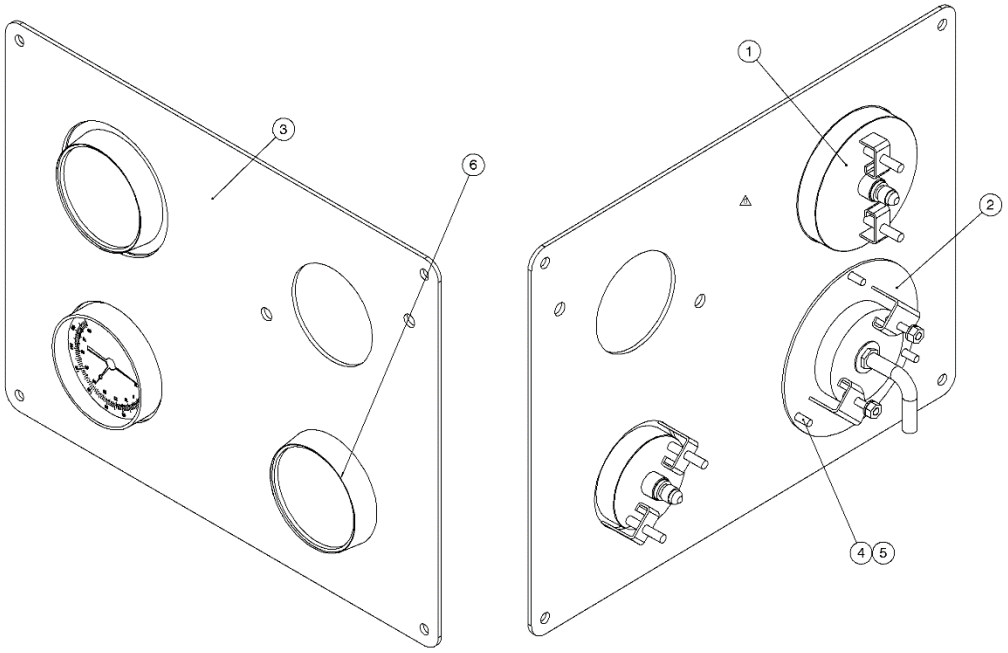


Parts List

Item	Part Number	Description	Qty
1	Z-5635-01	ASSY, FLOW SIGHT (MB)	1
2	N-2710-S-B	ELBOW, BULKHEAD	2
3	G-1250-1100W	FLATWASHER. 5/8 WIDE	2

9.7.3 Hydraulic Panel

Annual calibration of instrumentation is recommended. See Section ***12.0 – Calibration of Instrumentation*** for details of calibration. (System 1 pictured)

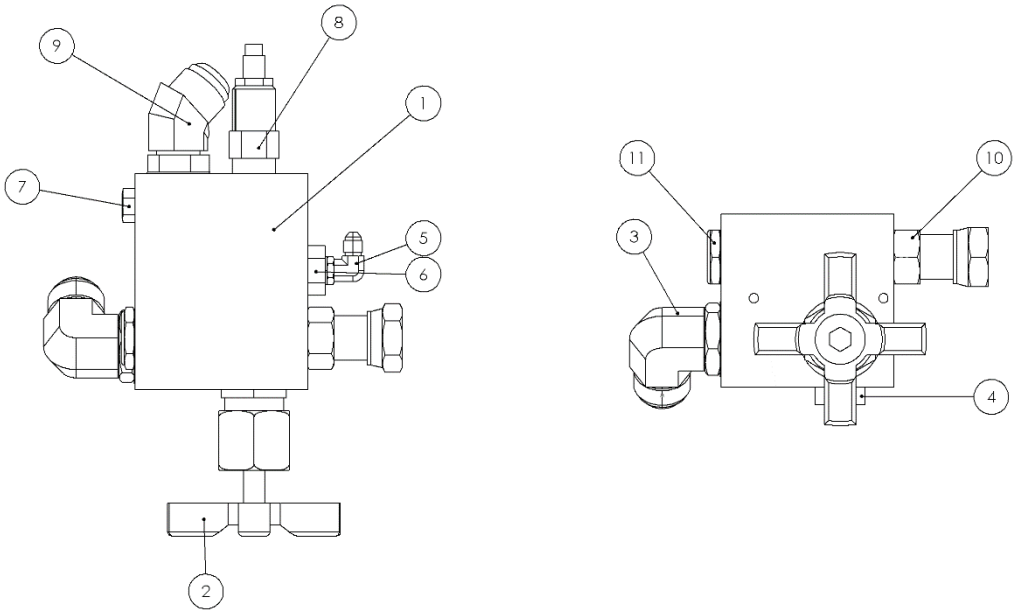


Parts List

Item	Part Number	Description	Qty
1	HC-2143	GAUGE, PRESSURE, 0-6000 PSI	1
2	HC-2268-01	GAUGE, PYROMETER	1
3	S-2898-01	PANEL, HYDRAULIC	1
4	G-1250-1030N	FLATWASHER #10 NARROW	3
5	G-1202-1035	STOPNUT, ELASTIC	3
System 1			
6	HC-2702	GAUGE, PRESSURE. 0-100 PSI	1
System 2			
6	H-2432-15	Plug	1

9.7.4 Pressure Manifold Assembly

The Pressure Manifold components do not require regular general maintenance. (System 1 pictured)



System 1 - Parts List

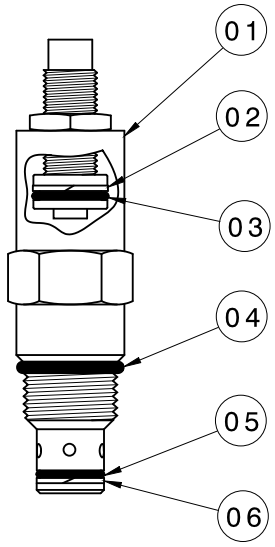
Item	Part Number	Description	Qty
1	J-3245	MANIFOLD, PRESSURE	1
2	HC-1245-05	VALVE, NEEDLE	1
3	N-2001-24-S-**B**	CONNECTOR, STR THD, #16 SAE X #16 JIC	1
4	N-2053-07-S-B	PLUG, O-RING HEX HEAD	1
5	N-2001-03-S-B	CONNECTOR, STRAIGHT THREAD	1
6	N-2463-36-S-B	FITTING, REDUCER-EXPANDER	1
7	N-2053-05-S-B	PLUG, HEX HEAD WITH O-RING	2
8	HC-1442	VALVE, PRESSURE RELIEF	1
9	N-2042-16-S-B	CONNECTOR, 45 ° STR THD	1
10	N-2650-05-S-B	CONNECTOR, ORFS SWIVEL	1
11	HC-2158	VALVE, CHECK	1

System 2 - Parts List

Item	Part Number	Description	Qty
1	J-3245	MANIFOLD, PRESSURE	1
2	HC-1245-05	VALVE, NEEDLE	1
3	N-2053-07-S-B	PLUG, O-RING HEX HEAD	1
4	N-2001-03-S-B	CONNECTOR, STRAIGHT THREAD	1
5	N-2463-36-S-B	FITTING, REDUCER-EXPANDER	1
6	N-2053-05-S-B	PLUG, HEX HEAD WITH O-RING	2
7	HC-1442	VALVE, PRESSURE RELIEF	1
8	N-2650-05-S-B	CONNECTOR, ORFS SWIVEL	1
9	N-2001-21-S-B	ELBOW, STRAIGHT THREAD	1
10	HC-2158	VALVE, CHECK	1
11	N-2042-09-S-B	ELBOW, 45 DEG STR THD	1

9.7.4.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.



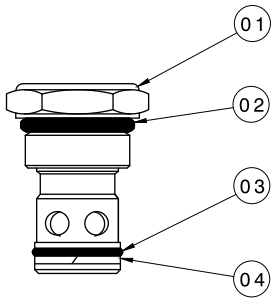
Parts List

Item	Part Number	Description	Qty
♦ 1	HC-1442	Pressure Relief Valve *(Not Set)*	1
2	HC-2020-015	Backup Ring, *(Teflon)*	1
3	HC-2000-015	O-ring, Series 2	1
4	HC-2010-910	O-ring, Series 3	1
5	HC-2000-014	O-ring, Series 2	1
6	HC-2020-014	Backup Ring, *(Teflon)*	1

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

9.7.4.b Check Valve

The Check Valve does not require regular general maintenance.



Parts List

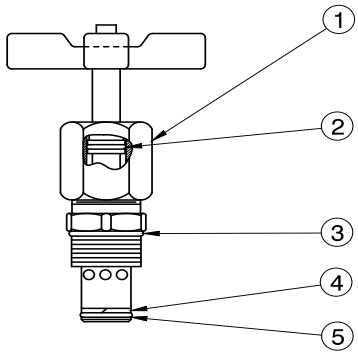
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
♦ 1	HC-2158	Check Valve	1
2	HC-2010-912	O-ring, Series 3	1
3	HC-2000-015	O-ring, Series 2	1
4	HC-2020-015	Backup Ring	1

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

9.7.4.c Bypass Valve

The Bypass Valve does not require regular general maintenance.



Parts List

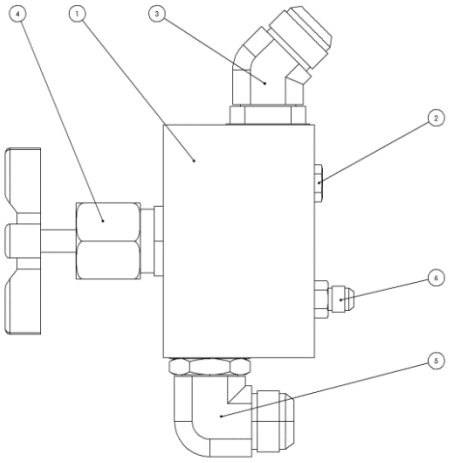
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
♦ 1	HC-1254-05	Needle Valve	1
2	HC-2000-112	O-ring	1
3	HC-2010-916	O-ring	1
4	HC-2020-118	Backup Ring	1
5	HC-2000-118	O-ring	1

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

9.7.5 Flow Control Assembly

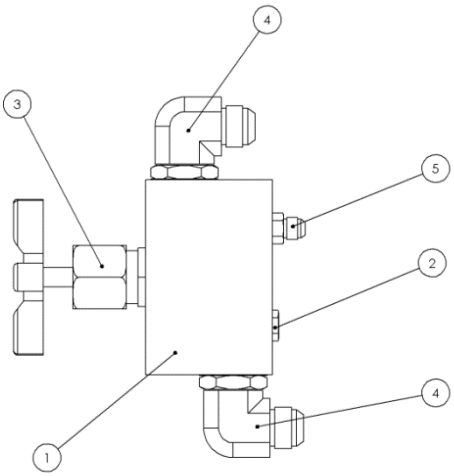
The Flow Control Assembly does not require regular general maintenance.



System 1 - Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	J-5128	MANIFOLD, FLOW CONTROL	1
2	N-2053-05-S-B	PLUG, HEX HEAD WITH O-RING	2
3	N-2042-12-S-B	ELBOW, 45 DEG STR THD	3
4	HC-1254-05	VALVE, NEEDLE	4
5	N-2001-24-S-B	CONNECTOR, STR THD, #16 SAE X #16 JIC	5
6	N-2007-08-S-B	CONNECTOR, STRAIGHT THREAD	6

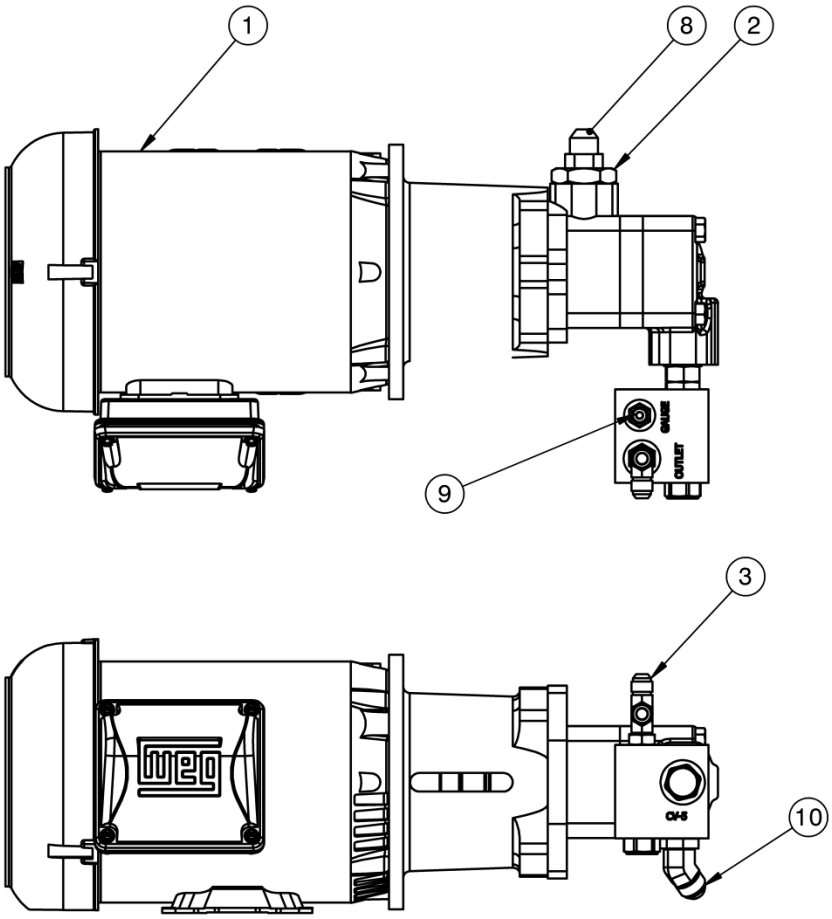


System 2 - Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	J-5128	MANIFOLD, FLOW CONTROL	1
2	N-2053-05-S-B	PLUG, HEX HEAD WITH O-RING	1
3	HC-1254-05	VALVE, NEEDLE	1
4	N-2001-21-S-B	ELBOW, STRAIGHT THREAD	2
5	N-2007-08-S-B	CONNECTOR, STRAIGHT THREAD	1

9.8 ELECTRIC FILL AND DEGASSING PUMP

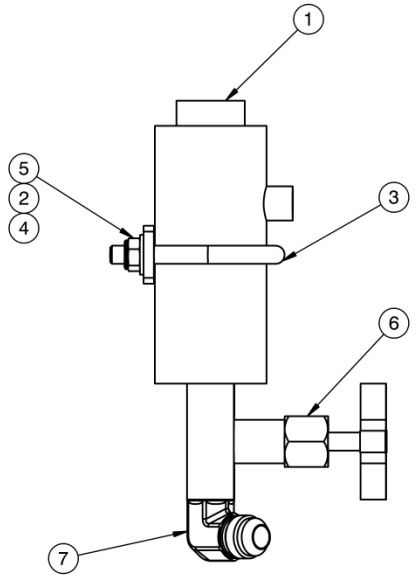


Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2797	PUMP/MOTOR, ELECTRIC FILL	REF
2	N-2463-16-S-B	FITTING, REDUCER/EXPANDER	1
3	N-2015-08-S-B	TEE, RUN, STR THD	1
4	TBD	ASSEMBLY, HOSE	1
5	TBD	ASSEMBLY, HOSE	1
6	TBD	ASSEMBLY, HOSE	1
7	TBD	ASSEMBLY, HOSE	1
8	N-2007-03-S-B	CONNECTOR, STR THD	1
9	N-2001-08-S-B	CONNECTOR, STRAIGHT THREAD	1
10	N-2042-06-S-B	ELBOW, 45º STRAIGHT THREAD	1
N/S	EC-1180-08	TERMINAL, RING TONGUE	13

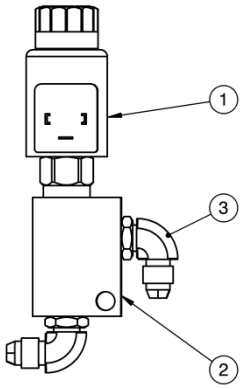
9.8.1 Degasser



Parts List

Item	Part Number	Description	Qty
1	HC-2808	BUBB-LESS, BM-10	1
2	S-3311-00	PLATE, BUBB-LESS MOUNT	1
3	G-1009-18	U-BOLT	1
4	G-1250-1060N	FLATWASHER. 5/16 NARROW	2
5	G-1202-1060	STOPNUT, 5/16-18 ELASTIC	2
6	HC-1081-01	VALVE, NEEDLE	1
7	N-2005-13-S	ELBOW, MALE	1

9.8.2 Degassing System Solenoids

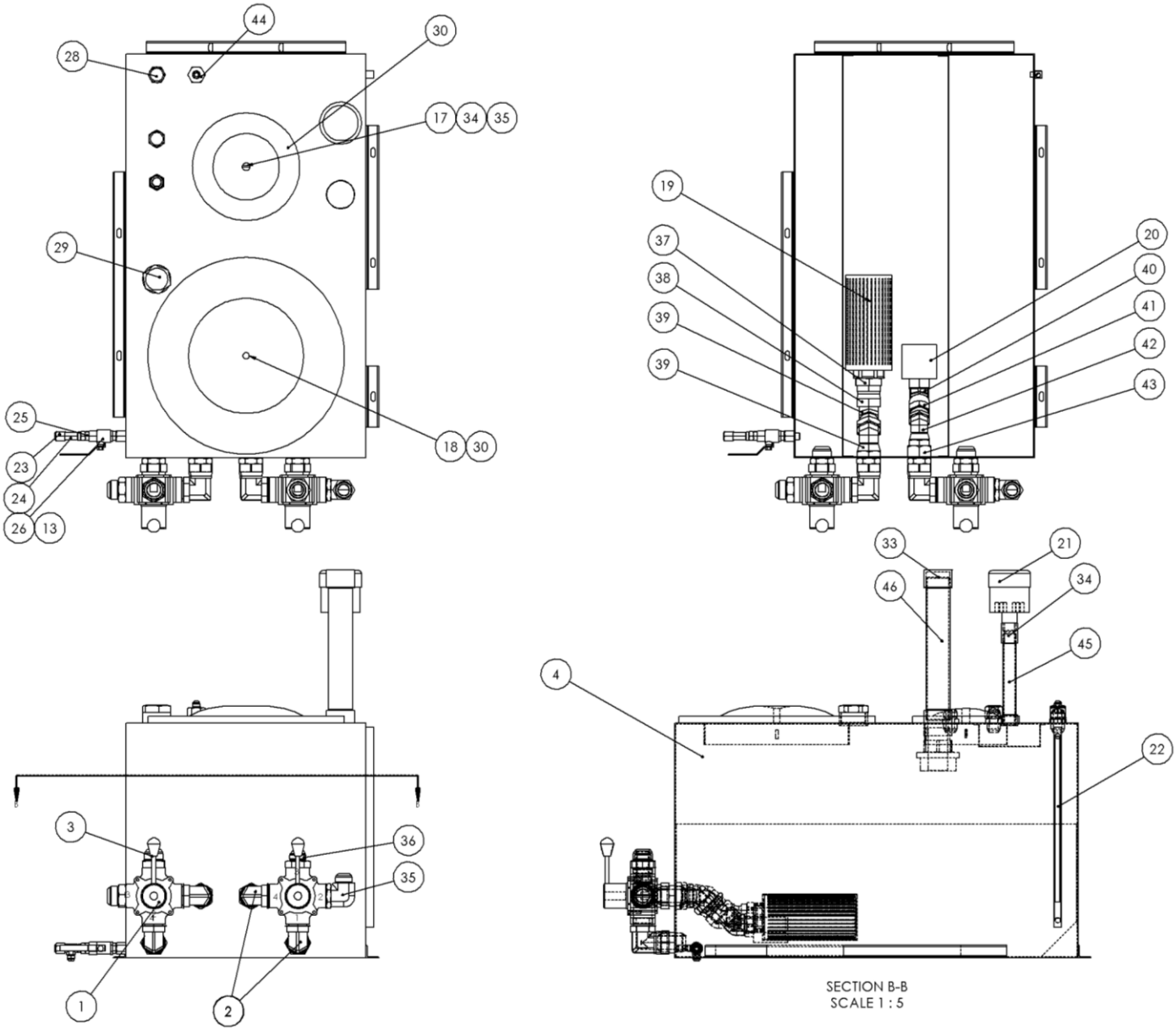


Parts List

Item	Part Number	Description	Qty
1	HC-2807	SOLENOID, N.C. W/ 115VAC COIL	1
2	J-6702	MANIFOLD, T-13A	1
3	N-2001-08-S-B	ELBOW, STRAIGHT THREAD	2

9.9 RESERVOIR ASSEMBLY

Replace the desiccant air filter whenever the material inside the element is pink or reddish in color (See Element label for details). The Reservoir Assembly does not require regular general maintenance. If periodic inspections for silt are desired, be certain to thoroughly clean the dome cover and surrounding area before removing the dome cover. The Selector Valve (Item 19) is not field serviceable.



9.9 RESERVOIR ASSEMBLY *(continued)*

Parts List

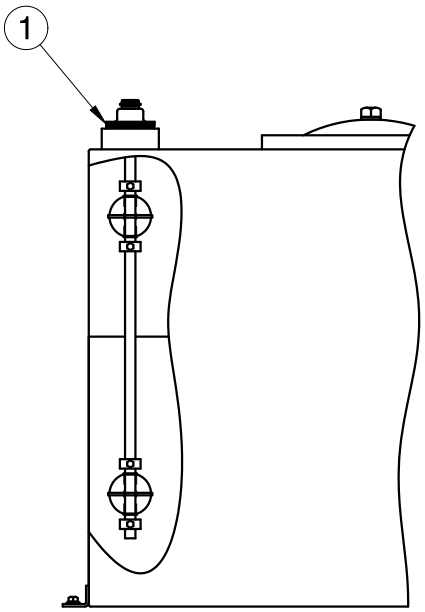
Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	HC-2042-01	VALVE, SELECTOR, #24 SAE	2
2	N-2049-24-S-B	ELBOW, 90°, SWIVEL & O-RING	4
3	N-2007-31-S-B	CONNECTOR, STR THD #24	2
4	H-3867	RESERVOIR, 90 GAL	1
5	HC-1397-05	DIFFUSER	1
6	HC-1397-03	DIFFUSER	1
7	HC-1763	FILTER, DESICCANT	1
8	HC-1383-18	GAUGE, SIGHT, 18"	1
9	N-2008-06-S	CAP	1
10	N-2016-06-S	TEE, RUN, SWIVEL NUT	1
11	N-2007-11-S-B	CONNECTOR, STRAIGHT THREAD	1
12	HC-1761	VALVE, BALL SAE #8, LOCKABLE	1
13	HC-2010-908	O-RING, 3 SERIES	1
14	N-2008-10-S	CAP	2
15	N-2206-09-S	PLUG, HEX HEAD	1
16	H-1741	ASSY, COVER (PLATED)	1
17	Z-2199	WELDMENT, CLAMP	1
18	H-1740	ASSEMBLY, COVER (PE)	1
19	N-2245-06	COUPLING, STAINLESS STEEL PIPE	1
20	N-2965	NIPPLE, PIPE	1
21	N-2964	NIPPLE, PIPE	1
22	N-2001-30-S-B	ELBOW, STRAIGHT THREAD	1
23	N-2007-30-S-B	CONNECTOR, STRAIGHT THREAD	1
24	N-2210-25-S	REDUCER, PIPE THREAD	1
25	N-2081-10-S	SWIVEL, 45° ELBOW	2
26	N-2213-21-S	ELBOW, STREET 45°	1
27	N-2030-12-S	SWIVEL, FEMALE 37°	1
28	N-2081-09-S	SWIVEL, 45° ELBOW	1
29	N-2055-27-S	REDUCER, TUBE	1
30	Z-5337	WELDMENT, CLAMP	1
31	N-2244-09	CAP, PIPE	1
32	N-2055-18-S	REDUCER, TUBE	1
33	N-2030-15-S	SWIVEL, FEMALE 37°	1
34	G-1202-1100	STOPNUT, ELASTIC 5/8-11	2
35	H-1735-02	WASHER, NYLON	2

9.9.1 Electric Reservoir Level

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-2314, INS-2375. Reference 9.7.1 Electrical Panel for Panel Light.



Parts List

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

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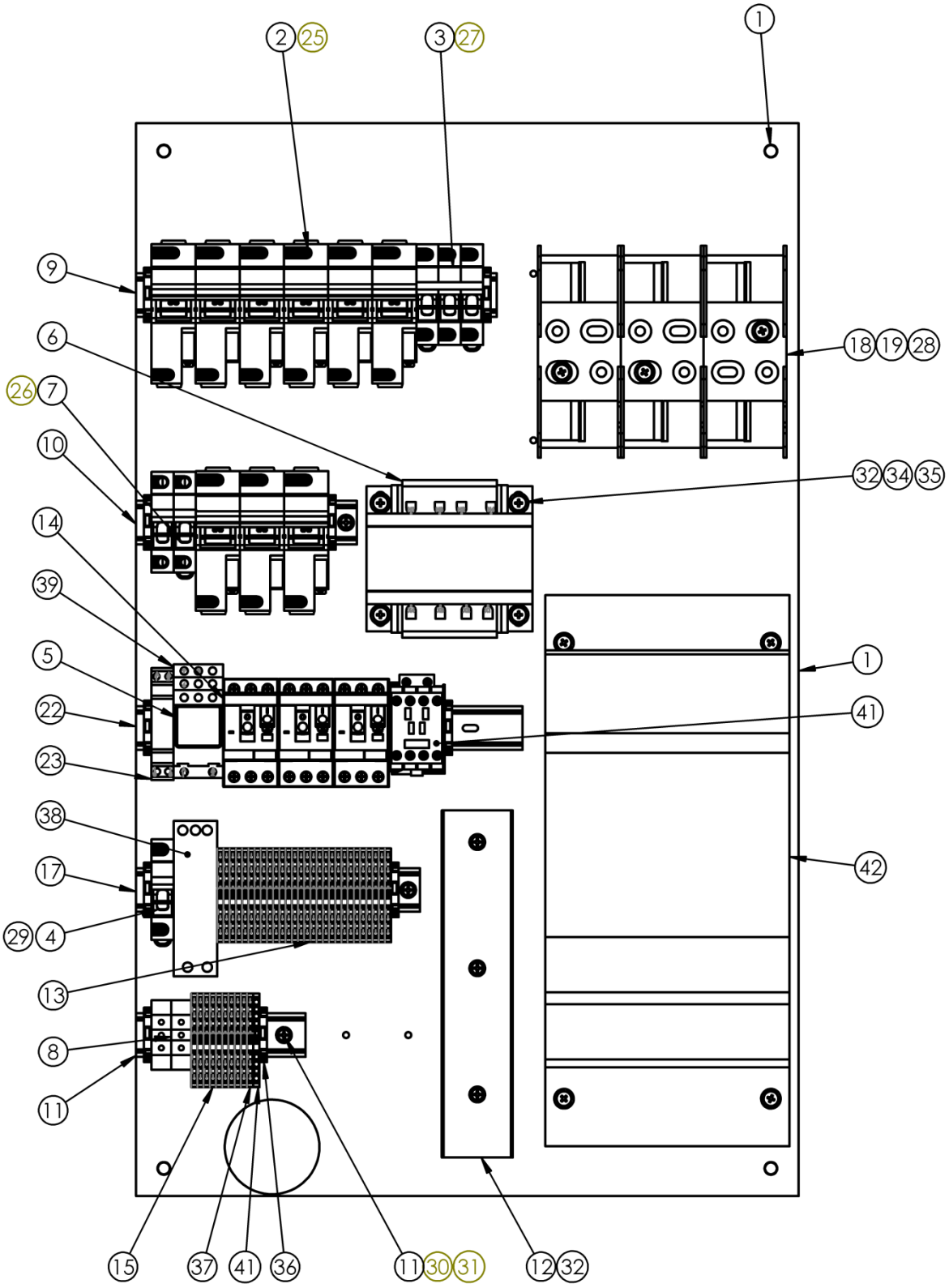
9.10 ELECTRICAL COMPONENTS

9.10.1 Electrical Components with Soft Start Option

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



Set Item 04 to Automatic Reset position. Wire per Electrical Schematic INS-2375.

9.10.1 Electrical Components with Soft Start Option *(continued)*

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	S-2827	PANEL, INNER ELECTRICAL	1
2	EC-2881	FUSEHOLDER, TRIPLE J30	3
3	EC-2882	FUSEHOLDER	1
4	EC-2884	BLOCK, FUSE	1
5	EC-1678	RELAY	1
6	EC-1804-04	TRANSFORMER, 250VA	1
7	EC-2883	FUSEHOLDER	1
8	EC-1957	BLOCK, GROUNDING	2
9	EC-1895-011.43	RAIL, DIN	1
10	EC-1895-007.00	RAIL, DIN	1
11	EC-1895-005.37	RAIL, DIN	1
12	EC-1710-20-11.00	DUCT, WIRING (11IN)	1
13	EC-2084	TERMINAL BLOCK, 4 COND (RED)	28
14	EC-2465	STARTER, MOTOR	3
15	EC-2923	BLOCK, TERMINAL GROUNDING	4
16	EC-2062	TERMINAL BLOCK, 4 COND (BLUE)	5
17	EC-1895-009.00	RAIL, DIN	1
18	EC-2695	FUSEBLOCK, CLASS J 110-TO 200A	1
19	EC-2697	COVER, FINGER SAFE	1
20	EC-1895-012.25	RAIL, DIN	1
21	EC-2690	RELAY, TIME DELAY ON	1
22	EC-1542-14	SECONDARY FUSE	1
23	G-1159-103504	SCREW, #10-32 X 1/2" LG. RD HEAD CROSS RECESS MACHINE	26
24	G-1159-105516	SCR, 1/4-20 RD HD CRS REC	4
25	G-1250-1030N	FLATWASHER, #10	26
26	SEE TABLE	FUSE, CLASS J, FAN/PUMP	9
27	SEE TABLE	FUSE, CLASS J, MAIN	3
28	SEE TABLE	FUSE, CLASS CC, PRIMARY	2
29	G-1250-1050N	FLATWASHER, 1/4 NARROW	11
30	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	4
31	EC-1711-03-011.00	COVER, WIRING DUCT	1
32	13070	ANCHOR, DIN RAIL END	10
33	EC-1675-12	FUSE, KTF, PHASE MONITOR	3
34	EC-2065	TERMINAL BLOCK, 4 COND (BLACK)	1
35	EC-2951	POWER SUPPLY, 12 VDC	1
36	EC-2807	SOCKET, RELAY 11PIN (TPDT)	1
37	EC-2083	TERMINAL BLOCK, 4 COND LT GRAY	1
38	EC-2964	HARNESS, WIRING (NOT SHOWN)	1
39	EC-1564	RELAY, CONTROL	1
40	G-1159-105505	SCR, 1/4-20 RD HD CRS REC	7
41	SEE TABLE	SOFTSTART, 110-240V HPU	1

9.10.1 Electrical Components with Soft Start Option *(continued)*

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				
	380 V	**480 V**	**575V**	**Description**	**Qty**
26	EC-1557-03	EC-1557-03	EC-1557-02	FUSE, CLASS J, FAN/PUMP	9
27	EC-1556-07	EC-1556-07	EC-1556-04	FUSE, CLASS J, MAIN	3
28	EC-1726-14	EC-1726-14	EC-1726-08	FUSE, CLASS CC, PRIMARY	2
42	EC-1974	EC-1974	EC-2022	SOFTSTART, 110-240V HPU	1

Item	50 Hz Applications				
	380 V	**415 V**	**440**	**Description**	**Qty**
26	EC-1557-03	EC-1557-03	EC-1557-03	FUSE, CLASS J, FAN/PUMP	9
27	EC-1556-07	EC-1556-07	EC-1556-07	FUSE, CLASS J, MAIN	3
28	EC-1726-14	EC-1726-14	EC-1726-14	FUSE, CLASS CC, PRIMARY	2
42	EC-1974	EC-1974	EC-1974	SOFTSTART, 110-240V HPU	1

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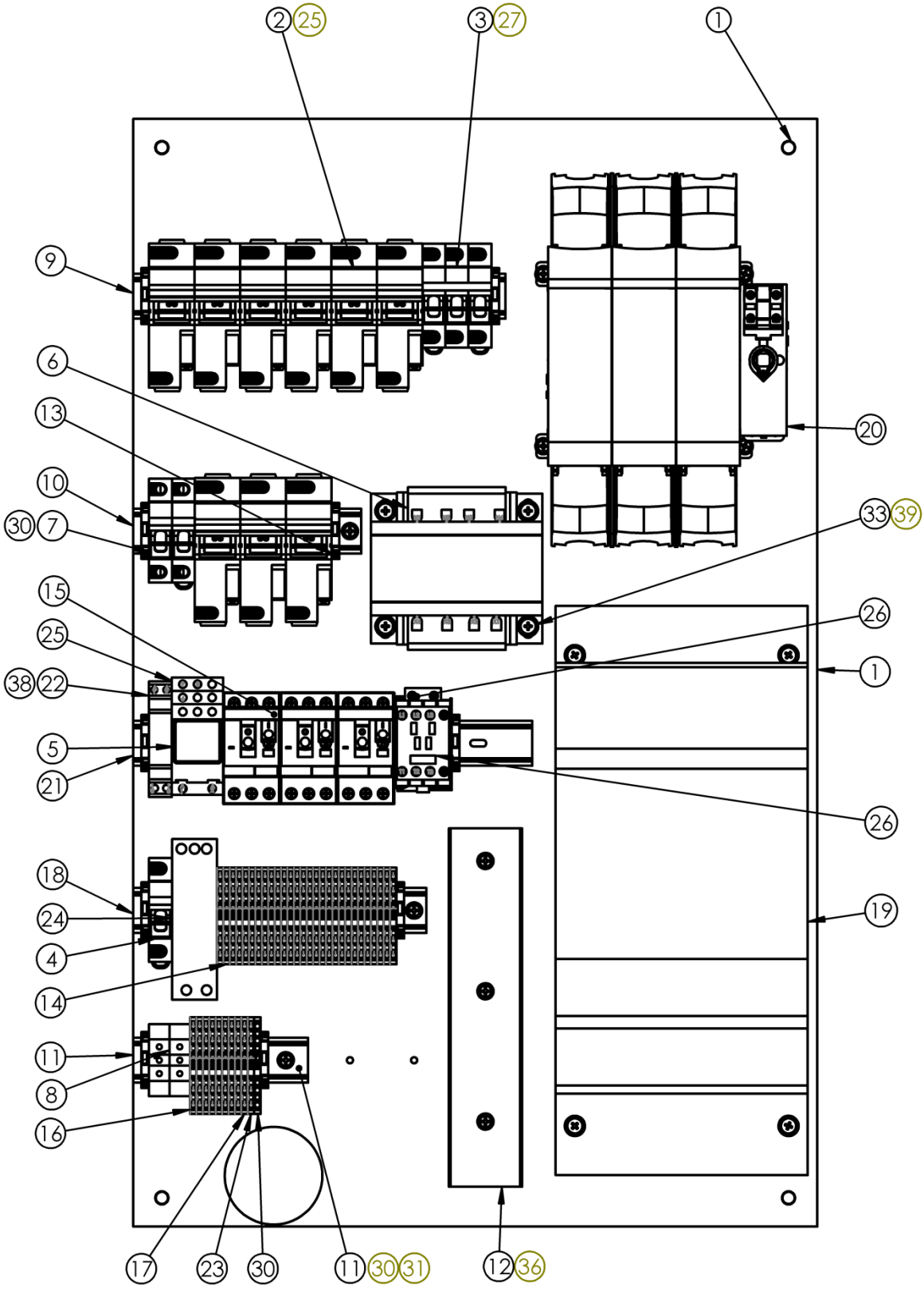
9.10.2 Electrical Components with Softstart and 100 ft Input Cord option



9.10.2 Electrical Components with Softstart and 100 ft Input Cord Option *(continued)*

Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	S-2827	PANEL, INNER ELECTRICAL	1
2	EC-2881	FUSEHOLDER, TRIPLE J30	3
3	EC-2882	FUSEHOLDER	1
4	EC-2884	BLOCK, FUSE	1
5	EC-1678	RELAY	1
6	EC-1804-04	TRANSFORMER, 250VA	1
7	EC-2883	FUSEHOLDER	1
8	EC-1957	BLOCK, GROUNDING	2
9	EC-1895-011.43	RAIL, DIN	1
10	EC-1895-007.00	RAIL, DIN	1
11	EC-1895-005.37	RAIL, DIN	1
12	EC-1710-20-011.00	DUCT, WIRING (11IN)	1
13	13070	ANCHOR, DIN RAIL END	10
14	EC-2084	TERMINAL BLOCK, 4 COND (RED)	28
15	EC-2465	STARTER, MOTOR	3
16	EC-2923	BLOCK, TERMINAL GROUNDING	4
17	EC-2062	TERMINAL BLOCK, 4 COND (BLUE)	5
18	EC-1895-009.00	RAIL, DIN	1
19	SEE TABLE	CONTROLLER, SOFTSTART MOTOR	1
20	SEE TABLE	DISCONNECT, FUSED 100A	1
21	EC-1895-012.25	RAIL, DIN	1
22	EC-2690	RELAY, TIME DELAY ON	1
23	EC-2065	TERMINAL BLOCK, 4 COND (BLACK)	1
24	EC-2951	POWER SUPPLY, 12 VDC	1
25	EC-2807	SOCKET, RELAY 11PIN (TPDT)	1
26	EC-1836	CONTACTOR, IEC MOTOR	1
27	SEE TABLE	FUSE, CLASS J, FAN/PUMP	9
28	SEE TABLE	FUSE, CLASS J, MAIN	3
29	SEE TABLE	FUSE, CLASS CC, PRIMARY	2
30	EC-2083	TERMINAL BLOCK, 4 COND LT GRAY	1
31	G-1159-103504	SCREW, #10-32 X 1/2" LG. RD HEAD CROSS RECESS MACHINE	30
32	G-1250-1030N	FLATWASHER, #10	30
33	G-1159-105505	SCR, 1/4-20 RD HD CRS REC	4
34	G-1159-105516	SCR, 1/4-20 RD HD CRS REC	4
35	EC-2964	HARNESS, WIRING (NOT SHOWN)	1
36	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	4
37	EC-1711-03-011.00	COVER, WIRING DUCT	1
38	EC-1542-14	FUSE, SECONDARY	1
39	G-1250-1050N	FLATWASHER, 1/4 NARROW	8

9.10.2 Electrical Components with Softstart and 100 ft Input Cord Option *(continued)*

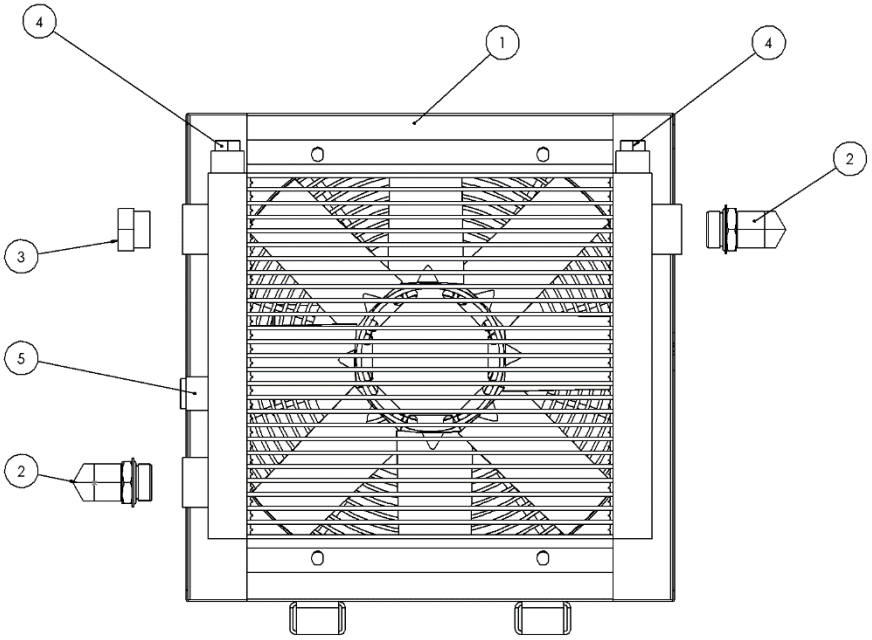
THE FOLLOWING PARTS ARE APPLICATION SPECIFIC
Be sure to locate the correct voltage and hertz of the unit before selecting the part

Item	60 Hz Applications				
	380 V	**480 V**	**575V**	**Description**	**Qty**
19	EC-1974	EC-1974	EC-2022	SOFTSTART, 110-240V HPU	1
20	EC-2670	EC-2670	EC-2653	DISCONNECT, FUSED 100A	1
28	EC-1557-03	EC-1557-03	EC-2942	FUSE, CLASS J, FAN/PUMP	9
29	EC-1556-07	EC-1556-07	EC-1556-04	FUSE, CLASS J, MAIN	3
30	EC-1726-14	EC-1726-14	EC-1726-08	FUSE, CLASS CC, PRIMARY	2

Item	50 Hz Applications				
	380 V	**415 V**	**440**	**Description**	**Qty**
19	EC-1974	EC-1974	EC-1974	SOFTSTART, 110-240V HPU	1
20	EC-2670	EC-2670	EC-2670	DISCONNECT, FUSED 100A	1
28	EC-1557-03	EC-1557-03	EC-1557-03	FUSE, CLASS J, FAN/PUMP	9
29	EC-1556-07	EC-1556-07	EC-1556-07	FUSE, CLASS J, MAIN	3
30	EC-1726-14	EC-1726-14	EC-1726-14	FUSE, CLASS CC, PRIMARY	2

9.11 HEAT EXCHANGER ASSEMBLY

The Heat Exchanger Assembly does not require regular general maintenance.



Parts List

Fluid Type: Aviation Phosphate Ester, Type IV

Item	Part Number	Description	Qty
1	*Reference table below*	EXCHANGER, HEAT	1
2	N-2001-24-S-B	CONNECTOR, STR THD, #16 SAE X #16 JIC	2
3	N-2053-10-S-B	PLUG, H H, #16 O-RING	1
4	HC-2010-908	O-RING SERIES 3	2
5	HC-2010-910	O-RING SERIES 3	1

Lower

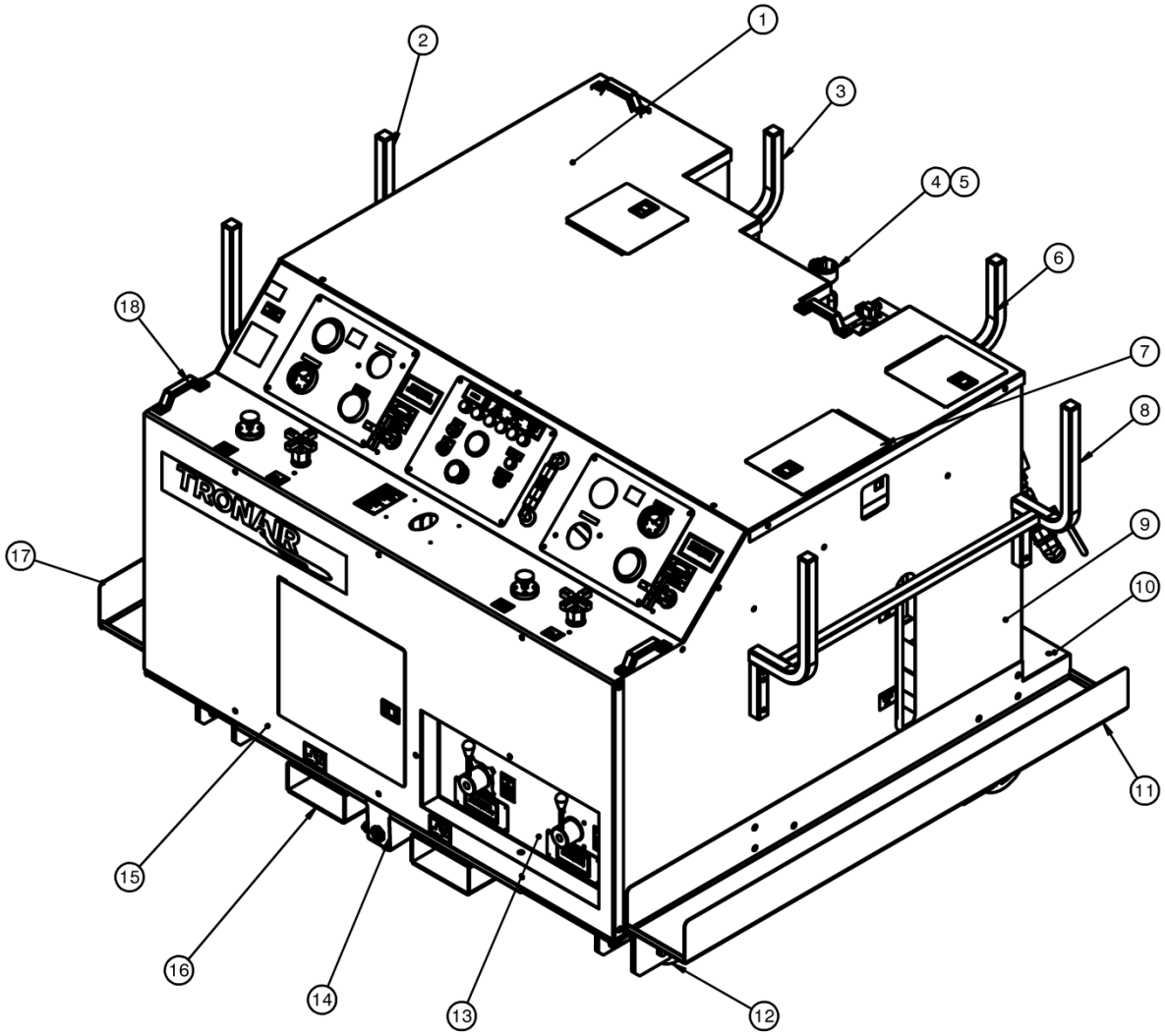
Voltage	Part Number
460 V	HC-2693
575 V/60 Hz	HC-2708

Upper

Voltage	Part Number
460 V	HC-2735
575 V/60 Hz	HC-2737

9.12 EXTERNAL COMPONENTS

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



Parts List

Item	Part Number	Description	Qty
1	Z-8957-01	TOP PANEL	1
2	Z-8847-01	HOSE HANGER	1
3	Z-8860-01	ELECTRICAL CORD HANGER	1
4	EC-1794	BOX, VERTICAL MOUNT JUNCTION	1
5	EC-1791	LIGHT, POLE MOUNTED STACK	1
6	Z-8894-01	ELECTRICAL CORD HANGER	1
7	Z-4783	RESERVOIR FILL ACCESS PANEL	1
8	Z-8846-01	HOSE HANGER	1
9	Z-8864-01	RIGHT SIDE PANEL	1
10	S-2834-01	REAR PANEL	1
11	J-6051	RIGHT SIDE HOSE PAN	1
12	U-1177	SWIVEL CASTER W/ 90° LOCKING	4
13	S-2837	SELECTOR VALVE PANEL	1

9.12 EXTERNAL COMPONENTS *(continued)*

Parts List

Item	Part Number	Description	Qty
14	S-2847	DRIP PAN	1
15	Z-8863	FRONT PANEL	1
16	Z-8868-01	FORKLIFT TUBE	2
17	J-6052	LEFT SIDE HOSE PAN	1
18	H-1780	HANDLE	4
N/S	Z-8942-01	FILTER PANEL	1
N/S	Z-8865-01	LEFT SIDE PANEL	1
N/S	S-2836	SKIRT PANEL	1
N/S	EC-2879	ELECTRICAL BOX COVER	1
N/S	Z-8820-01	FRAME	1

9.13 REPLACEMENT LABELS PARTS LISTS

9.13.1 Base Unit

Part Number	Description	Qty
V-1001	LABEL, MADE IN USA	1
V-1033	LABEL, TRONAIR	1
V-1050	LABEL, ISO ELECTRICAL SHOCK	1
V-1340	LABEL, TRONAIR	2
V-1366	LABEL, BYPASS INSTRUCTION	2
V-1826	LABEL, NO STEP	2
V-1845	LABEL, SERIAL NO. (CE)	1
V-1884	LABEL, FLOWMETER	2
V-1886	LABEL, PYROMETER	2
V-1893	LABEL, SAMPLE VALVE	1
V-1896	LEBEL, MAXIMIM OIL LEVEL	1
V-1897	LABEL, MINIMUM OIL LEVEL	1
V-1919	LABEL, OPER. INST.	1
V-1900	LABEL, WARNING KEEP 5' FT CLEAR	2
V-1914	LEBEL, HPU RES. SELECTOR	2
V-2004	LABEL, SYSTEM 1 PRESSURE	1
V-2005	LABEL, SYSTEM 2 PRESSURE	1
V-2006	LABEL, SYSTEM 1 RETURN	1
V-2007	LABEL, SYSTEM 2 RETURN	1
V-2008	LABEL, FLOW INCREASE	2
V-2009	LABEL, PRESSURE INCREASE	2
V-2075	LABEL, FORKLIFT POINT	2
V-2293	LABEL, CIRCUIT CAPABLE	1
V-2294	LABEL, DANGER	1
V-2639	LABEL, SYSTEM 1 34GPM	3
V-2640	LABEL, SYSTEM 2, 20 GPM	3

9.13.2 Fluid Labels

Fluid Type: MIL-PRF-5606

Part Number	Description	Qty
V-1975	LABEL, MIL-PRF-5606	2

9.13.3 Filter Element Kit Labels

Fluid Type: MIL-PRF-5606

Part Number	Description	Qty
V-2717	LABEL, REPLACEMENT FILTER ELEMENT K-5244	1
V-1961	LABEL, REPLACEMENT FILTER ELEMENT K-3615	1
V-1916	LABEL, REPLACEMENT DESICCANT FILTER ELEMENT HC-1763	1
V-1905	LABEL,REPLACEMENT FILTER ELEMENT K-3493	1
V-2718	LABEL,REPLACEMENT FILTER ELEMENT K-5243	1

10.0 PROVISION OF SPARES

10.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

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

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

For Spare Parts, Operations & Service Manuals or Service Needs:
Scan the QR code or visit Tronair.com/aftermarket

10.2 RECOMMENDED SPARE PARTS LISTS

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

10.2.1 Spare Electrical Parts

Part Number	Description	Qty
Refer to Section 9.9 Electrical Components Item 20	Fuse, Transformer Primary	2
EC-1542-09	Fuse, Transformer Secondary	1
Refer to Section 9.9 Electrical Components Item 22	Fuse, Heat Exchanger	3
EC-1675-12	Fuse, Phase Monitor	3
Refer to Section 9.9 Electrical Components Item 2	Fuse, Main Power	3
	Fuse, Fill Pump Motor	3

10.2.2 Spare Parts

Fluid Type: MIL-PRF-5606

Part Number	Description	Qty
HC-1763	Desiccant Filter Element	1
K-5244	Kit, Pressure Filter Element	1
K-5243	Kit, Pressure Filter Element	1
K-3615	Kit, Return Filter Element	1
K-3493	Kit, Return Filter Element	1
936698Q	Kit, Fill Pump Filter Element	1

11.0 CALIBRATION OF INSTRUMENTATION

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

11.1 SOURCE OF CALIBRATION

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

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

11.2 ANALOG PRESSURE GAUGE – System Pressure

11.2.1 Self Calibration

An accurate pressure calibration gauge is required for calibration of the System Pressure gauge.

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

SYSTEM PRESSURE GAUGE (HC-2144) Systems 1 & 2

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

11.3 ANALOG TEMPERATURE GAUGE *(Pyrometer)*

11.3.1 Self Calibration

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

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

THE TEMPERATURE VALUE MUST BE:

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

11.4 ELECTRIC FILL PUMP PRESSURE GAUGE

11.4.1 Self Calibration

Applied Pressure (Electric Fill Pressure Gauge) (psig)	Minimum Acceptable (psig)	Maximum Acceptable (psig)	Increasing/Decreasing
25	24	26	Increasing
50	49	51	Increasing
75	73	77	Increasing
100	97	103	Increasing
75	73	77	Decreasing
50	49	51	Decreasing
25	24	26	Decreasing

12.0 IN SERVICE SUPPORT

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

13.0 GUARANTEES/LIMITATION OF LIABILITY

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

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

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

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

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

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

14.0 APPENDICES

APPENDIX I	Declaration of Conformity
APPENDIX II	Hydraulic Schematic (INS-2315)
APPENDIX III	Electrical Schematic (INS-2431)
APPENDIX IV	Wiring Diagram (INS-2694)
APPENDIX V	Lincoln Motor Manual
APPENDIX VI	Oilgear Pump Manual PVG
APPENDIX VII	Safety Data Sheet (SDS) pertaining to Hydraulic Fluid MIL-PRF-5606
APPENDIX VIII	Instrument Certification Notice

APPENDIX I

Declaration of Conformity

Declaration of Conformity

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

Dual Hydraulic Power Unit
(Electric Motor Driven)

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

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

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

Patrick Finch

Quality Assurance Representative

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

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

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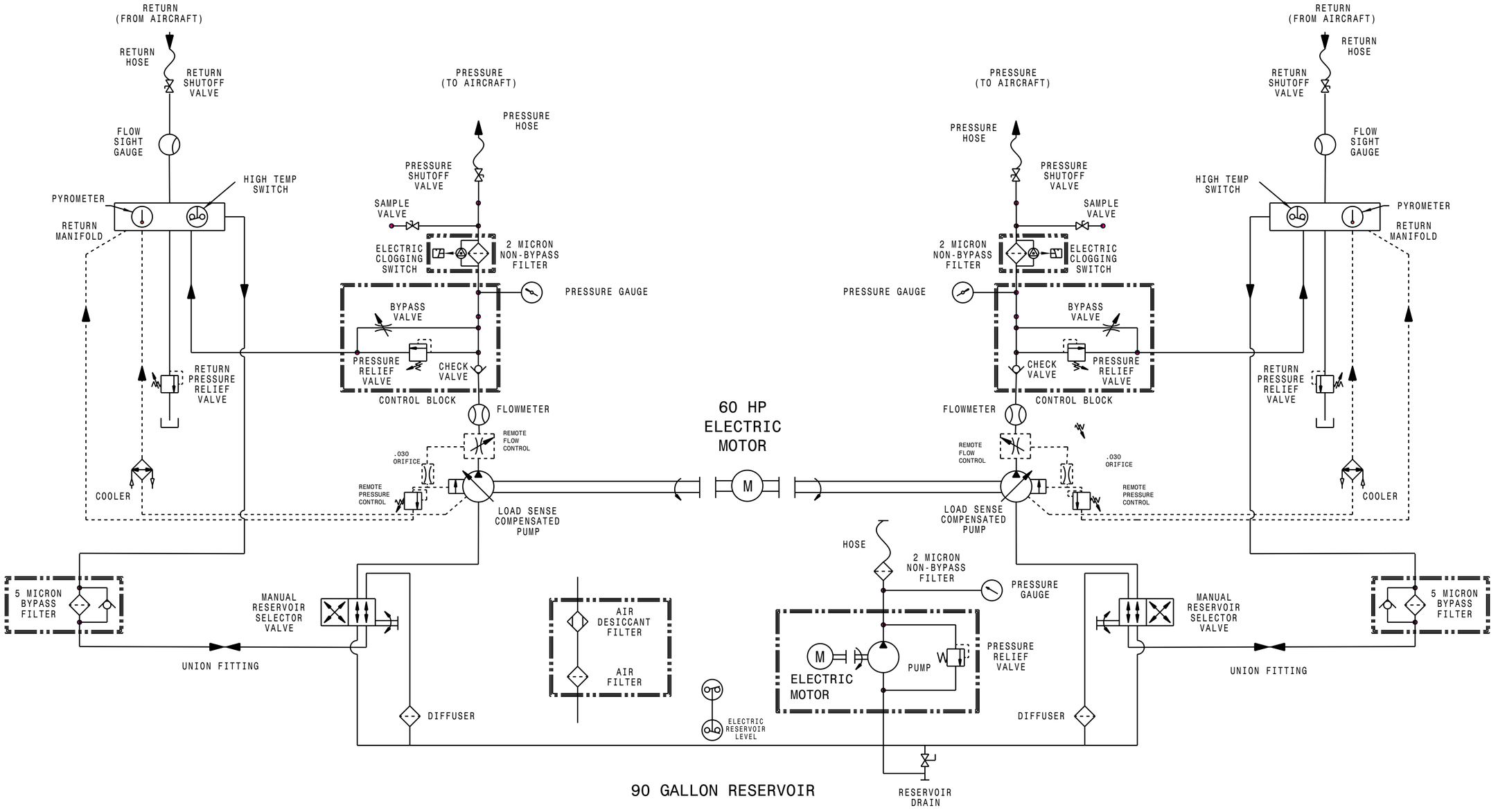
APPENDIX II

Hydraulic Schematic
(INS-2315)

LET	REVISION	EC	DWN	CHK	DATE
A	ORIGINAL RELEASE	19932	-	-	12/5/16



MAKE FROM: N/A		BREAK ALL SHARP EDGES AND CORNERS () INDICATES REFERENCE DIMENSIONS ITEM NUMBER ABOVE, QUANTITY BELOW	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT
MATERIAL: N/A	TYPE:	TOLERANCES UNLESS OTHERWISE SPECIFIED DECIMAL INCH[mm]: .X[X] ± .100[3] .XX[.X] ± .030[0.8] .XXX[.XX] ± .010[0.25] .XXXX[.XXX] ± .003[0.076] FRACTION INCH[mm]: 1/XX[1/X] ± 1/16[1.6] ANGLES DEGREE[RADIANS] X[XX] ± .5[0.01]	DWN BY KAG · CKD BY PEH · 12/5/16
FINISH: N/A			SCHEMATIC, HYDRAULIC
THIRD ANGLE PROJECTION	SIZE C		05 INS-2315 REV A
SCALE: XX	DO NOT SCALE DRAWING		

APPENDIX III

Electrical Schematic
(INS-2431)

LET	REVISION	EC	DWN	CHK	DATE
A	ORIGINAL RELEASE	20634			12-11-17
B	DIAGRAM CHANGE	20902	ADO	PEH	07-25-18
C	REMOTE PENDANT ADDED	21056	ADO	PEH	01-24-19
D	ADDED CONT. MONITOR	23066	NCS	XXX	10-18-21

MADE FROM:		BREAK ALL SHARP EDGES AND CORNERS ( ) INDICATES REFERENCE DIMENSIONS ITEM NUMBER ABOVE, QUANTITY BELOW TOLERANCES UNLESS OTHERWISE SPECIFIED DECIMAL INCH[mm]: .X[X] ± .100[3] .XX[.X] ± .030[0.8] .XXX[.XX] ± .010[0.25] .XXXX[.XXX] ± .003[0.076] FRACTION INCH[mm]: 1/XX[1/X] ± 1/16[1.6] ANGLES DEGREE[RADIANS] X[XX] ± .5[0.01]	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT
MATERIAL:	TYPE:		DWN BY EMB · CKD BY CDG · 12-11-17
FINISH: MILL			SCHEMATIC, ELECTRICAL
THIRD ANGLE PROJECTION	SIZE D		05 · INS-2431 · REV D
SCALE: NA	DO NOT SCALE DRAWING		

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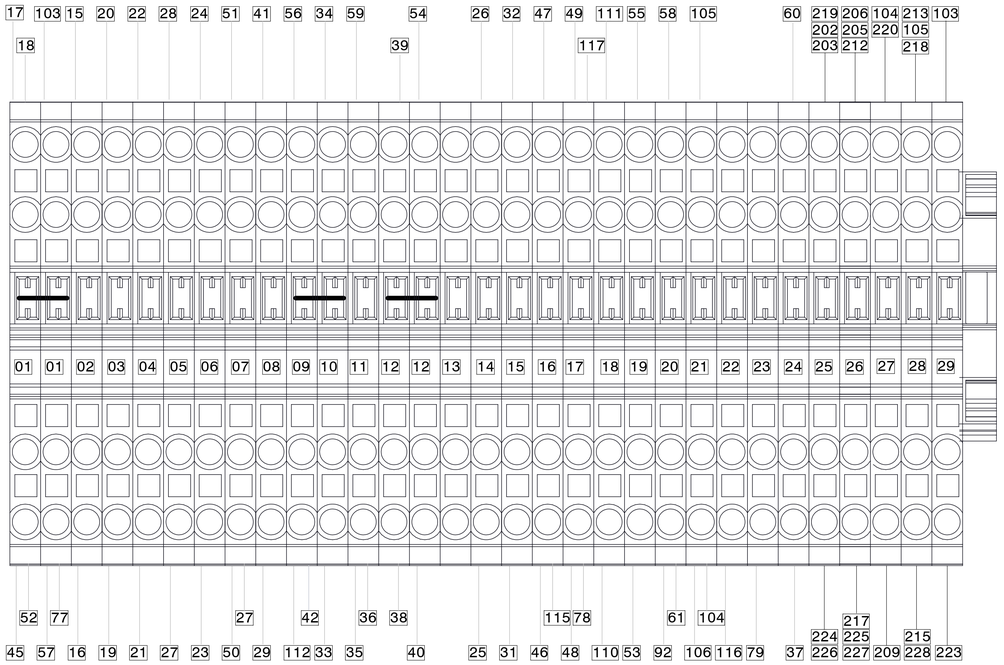
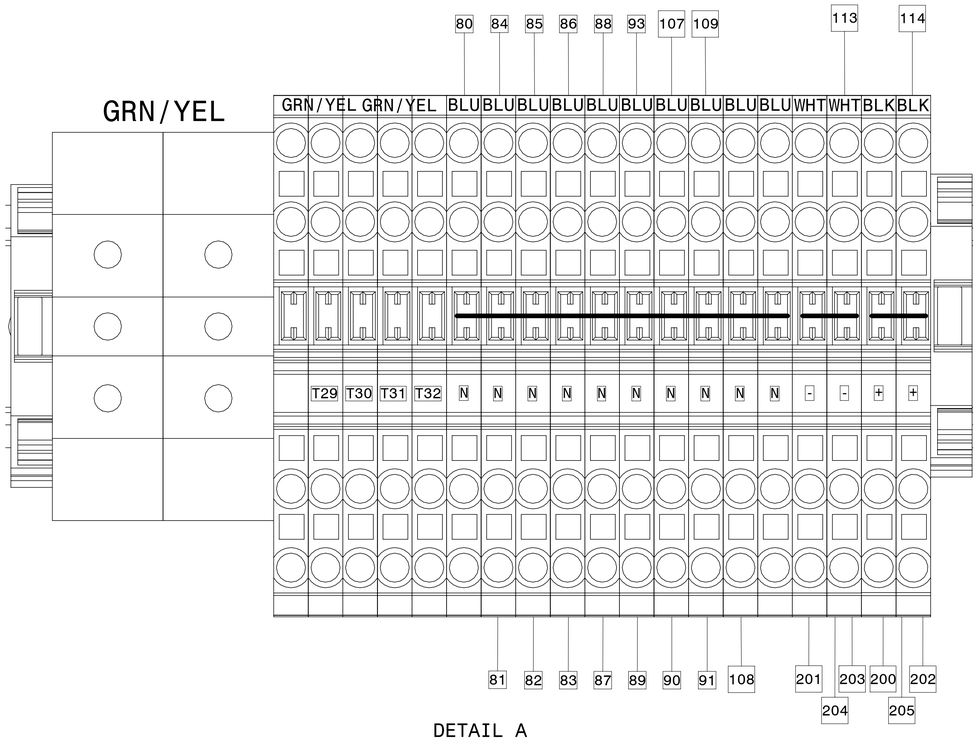
APPENDIX IV

Wiring Diagram
(INS-2694)

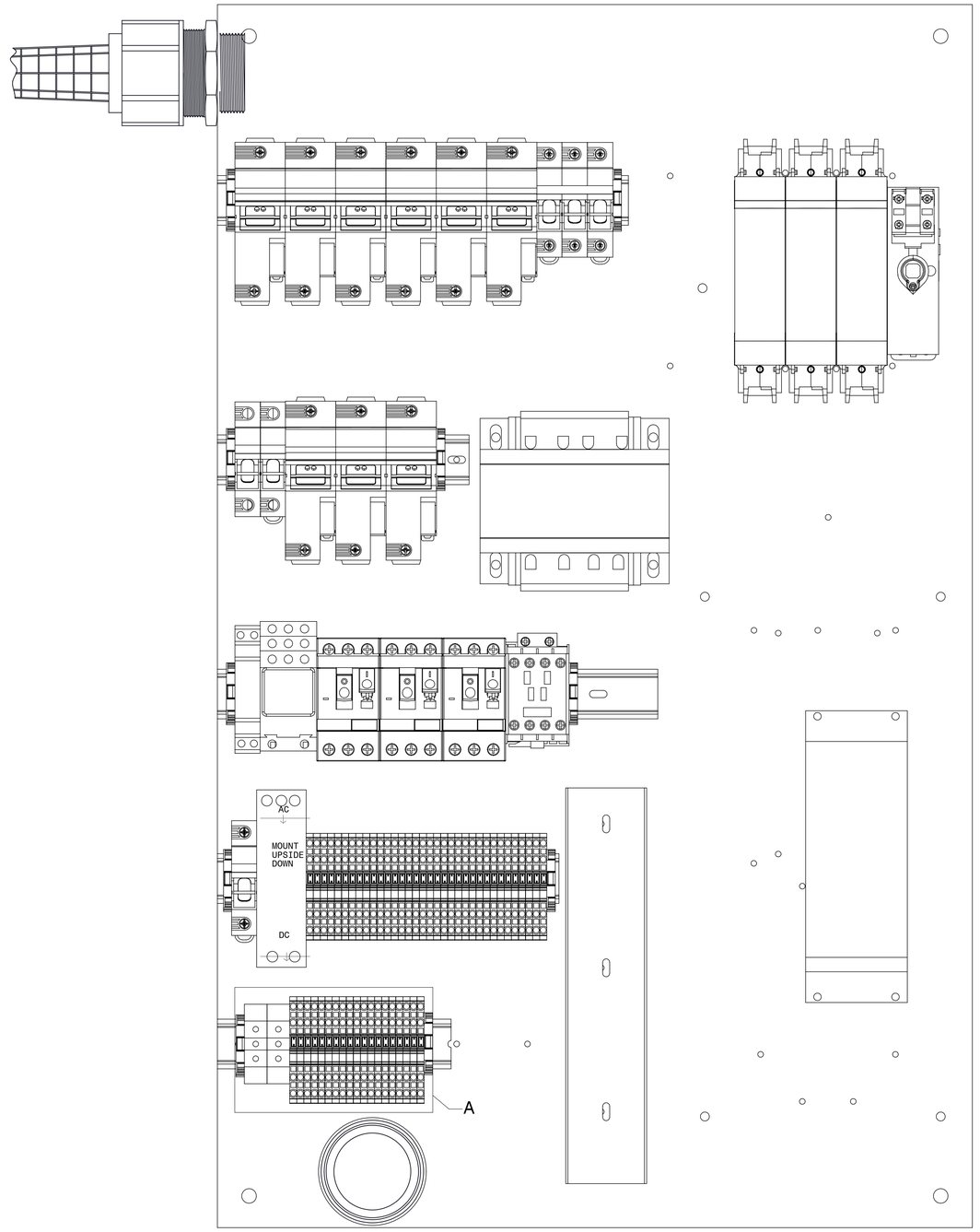
RED TERMINALS

REVISIONS					
LET	REVISION	EC	BY	CHK	DATE
A	ORIGINAL RELEASE	23066	-	-	12-29-21



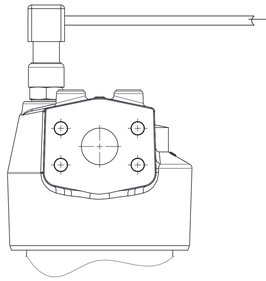


DETAIL A
SCALE 3 : 1



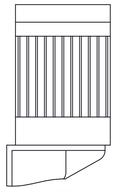
ELECTRICAL OPTIONS 15-18, & 23-26, SOFT START ONLY

MADE FROM: SEE BOM	BREAK ALL SHARP EDGES AND CORNERS INTERPRET PER ASME Y14.5-2009	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT	
MATERIAL: N/A	DIMENSIONS IN INCHES AND TOLERANCES PER BELOW UNLESS OTHERWISE SPECIFIED: **DIMENSION INCH [mm]:** .X [X] ± .1 [3] .XX [.X] ± .03 [0.8] .XXX [.XX] ± .010 [0.25] .XXXX [.XXX] ± .0030 [0.076] **FRACTION INCH [mm]:** 1/XX [1/X] ± 1/16 [1.2] **ANGULAR DEGREE [RADIANS]:** X [XXX] ± .5 [.001]	DWN BY: PEH CKD BY: XXX DATE: 12-29-21	
FINISH: MILL		ASSEMBLY, ELECTRICAL	
THIRD ANGLE PROJECTION — SCALE: 1:4 — SIZE: E		05 INS-2694 REV: A	
DO NOT SCALE DRAWING		WEIGHT: 56.78 LB	SHEET 1 OF 2



PRESSURE CLOGGING
(FROM PRESSURE FILTER SYSTEM 2)

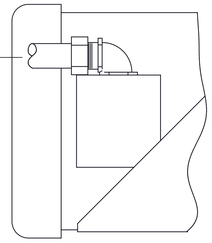
(BLK) 47
(RED) 48
(WHT) 79
(GRN) GND



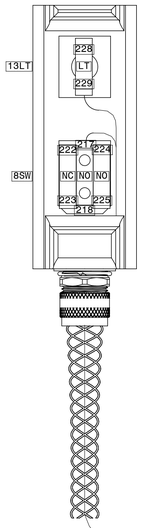
GND
NEU
HOT
89
54

VERTICAL MOUNT STACK LIGHT

(BLK) 68
(BLK) 69
(BLK) 70
(GRN/YEL) GND



HEAT EXCHANGER MOTOR BOX
(SYSTEM 2)



MULT-CABLE	COLORS
228	WHT/B
229	WHT
222	RED/B
223	RED
217	ORG
218	ORG/B
224	BLU
225	BLK

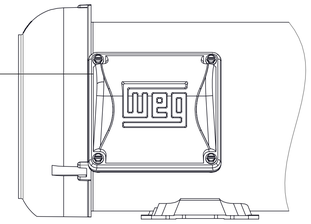
PENDANT
(LOOKING FROM OPEN BACK)

+(RED) +(BLK) 200
-(BLK) -(WHT) 201
+(RED) +(BLK) 202
-(BLK) -(WHT) 203

SIGHTGAUGE BACKLIGHT

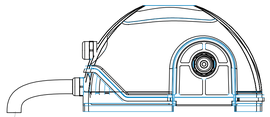
XXX
XXX
XXX
XXX

(BLK) 100
(BLK) 101
(BLK) 102
(GRN/YEL) GND



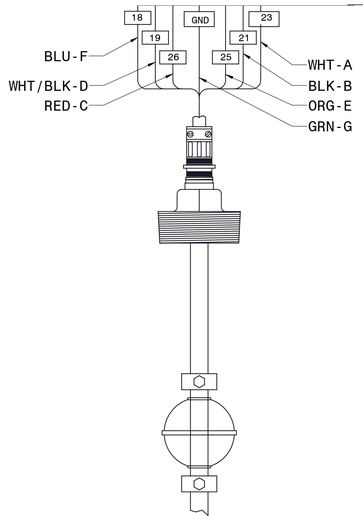
FILL PUMP MOTOR BOX

+(RED) 205
-(BLU) 204



OPTION, ICOUNT

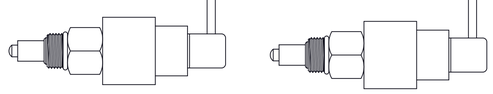
plug



MULTI-LEVEL SWITCH
(FROM RESERVOIR)

YEL/GRN GND
WHT 29
BLK 24
RED 50

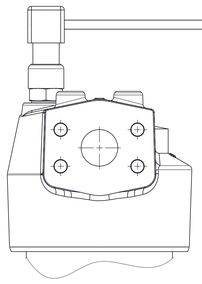
YEL/GRN GND
WHT 42
BLK 41
RED 51



TEMPERATURE SWITCH
(FROM RETURN MANIFOLD 1)

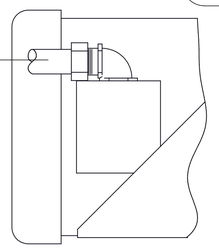
TEMPERATURE SWITCH
(FROM RETURN MANIFOLD 2)

(BLK) 115
(RED) 78
(WHT) 116
(GRN) GND

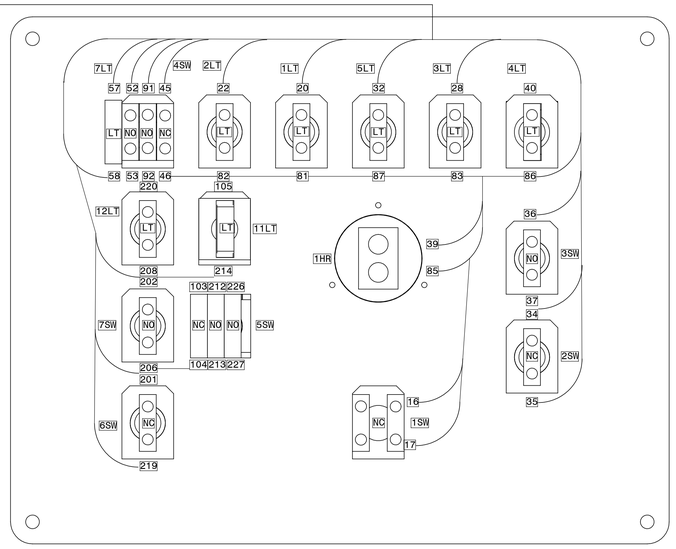


PRESSURE CLOGGING
(FROM PRESSURE FILTER SYSTEM 1)

(BLK) 74
(BLK) 75
(BLK) 76
(GRN/YEL) GND



HEAT EXCHANGER MOTOR BOX
(SYSTEM 1)



ELECTRICAL INSTRUMENT PANEL
(LOOKING FROM REAR OF PANEL)

REF: INS-2431 ELECTRICAL SCHEMATIC (softstart)

TADHPU-5FJ

THIRD ANGLE PROJECTION	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT	
SCALE: 1:4 DO NOT SCALE	ASSEMBLY, ELECTRICAL	
SIZE E	INS-2694	REV A
WEIGHT:	SHEET 2 OF 2	

APPENDIX V

Lincoln Motor Manual

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

1. SAFETY DEPENDS ON YOU

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

2. RECEIVING AND INSPECTION

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

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

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

3. HANDLING

⚠ WARNING

FALLING EQUIPMENT can injure.

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

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

4. STORAGE

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

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

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

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

5. INSTALLATION

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

⚠ WARNING

MOVING PARTS can injure.

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

5.1 INSTALLATION – MECHANICAL

Base

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

Position

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

Drains

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

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

Drive – Power Transmission

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

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

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

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

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

5.2 INSTALLATION – ELECTRICAL

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

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

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

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

Properly ground the motor – See GROUNDING.

Terminal Box

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

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

Motor Connection

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

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

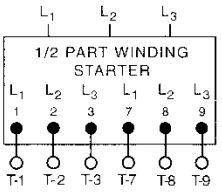
Number of Motor Leads	Number of Rated Voltages	Lead Numbers	YDS	PWS
3	Single	1-3	No	No
6	Single	1-3, 7-9	No	Yes
	Single	1-6	Yes	No
	Dual	1-6	Yes(1)	No
9	Dual	1-9	No	No
12	Single	1-12	Yes	Yes
	Dual	1-12	Yes	No(2)

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

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

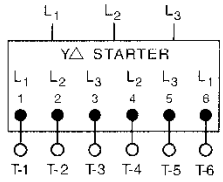
Connection Diagram 1

Single Voltage, 6 Leads
Part Winding Start Connection



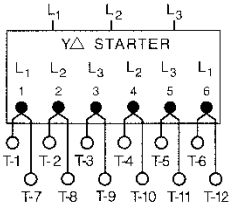
Connection Diagram 2

Single Voltage, 6 Leads
Y△ Start Connection



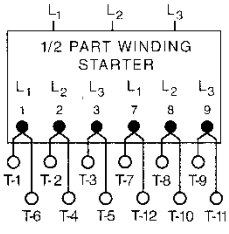
Connection Diagram 3

Single Voltage, 12 Leads
Y△ Start Connection



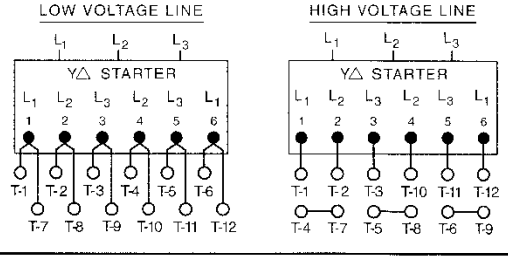
Connection Diagram 4

Single Voltage, 12 Leads
Part Winding Start Connection



Connection Diagram 5

Dual Voltage, 12 Leads
Y△ Start Connection



Space Heater (option)

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

Thermostat (option)

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

Table 1 — Thermostat Contact Ratings

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

Thermistor (option)

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

Brake (option)

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

GROUNDING

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

6. OPERATION

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

⚠ WARNING

MOVING PARTS can injure.

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

ELECTRIC SHOCK can kill.

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

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

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

7. MAINTENANCE

⚠ WARNING

ELECTRIC SHOCK can kill.

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

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

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

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

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

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

BEARING SYSTEM

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

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

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

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

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

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

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

Table 2 : Bearing Lubrication Intervals

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

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

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

⚠ CAUTION

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

PARTS

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

8. WHO TO CALL

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

9. WARRANTY

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

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

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

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

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

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

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

Lincoln™ MOTORS

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Fax: 1-888-536-6867
Web: www.lincolnmotors.com
E-Mail: mailbox@lincolnmotors.com

IM566-A December 1999

- indicates change since last printing.

TRONAIR®

APPENDIX VI

Oilgear Pump Manual
PVG

SERVICE INSTRUCTIONS

OILGEAR TYPE "PVG" PUMPS

PURPOSE OF INSTRUCTIONS

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

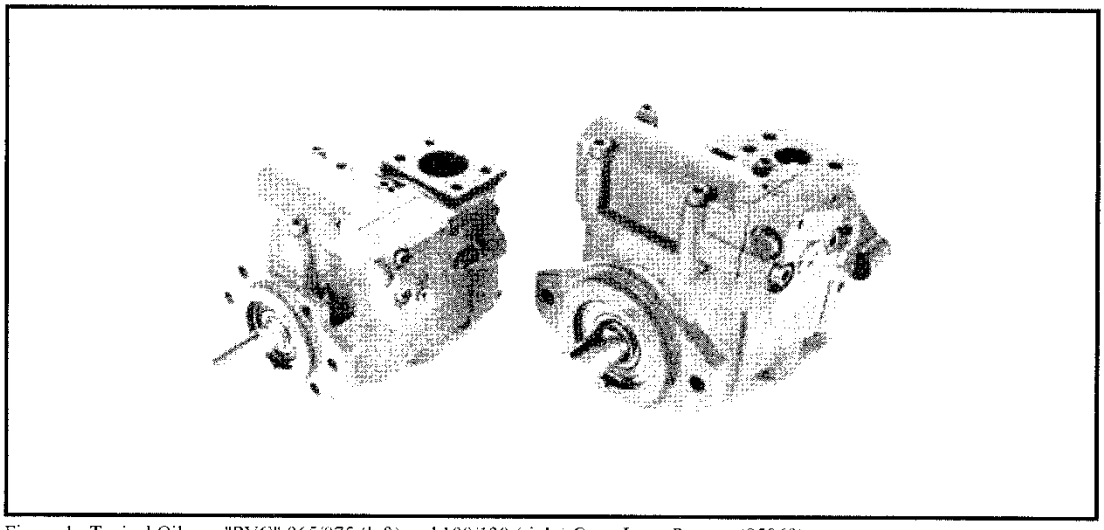


Figure 1. Typical Oilgear "PVG" 065/075 (left) and 100/130 (right) Open Loop Pumps. (95069)

REFERENCE MATERIAL

Fluid Recommendations	Bulletin	90000
Contamination Evaluation Guide	Bulletin	90004
Filtration Recommendations	Bulletin	90007
Piping Information	Bulletin	90011

PUMP CONTROL INSTRUCTIONS

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

I PREPARATION AND INSTALLATION

A. MOUNTING

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

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

B. PIPING AND FITTINGS

See referenced "Piping Information" bulletin and individual circuit diagram before connecting pump to system. Inlet velocity must not exceed 5 fps (1.5 mps). Inlet should be unrestricted and have a minimum of fittings. An inlet strainer is not recommended.

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

Re-Issued Sept., 1995

Bulletin 947019A

Arrange line from "case drain" so case remains full of fluid (non-siphoning). Case pressure be less than 25 psi (1,7 bar). For higher case pressures and special shaft seals required, contact our factory. The PVG-100 case to inlet differential pressure must be less than 60 psi (4,1 bar) for speeds of 1200 and 1800 rpm. The PVG-130 case to inlet differential pressure must be less than 60 psi (4,1 bar) for 1200 rpm and less than 50 psi (3,4 bar) for 1800 rpm. Case to inlet differential pressure can be described as (case pressure minus inlet pressure). For speeds above 1800 rpm, contact our factory. Each drain line must be a separate line, unrestricted, full sized and connected directly to the reservoir below lowest fluid level. Provisions for opening this line without draining (siphoning) reservoir should be made.

WARNING

Running pump in "Neutral" position (servo delivery) for long periods of time without supercharge can damage the pump.

System and pump must be protected against overloads by separate high pressure relief valves. Install bleed valve(s) at highest point(s) in system.

C. POWER

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

CAUTION

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

D. DRIVE

See rotation direction plate on unit's housing. Clockwise units should not be driven counter-clockwise nor counter-clockwise units driven clockwise. Use direct drive coupling. Size and install coupling per manufactures instructions.

CAUTION

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

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

E. FILTRATION

To assure long life from your hydraulic system keep fluid clean at all times. See reference bulletin on "Filtration Recommendations" and on "Contamination Evaluation". Oilgear recommends use of a filter in the pressure or return line. Replace filter element(s) when filter condition indicator reaches change area at normal fluid temperature. Drain and thoroughly clean filter case. Use replacement element(s) of same beta 10 ratio (normally a ratio of 4 with hydraulic oils).

F. FLUID COOLING

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

G. AIR BREATHER

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

H. FLUID, FILLING AND STARTNG RECOMMENDATIONS

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

Pump all fluid into reservoir through a clean (beta 10 ratio of 4 or more) filter. Fill reservoir to, but not above, "high level" mark on sight gage. **Remove case drain line and fill pump case with hydraulic fluid.**

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

Table 1. TORQUE TO TURN SHAFT

Size Unit	075	100 130
Approx. Torque to turn driveshaft - foot pounds	9	24
-Nm.	12	32

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

II. CONSTRUCTION

Refer to Figures 2, 9 an 10. A driveshaft (301) runs through the center line of pump housing (001) and valve plate (401) with pump cylinder barrel (101) splined to it. A bearing (306) supports the outboard end of the driveshaft and a bushing (402) is part of valve plate assembly) supports the inboard end. The pump cylinder barrel is carried in a polymerous (journal type) cylinder bearing (202). The valve plate (401) has two crescent shaped ports. Pumping piston/shoe assemblies (102) in the cylinder barrel are held against a swashblock (201) by a shoe retainer (104). The shoe retainer is held in position by the fulcrum ball (103) which is forced outward by shoe retainer spring (105). The spring acts against the pump cylinder barrel forcing it against the valve plate while also forcing the piston shoes against the swashblock. The semi-cylindrical shaped swashblock limits the piston stroke and can be swivelled in arc shaped saddle bearings (204). The swashblock is swivelled by a control (covered in referenced material).

(See Pages 4 and 5 for "III. PRINCIPLE OF OPERATION").

IV. SPECIFICATIONS

See reference material, pump control material and individual application circuit for exceptions.

Table 2. NOMINAL PERFORMANCE DATA with 150-300 SSU viscosity fluids.

UNIT	THEORETICAL MAXIMUM DISPLACEMENT		RATED CONTINUOUS PRESSURE		MAXIMUM PRESSURE		FLOW RATE at 1800 rpm, rated continuous pressure & 14.7 psia (bar $_{abs}$) inlet condition		MINIMUM INLET PRESSURE psia (bar $_{abs}$)			MAXIMUM SPEED	POWER INPUT	
	in 3/rev	ml/rev	psi	bar	psi	bar	gpm	l/mi	1200 rpm	1500 rpm	1800 rpm	rpm	hp	kw
PVG 075	4.60	75,4	3750	258.6	4250	293,1	33.3	126,0	6.2 (.43)	6.9 (.48)	7.3 (.50)	2700	89	66,4
PVG 100	6.00	98,3	5000	344.8	5800	400,0	42.4	160,5	9.5 (.66)	10.3 (.71)	11.2 (.77)	2400	150	111,9
PVG 130	7.94	130,2	3750	258.6	4250	293,1	57.6	218,0	8.6 (.59)	9.2 (.63)	10,8 (.74)	2400	150	111,9

Table 3. NOMINAL DIMENSIONS and WEIGHTS without controls.

UNIT	LENGTH		WIDTH		HEIGHT		WEIGHT		FACE MTG.
	in.	mm.	in.	mm.	in.	mm.	lbs.	kg.	
075	12.0	303,9	6.9	174,5	6.3	160,4	55	25	SAE "B" 2 & 4 bolt
100 & 130	13.0	330,5	8.4	212,9	7.3	185,7	110	50	SAE "C" 2 bolt

See installation drawings for more detailed dimensions and port configurations.

V. MALFUNCTIONS AND CAUSES

A. UNRESPONSIVE OR SLUGGISH CONTROL

1. See referenced control instruction material.
2. Low control input (pilot) pressure – for "R" and "V" volume type controls only.
3. Swashblock saddle bearings (204) worn or damaged.

B. INSUFFICIENT PUMP VOLUME

1. Delivery limited by faulty control (see appropriate control instruction material).
2. Obstructed suction circuit or insufficient supercharge volume.
3. Insufficient drive motor speed.
4. Worn or grooved cylinder barrel (101) and/or valve plate (401) matching surfaces.
5. Worn piston/shoe assemblies (102) or piston bores in cylinder (101).
6. Worn or damaged piston shoe or swashblock (201).

C. IRREGULAR OR UNSTEADY OPERATION

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

D. LOSS OF PRESSURE

1. Worn piston pump.
2. Worn or grooved cylinder barrel (101) and/or valve plate (401) matching surfaces.
3. Worn piston/shoe assemblies (102) or piston bores in cylinder.
4. Faulty output circuit components.

E. EXCESSIVE or HIGH PEAK PRESSURE

1. Faulty output circuit components (pay particular attention to relief valves).

F. EXCESSIVE NOISE

1. Pump incorrectly being stopped or started under load.
2. Low fluid level in reservoir or insufficient supercharge resulting in cavitation.
3. Air entering hydraulic system.
4. Fluid too cold or viscosity too high.
5. Suction line problem i.e.; obstructions in line, line too long, line diameter too small or too many bends and/or loops in line.
6. Broken or worn piston/shoe assembly (102).
7. Pump rotating in wrong direction.

(Continued on Page 6)

III. PRINCIPLE OF OPERATION

DRIVEN CLOCKWISE (RIGHT HAND), IS DESCRIBED. **DIAGRAMS** ARE SHOWN FROM TOP (PLAN) VIEW.

SEE FIGURE 3. POSITION B. Rotating the driveshaft clockwise turns the splined cylinder, which contains the pumping pistons. When the cylinder is rotated, the pistons move in and out of their bores as the shoes "ride" against the angled swashblock.

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

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

SEE FIGURE 4. POSITION B/2. A study of the diagram will show that the degree of swashblock angle determines the length of piston stroke (difference between outermost and innermost position) thereby determining the amount of delivery from the pump. In this case, the stroke angle is one-half of the former stroke angle. Therefore, the piston stroke is one half the former and pump delivery is one half the former delivery.

SEE FIGURE 5. POSITION N. Neutral position results when the control centers the swashblock. The swashblock angle is now zero and swashblock face is now parallel to cylinder face. Therefore, no inward or outward motion of the pump pistons exist as piston shoes rotate around the swashblock face. The lack of inward and outward motion results in no fluid being displaced from the piston bores to the crescents in the valve plate and consequently no delivery from pump ports.

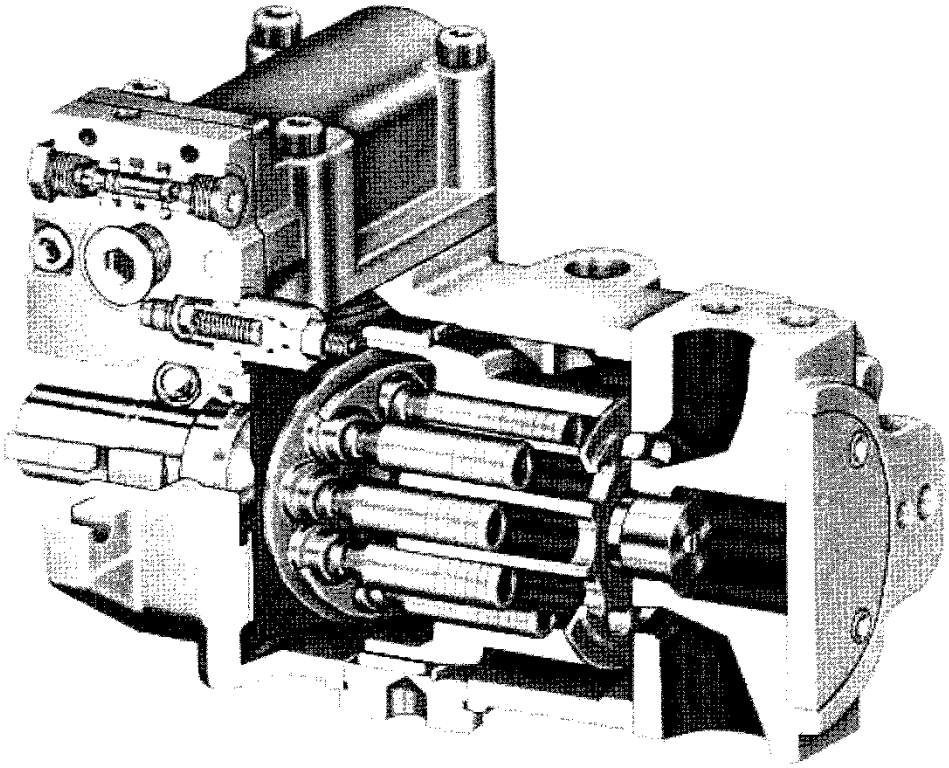


Figure 2. Cut-a-way (cross-section) of typical "PVG" Pump (92011R).

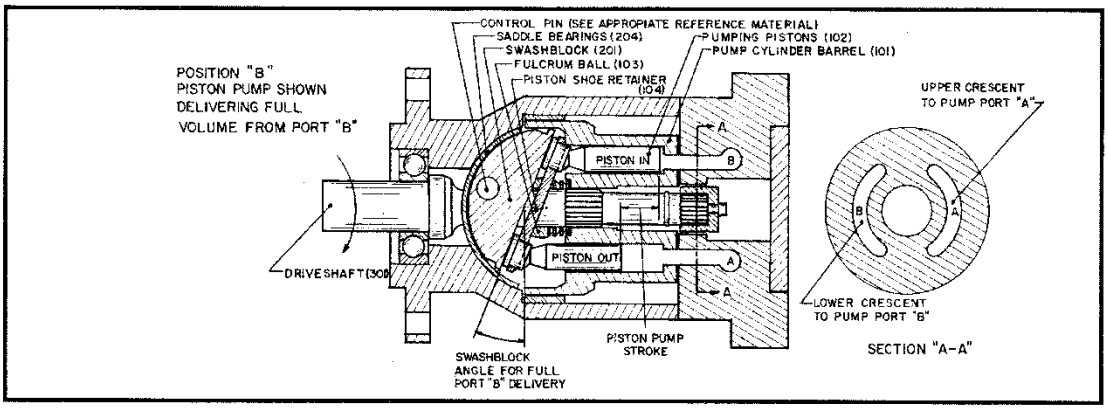


Figure 3. POSITION B plan view (5V-12015-L)

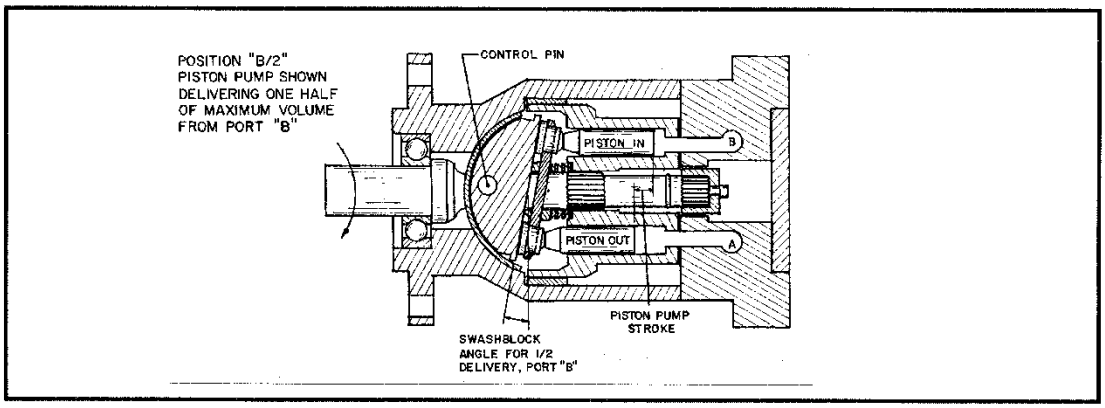


Figure 4. POSITION B/2 plan view (5V-12015-L)

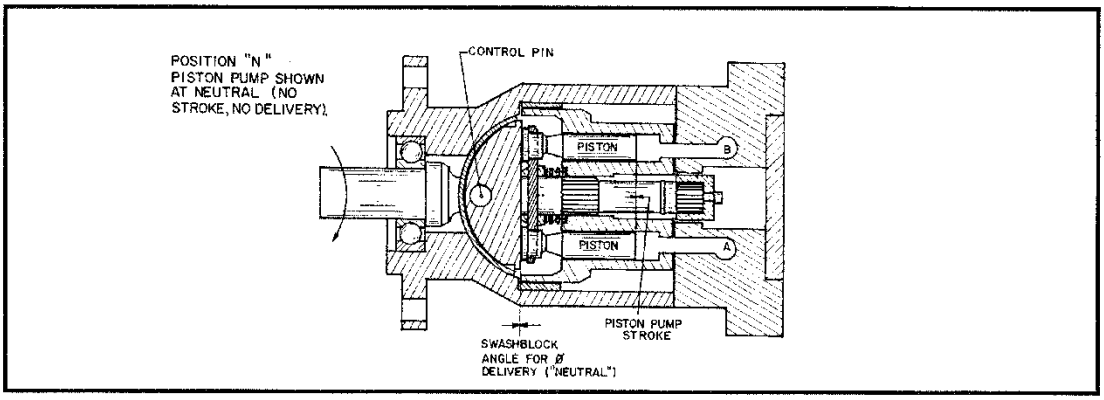


Figure 5. POSITION N plan view (5V-12015-L)

(See Page 3 for "IV SPECIFICATIONS")

G. EXCESSIVE HEATING

1. Operating pump above rated or peak pressure.
2. Low fluid level in reservoir or insufficient supercharge.
3. Air entering hydraulic system.
4. Worn piston pump.
5. Worn or grooved cylinder barrel (101) and/or valve plate (401) matching surfaces.
6. Faulty output circuit components (continuous blowing relief valves or "slip" through valves, cylinder, etc.)
7. Insufficient cooling provision or clogged coolers.

VI. TESTING AND ADJUSTING

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

A. PISTON PUMP

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

CAUTION:

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

With an accurate high pressure gage in the pressure line, start the pump and stall (or block) output device to raise system pressure to maximum (as set by system relief valve). Read the flow meter or time the case drain flow used to fill a known size container and calculate the flow rate in terms of cubic inches per minute (cipm). The leakage should conform with Table 4. Additional leakage indicates wear, but does not become critical until it impairs performance.

VII. DISASSEMBLY

A. PREPARATION

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

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

Disconnect case drain line from port "1" or "1A" and drain pump case through the remaining (port "1" or 1A") on bottom of case. If plugs are inaccessible, it may be necessary to remove pump from mounting (and drive motor) before draining it.

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

Refer to figures 9 and 10. Depending upon what part or parts are to be inspected, it may not be necessary to completely take apart all assemblies.

B. CONTROL GROUP

See reference material for applicable information on the control your unit is equipped with. Some force is required to remove the control housing. Remove socket head cap screws and lift the control group assembly, with control pin, straight up from the top of the pump assembly. Control pin may or may not remain in the swashblock (201). Remove control gasket and o'rings from pump housing.

C. VALVE PLATE GROUP

If another unit is coupled to thru shaft units, it will be necessary to remove coupling (half) before removing valve place. Block unit on bench with driveshaft facing down. Remove valve plate (401) by removing four hex head cap screws (403) and lifting straight up. Remove valve plate gasket (411) and o'ring (404).

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

Pump Size		Case Slip at Full Stroke and Indicated Pressure						
		500 psi	1000 psi	2000 psi	3000psi	3750 psi	4000 psi	5000 psi
075	cipm	130	195	455	760	1070	NA	NA
	lpm	2,1	3,2	7,5	12,5	17,5	NA	NA
100	cipm	190	250	400	600		900	1200
	lpm	3,1	4,1	6,5	9,8		14,7	19,7
130	cipm	300	400	600	1000	140	NA	NA
	lpm	4,9	6,6	9,8	16,4	22,9	NA	NA

D. ROTATING GROUP

WARNING: Size 100 and 130 rotating group weigh approximately 15 lbs. (7 kg). Extreme care must be taken not to damage cylinder wear surface (that matches against the valve plate), bearing diameters or piston shoes. Assistance from others and use of proper lifting techniques are strongly recommended to prevent personal injury.

On thru shaft units, the tailshaft bushing assembly (307, 308, 309) or a coupling will have to be removed (a "jacking" screw can be used) before rotating group can be disassembled. Place the pump in a horizontal position and remove the rotating group by turning shaft (301) slowly while pulling the cylinder barrel (101) from the housing.

Mark (number) each pump piston shoe assembly (102) and its respective bore in cylinder barrel (101) and shoe retainer (104). See Figure 7. Lift out shoe retainer (104) with pistons (102) and remove fulcrum ball (103) and shoe retainer spring (105).

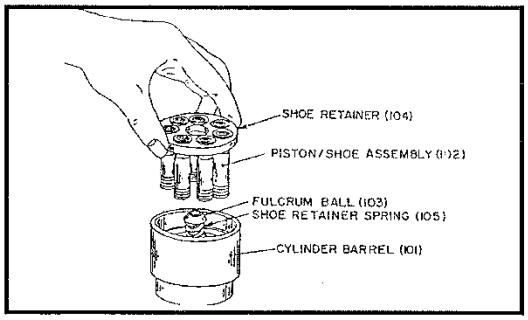


Figure 7 ROTATING GROUP DISASSEMBLY (5V-12015-L).

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

E. DRIVESHAFT GROUP

Remove drive key (303) if used and driveshaft bearing retainer ring (305). Grasp outboard end of driveshaft (301) and pull out from pump housing. Remove shaft seal retainer (302) and shaft seal (007) from housing only if necessary.

F. SWASHBLOCK GROUP

For size 100 and 130 only, remove flat head screws (206) and guide plate (203). Reach inside the case and remove the swashblock (201) and saddle bearings (204).

VIII. INSPECTION

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

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

A. CONTROL GROUP

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

B. VALVE PLATE GROUP

Inspect the valveplate (401) surface that mates with the cylinder barrel (101) for excessive wear or scoring. Remove minor defects by lightly stoning the surface with a hard stone that is flat to within 0.001" (0,03mm). Be sure to stone lightly. Any excessive stoning will remove the hardened surface. If wear or damage is extensive, replace the valve plate.

C. ROTATING GROUP

Inspect cylinder barrel (101) piston bores and the face that mates with valve plate for wear and scoring. Remove minor defects on the face by lightly stoning or lapping the surface. If defects can not be removed by this method, replace the cylinder barrel.

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

See Figure 8. Check each shoe face for nicks and scratches. Check the shoe for smooth pivot action on piston. If one or more piston/shoe assembly needs to be replaced, replacement of all piston/shoe assemblies is necessary. When installing new piston/shoe assemblies or rotating group, make sure pistons are free in their respective bores.

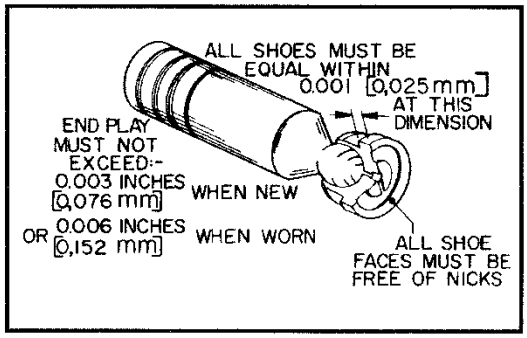


Figure 8 PISTON and SHOE INSPECTION (5V-12015-L).

D. SWASHBLOCK GROUP

Inspect the swashblock (201) for wear and scoring. If defects are minor, stone the swashblock lightly. If damage is extensive, replace the swashblock. Check the very small hole in the face of the swashblock. These holes provide "porting" for the hydrostatic balance fluid (of the piston/shoe assembly) to be channeled through the swashblock to the face of the saddle bearing (providing pressure lubrication).

Compare saddle bearing (204) thickness in worn area to thickness in an unworn area. Replace saddle bearings if difference is greater than 0.015 in. (0,4 mm). Check mating surface of swashblock for cracks or excessive wear. Swashblock movement in saddle bearings must be smooth. Replace if necessary.

E. DRIVESHAFT GROUP

Check shaft seal (007) for deterioration or cracks. Replace (press out) if necessary. Check shaft bearing (306) for galling, pitting, binding or roughness. Check rear shaft bushing in valve plate. Check shaft and it's splines for wear. Replace any part necessary.

IX. ASSEMBLY

Refer to figures 9 and 10. The procedure for assembling the pump are basically the reverse order of disassembly procedures. During assembly, install new gaskets, seals and o'rings. Apply a thin film of CLEAN grease or hydraulic fluid to sealing components to ease assembly. If a new rotating group is used, lubricate thoroughly with CLEAN hydraulic fluid. Apply fluid generously to all wear surfaces.

A. SWASHBLOCK GROUP

If removed, press shaft seal (007) into front of pump housing and then place housing on bench with mounting flange side down. If replaced or removed, press two roll pins (207) into the pump housing so pins extend 0.050 to 0.065 inches (1.3 to 1,6 mm) from case. Grease back side of saddle bearing (204) and place on the pin to locate the bearing in pump case. Be sure the pin does not protrude.

For size 100 and 130 only, partially insert swashblock (201) into pump housing then insert guide plate (203) into the case, so flat head cap screws (206) can be used to fasten the guide plate (203) to the housing, and place the swashblock (201) on the guide plate (203) making sure the guide plate (203) is in the groove of the swashblock (201). For other sizes, insert swashblock (201) into pump housing. Once in place, be sure swashblock swivels in the saddle bearings. With new bearings, swivelling may be stiff (not always smooth).

Be sure the roll pin (205) [two are used on size 130] is inserted into the cylinder bearing (202). Position the cylinder bearing so the pins are located nearest the control facing the outboard end of driveshaft (301). The bearing should be positioned with "scarf" cuts positioned top and bottom and with pin (205) located on top of internal cast boss. The bearing should fit into place with a little difficulty and be square to the axis of the pump. Tap bearing into place if necessary using extreme care not to damage the bearing. Insert retaining ring (208) to hold bearing in place.

B. DRIVESHAFT GROUP

Place housing on its side with the axis horizontal and then install seal retainer (302). Place front driveshaft bearing (306) onto driveshaft (301) and lock in place with shaft retaining ring (304). Lubricate shaft seal (007) and shaft, then insert driveshaft (301) and bearing assembly into housing and lock in place with driveshaft bearing retainer ring (305).

C. ROTATING GROUP

See Figure 7. Place the cylinder barrel (101), wear surface down, on a clean cloth. Place the shoe retainer spring (105) in the center of the barrel with the fulcrum ball (103) on top of it. Insert the (numbered on disassembly) pistons (102) into their corresponding (numbered) holes of the shoe retainer (104). As a unit, fit the pistons into their corresponding (numbered) bores in the cylinder barrel. **DO NOT FORCE.** If aligned properly, the pistons will fit smoothly.

WARNING – The assembled rotating group for sizes 100 and 130 weighs approximately 15 lbs. (7kg). Assistance from others and proper lifting techniques is strongly recommended to prevent personal injury. The rotating group can now be carefully installed over the tail of the driveshaft (301) and into the pump housing (001). When installing the rotating group, support the weight of the cylinder barrel (101), as cylinder spline is passed over the tailshaft, to avoid scratching or damage. Push cylinder forward until the cylinder spline reaches the driveshaft spline and rotate slightly to engage shaft splines. Continue to slide cylinder forward until it encounters the cylinder bearing (202). Lifting the tailshaft slightly helps cylinder (101) and cylinder bearing (202) engagement. Continue pushing cylinder forward until the piston shoes contact the swashblock. At this point, the back of the cylinder should be located approximately 0.4 in. (10,2 mm) outside the back of the pump housing. On thru shaft units without another pump or device connected to them, install roll pin (309) into spline cover (307), slide assembly onto shaft (301) and secure in place with socket head shoulder screw (308).

D. VALVE PLATE GROUP

Place pump housing on bench with open end facing up. Install new o'ring (411) and gasket (407) on housing. Make sure the tail end of shaft engages bushing (in rear ported valve plates) while positioning valve plate (401) on pins (005) and housing. Finger tighten hex head cap screw (403) closest to o'ring (404) first then alternately tighten the other cap screws. On thru shaft units connected to another pump or device, install coupling (half).

SEE SECTION "I. PREPARATION and INSTALLATION"

X. PARTS LIST

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

ITEM NO.	DESCRIPTION
000	HOUSING ASSEMBLY GROUP
001	Housing, Pump
003	Nameplate, Identification
004	Plug, SAE
005	Pin, Roll
006	Pin, Roll
007	Seal, Shaft
008	Screw
010	Seal, O'ring
100	ROTARY ASSEMBLY GROUP
101	Barrel, Cylinder
102	Assembly, Piston/Shoe
103	Ball, Fulcrum
104	Retainer, Shoe
105	Spring, Shoe Retainer
200	SWASHBLOCK ASSEMBLY GROUP
201	Swashblock
202	Bearing, Cylinder
203**	Plate, Guide
204	Bearing, Saddle
205	Pin, Roll
206**	Screw, Flt. Hd. Cap
207	Pin, Roll
208	Ring, Retainer

** Size 100 & 130 only

ITEM NO.	DESCRIPTION
300	DRIVESHAFT ASSEMBLY GROUP
301A**	Driveshaft, thru w/keyway (side port)
301B**	Driveshaft, thru w/SAE Spline (side port)
301D	Driveshaft, w/Keyway (rear port)
301E	Driveshaft, w/SAE Spline (rear port)
302	Retainer, Seal
303	Key, Driveshaft
304	Ring, Shaft Retainer
305	Ring, Driveshaft Bearing Retainer
306	Bearing, Front Driveshaft
307	Cover, Spline
308	Screw, Sock. Hd. Cap Shoulder
309	Pin, Roll
400	VALVE PLATE ASSEMBLY GROUP
401A	Valve Plate, side port/rear shaft
401E	Valve Plate, side port/no rear shaft
401I	Valve Plate, rear port
402	Bushing, (part of valve plate)
403	Screw, Hex. Hd.
404	Seal, O'ring
405	Seal, O'ring
406	Seal, O'ring
407	Seal, O'ring
408	Plug, SAE
409	Plug, SAE
410	Plug, SAE
411	Gasket, Valve Plate
412	Cover, Rear Shaft
413	Seal, O'ring
414	Screw, Sock. Hd. Cap

O'RING SIZES

ARP 568 Uniform Size Number with Durometer

ITEM NO.	PUMP SIZE	
	075	100 & 130
010	912 - 70	912 - 70
404	012 - 90	013 - 90
405	902 - 90	902 - 90
406	903 - 90	903 - 90
407	904 - 90	904 - 90
413	138 - 70	138 - 70

PARTS DRAWINGS ON PAGES 10 AND 11

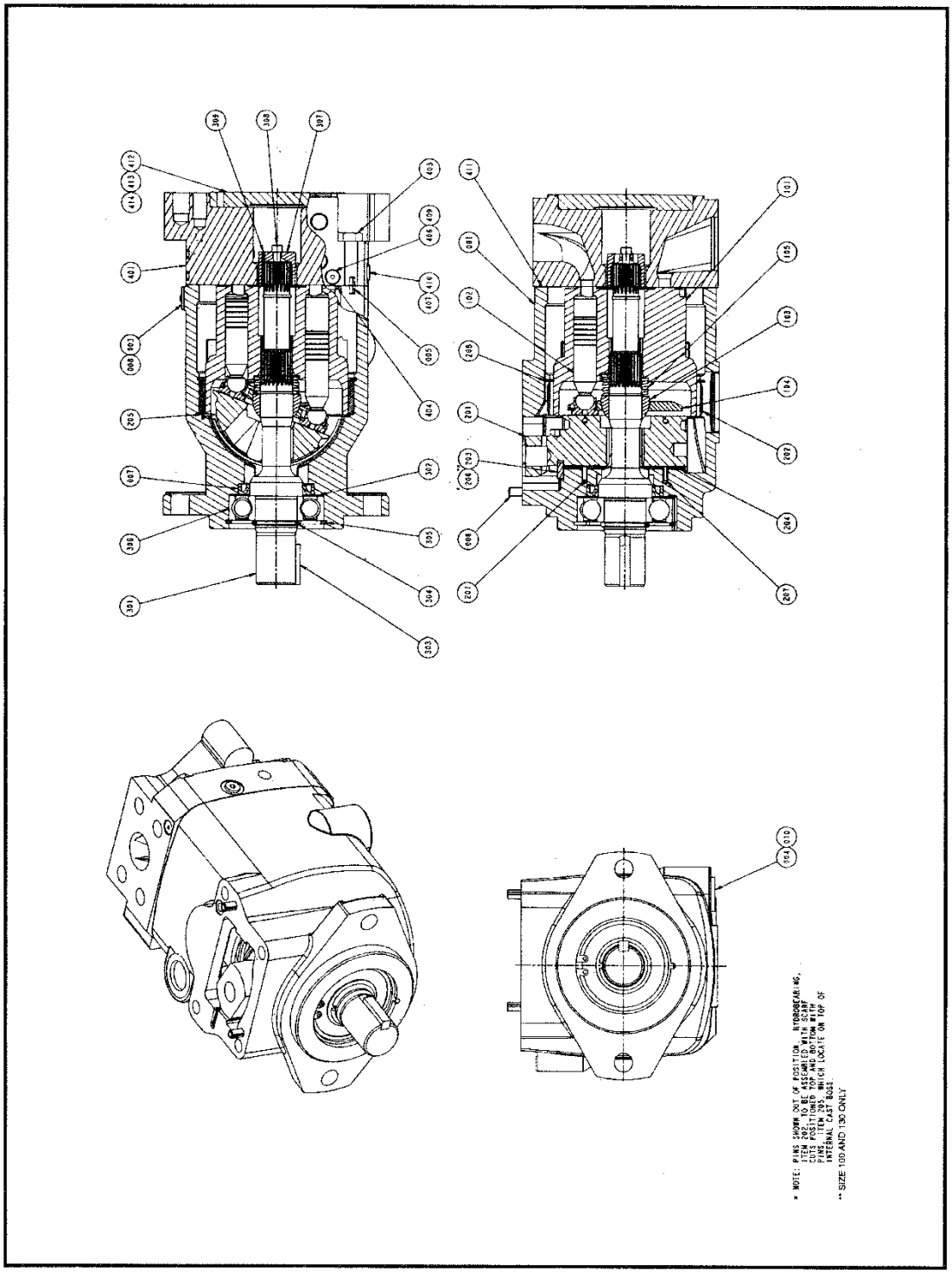


Figure 9. Cross Section and Plan View Parts Drawing (516246 sh. 1 of 3).

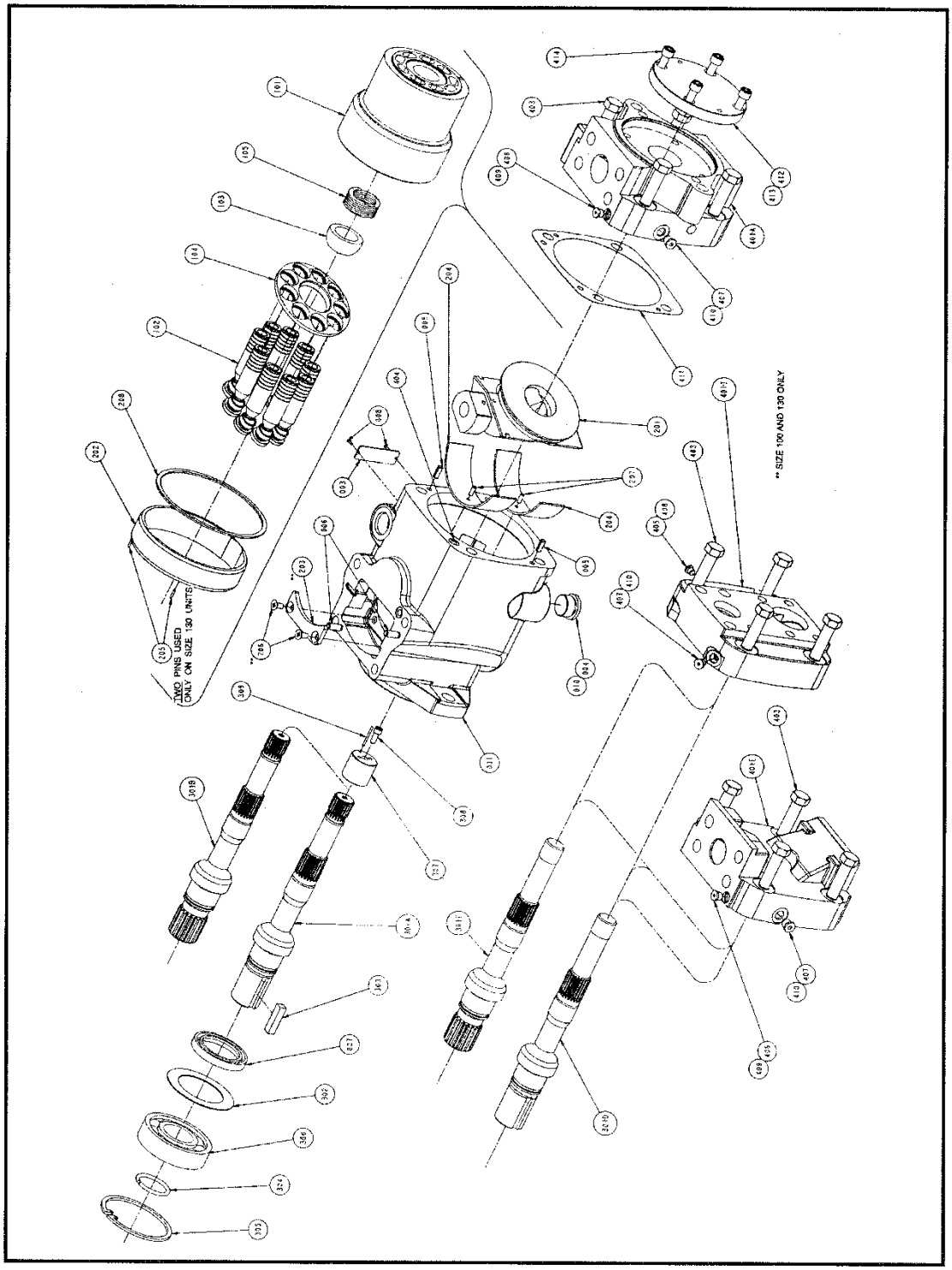


Figure 10 Exploded Parts Drawing (516246 sh. 2 of 3).

XI. AFTER SALES SERVICES

Oilgear builds products that last. However, it is the nature of this type of machinery to require proper maintenance regardless of the care that goes into its manufacture. Oilgear has several service programs to help you.

"STAY-ON-STREAM' SERVICE

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

SERVICE SCHOOLS

Oilgear holds schools to train your maintenance personnel. A "general" hydraulic or electronic school is conducted in our Milwaukee plant on a regular basis. "Custom" schools, specifically addressing your particular hydraulic and electrohydraulic equipment can be conducted in your plant.

SPARE PARTS AVAIBILITY:

Prepare for future needs by stocking Oilgear original factory parts. Having the correct parts and necessary skills "in-plant" enables you to minimize down-time. Oilgear has developed parts kits to cover likely future needs. Oilgear field service technicians also stand ready to assist your maintenance people in trouble-shooting and repairing equipment.

OILGEAR EXCHANGE SERVICE

Standard replacement pumps and motors are available to users of Oilgear equipment where comparable units will be returned in exchange. When standard replacements must be modified to replace units which are special, shipment will depend on availability of parts, assembly and test time necessary.

To obtain this service, place and order for an exchange unit and provide the serial number and type designation. The replacement unit will be shipped F.O.B. our factory, Milwaukee, Wisconsin. User retains the replacement and returns the worn unit prepaid to The Oilgear Company for reconditioning and test. When the unit is reconditioned or stocked, the user is billed the cost of reconditioning or a flat rate exchange price if one has been applied to that particular type of unit.

Oilgear
PERFORMANCE
ASSURANCE

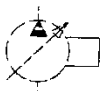
THE OILGEAR COMPANY
2300 So. 51st. Street
Milwaukee, Wisconsin 53219

Litho in USA

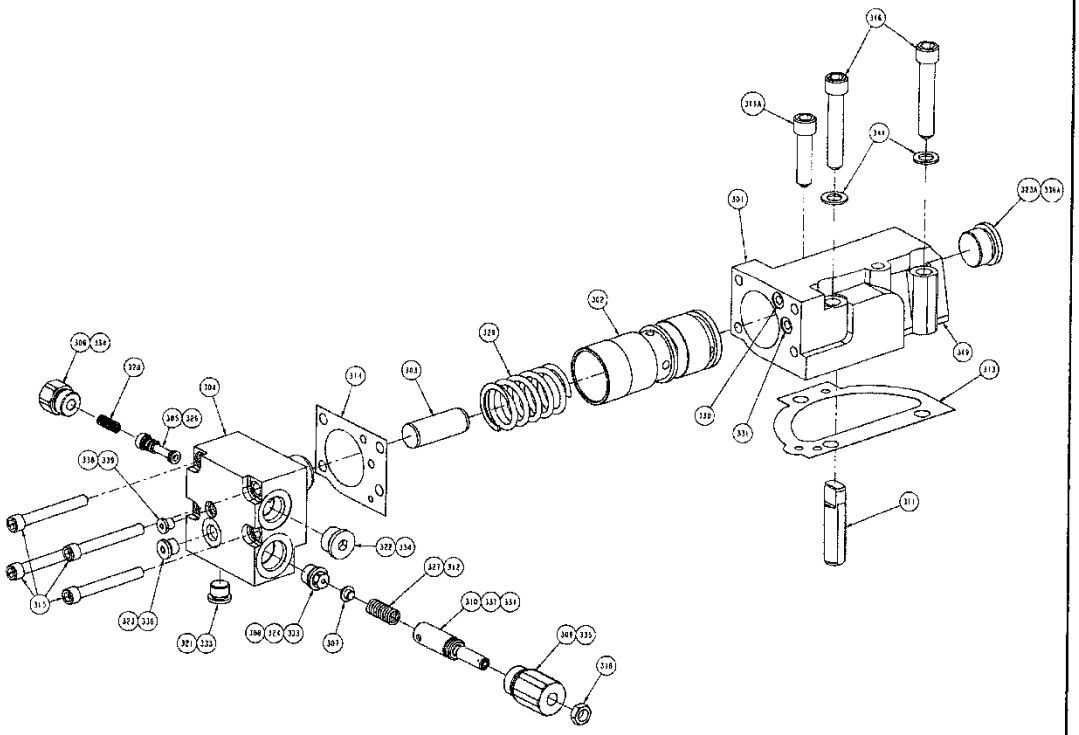
Oilgear

PUMP, VARIABLE DELIVERY
PVG 075
"P-1NN" CONTROL

MAINTENANCE 1



Parts Drawing — **Single Pressure Compensator Control**



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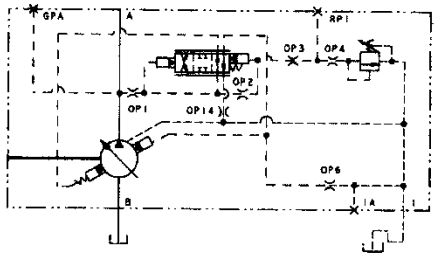

HYDRAULIC CIRCUIT

Telephone: (414) 327-1700
Fax: (414) 327-0532

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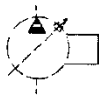
PUMP, VARIABLE DELIVERY
PVG 075

"P-1NN" CONTROL

MAINTENANCE 2



Parts List — **Single Pressure Compensator Control**

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

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
301	Housing, Control	322	Plug, SAE
302	Piston, Main Control	323	Plug, SAE
303	Piston, Bias Control	324	Orifice, (OP-4)
304	Cap, End	325	Orifice, (OP-3)
305	Spool, 4-Way Valve	326	Orifice, (OP-2)
306	End Plug, 4-Way Valve	327	Spring, Relief Valve
307	Poppet, Relief Valve	328	Spring, 4-Way Valve
308	Seat, Relief Valve	329	Spring, Bias Piston
309	Bonnet, Relief Valve	330	Seal, O'ring
310	Screw, Relief Valve Adjusting	331	Seal, O'ring
311	Pin, Control Piston	333	Seal, O'ring
312	Shim, Relief Valve	334	Seal, O'ring
313	Gasket, Control Housing	335	Seal, O'ring
314	Gasket, Control Head	336	Seal, O'ring
315	Screw, S.H.C.	337	Ring, Back-up
316	Screw, S.H.C.	338	Seal, O'ring
316A	Screw, S.H.C.	339	Plug, SAE
318	Nut, Jam	341	Washer
319	Orifice, (OP-6)	343	Orifice, (OP-14)
321	Plug, SAE	344	Orifice, (OP-01)

APR 568 UNIFORM SIZE NUMBERS
for O'ring (w/Durometer) and Back-up Rings

ITEM NO.	PUMP SIZE 065 & 075
330	012 - 90
331	014 - 90
333	906 - 90
334	908 - 90
335	910 - 90
336	904 - 90
337	014
338	902 - 90

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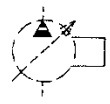
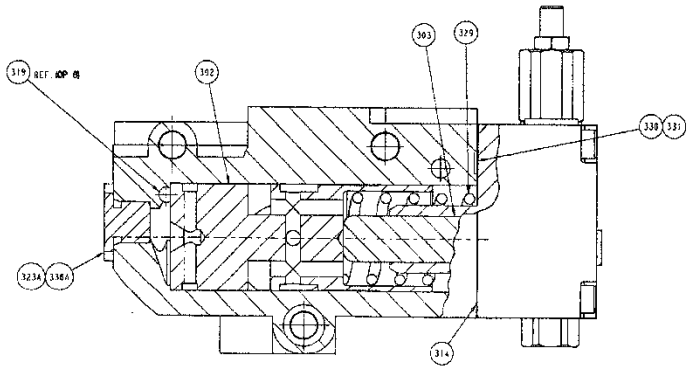
PUMP, VARIABLE DELIVERY
PVG 075
"P-1NN" CONTROL

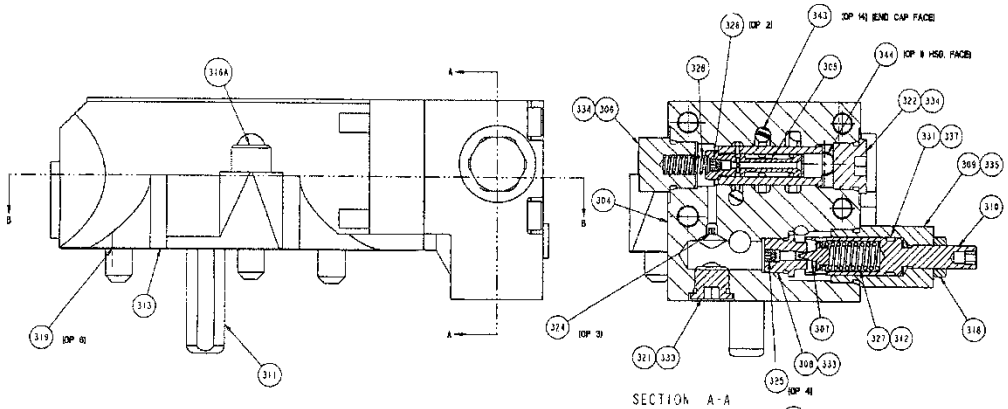
MAINTENANCE 3



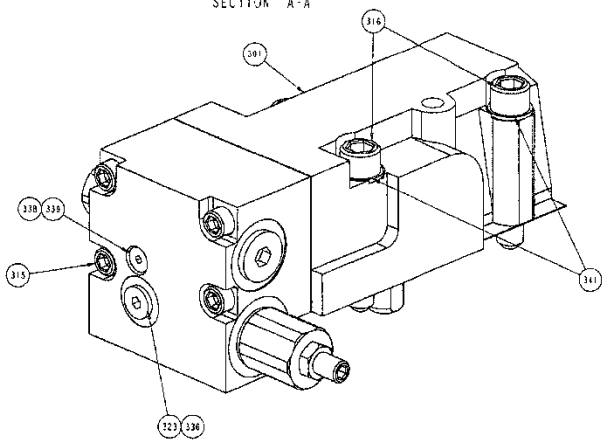
Parts Drawing — **Single Pressure Compensator Control**



SECTION B-B



SECTION A-A



Telephone: (414) 327-1700
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DS-947551

APPENDIX VII

Safety Data Sheet (SDS)
Hydraulic Fluid – MIL-PRF-5606

SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: **MOBIL AERO HFA**
Product Description: Base Oil and Additives
Product Code: 201550401020, 490110-00, 970584
Intended Use: Aviation hydraulic oil

COMPANY IDENTIFICATION

Supplier: **EXXON MOBIL CORPORATION**
22777 Springwoods Village Parkway
Spring, TX. 77253 USA

24 Hour Health Emergency	609-737-4411
Transportation Emergency Phone	800-424-9300 or 703-527-3887 CHEMTREC
Product Technical Information	800-662-4525
MSDS Internet Address	http://www.exxon.com, http://www.mobil.com

SECTION 2 HAZARDS IDENTIFICATION

This material is hazardous according to regulatory guidelines (see (M)SDS Section 15).

CLASSIFICATION:

Flammable liquid: Category 4.
Aspiration toxicant: Category 1.

LABEL:
Pictogram:

Signal Word: Danger

Hazard Statements:
H227: Combustible liquid. H304: May be fatal if swallowed and enters airways.

Precautionary Statements:
P210: Keep away from flames and hot surfaces. -- No smoking. P273: Avoid release to the environment. P280: Wear protective gloves and eye / face protection.P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P331: Do NOT induce vomiting. P370 + P378: In case of fire: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish.P403 + P235: Store in a well-ventilated place. Keep cool. P405: Store locked up.P501: Dispose of contents and container in accordance with local regulations.

Other hazard information:

HAZARD NOT OTHERWISE CLASSIFIED (HNOC): None as defined under 29 CFR 1910.1200.

PHYSICAL / CHEMICAL HAZARDS

Material can accumulate static charges which may cause an ignition. Material can release vapors that readily form flammable mixtures. Vapor accumulation could flash and/or explode if ignited. Combustible.

HEALTH HAZARDS

High-pressure injection under skin may cause serious damage. Excessive exposure may result in eye, skin, or respiratory irritation.

ENVIRONMENTAL HAZARDS

No significant hazards.

NFPA Hazard ID:	Health:	1	Flammability:	2	Reactivity:	0
HMIS Hazard ID:	Health:	1*	Flammability:	2	Reactivity:	0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

This material is defined as a mixture.

Hazardous Substance(s) or Complex Substance(s) required for disclosure

Name	CAS#	Concentration*	GHS Hazard Codes
2,6-DI-TERT-BUTYL-P-CRESOL	128-37-0	0.1 - < 1%	H400(M factor 1), H410(M factor 1)
DISTILLATES (PETROLEUM), HYDROTREATED LIGHT	64742-47-8	5 - < 10%	H304
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	50 - < 70%	H227, H304
HYDROTREATED MIDDLE DISTILLATE (PETROLEUM)	64742-46-7	20 - < 30%	H304
TRIPHENYL PHOSPHATE	115-86-6	0.1 - < 0.25%	H400(M factor 1), H410(M factor 1)

* All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

As per paragraph (i) of 29 CFR 1910.1200, formulation is considered a trade secret and specific chemical identity and exact percentage (concentration) of composition may have been withheld. Specific chemical identity and exact percentage composition will be provided to health professionals, employees, or designated representatives in accordance with applicable provisions of paragraph (i).

SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIAN

If ingested, material may be aspirated into the lungs and cause chemical pneumonitis. Treat appropriately.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Combustible. Pressurized mists may form a flammable mixture.

Hazardous Combustion Products: Aldehydes, Incomplete combustion products, Oxides of carbon, Phosphorus oxides, Smoke, Fume, Sulfur oxides

FLAMMABILITY PROPERTIES

Flash Point [Method]: >82°C (180°F) [ASTM D-93]
Flammable Limits (Approximate volume % in air): LEL: 0.7 UEL: 7.0 [Estimated]
Autoignition Temperature: >225°C (437°F)

SECTION 6 ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable

regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding and downwind areas if required due to toxicity or flammability of the material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for advice on the minimum requirements for personal protective equipment. Additional protective measures may be necessary, depending on the specific circumstances and/or the expert judgment of the emergency responders.

For emergency responders: Respiratory protection: respiratory protection will be necessary only in special cases, e.g., formation of mists. Half-face or full-face respirator with filter(s) for dust/organic vapor or Self Contained Breathing Apparatus (SCBA) can be used depending on the size of spill and potential level of exposure. If the exposure cannot be completely characterized or an oxygen deficient atmosphere is possible or anticipated, SCBA is recommended. Work gloves that are resistant to hydrocarbons are recommended. Gloves made of polyvinyl acetate (PVA) are not water-resistant and are not suitable for emergency use. Chemical goggles are recommended if splashes or contact with eyes is possible. Small spills: normal antistatic work clothes are usually adequate. Large spills: full body suit of chemical resistant, antistatic material is recommended.

SPILL MANAGEMENT

Land Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do it without risk. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Prevent entry into waterways, sewer, basements or confined areas. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Large Spills: Water spray may reduce vapor; but may not prevent ignition in closed spaces. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Avoid contact with skin. Avoid prolonged breathing of mists and heated vapor. Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source). When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations). Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static

accumulation. Consult local applicable standards for guidance. Additional references include American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents) or National Fire Protection Agency 77 (Recommended Practice on Static Electricity) or CENELEC CLC/TR 50404 (Electrostatics - Code of practice for the avoidance of hazards due to static electricity).

Static Accumulator: This material is a static accumulator.

STORAGE

The container choice, for example storage vessel, may effect static accumulation and dissipation. Keep container closed. Handle containers with care. Open slowly in order to control possible pressure release. Store in a cool, well-ventilated area. Storage containers should be grounded and bonded. Fixed storage containers, transfer containers and associated equipment should be grounded and bonded to prevent accumulation of static charge.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMIT VALUES

Exposure limits/standards (Note: Exposure limits are not additive)

Substance Name	Form	Limit / Standard			NOTE	Source
2,6-DI-TERT-BUTYL-P-CRESOL	Inhalable fraction and vapor	TWA	2 mg/m3		N/A	ACGIH
DISTILLATES (PETROLEUM), HYDROTREATED LIGHT [total hydrocarbon vapor]	Non-Aerosol	TWA	200 mg/m3		Skin	ACGIH
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m3		N/A	OSHA Z1
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Inhalable fraction.	TWA	5 mg/m3		N/A	ACGIH
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m3		N/A	ACGIH
HYDROTREATED MIDDLE DISTILLATE (PETROLEUM)	Mist.	TWA	5 mg/m3		N/A	OSHA Z1
HYDROTREATED MIDDLE DISTILLATE (PETROLEUM)	Inhalable fraction.	TWA	5 mg/m3		N/A	ACGIH
TRIPHENYL PHOSPHATE		TWA	3 mg/m3		N/A	OSHA Z1
TRIPHENYL PHOSPHATE		TWA	3 mg/m3		N/A	ACGIH

Exposure limits/standards for materials that can be formed when handling this product: When mists/aerosols can occur the following are recommended: 5 mg/m^3 - ACGIH TLV (inhalable fraction), 5 mg/m^3 - OSHA PEL.

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

No biological limits allocated.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions.

Control measures to consider:
Use explosion-proof ventilation equipment to stay below exposure limits.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:
No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:
If prolonged or repeated contact is likely, chemical resistant gloves are recommended. If contact with forearms is likely, wear gauntlet style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:
If prolonged or repeated contact is likely, chemical, and oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

Comply with applicable environmental regulations limiting discharge to air, water and soil. Protect the environment by applying appropriate control measures to prevent or limit emissions.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Note: Physical and chemical properties are provided for safety, health and environmental considerations only and may not fully represent product specifications. Contact the Supplier for additional information.

GENERAL INFORMATION

Physical State: Liquid
Color: Red

Odor: Characteristic
Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.88
Flammability (Solid, Gas): N/A
Flash Point [Method]: >82°C (180°F) [ASTM D-93]
Flammable Limits (Approximate volume % in air): LEL: 0.7 UEL: 7.0 [Estimated]
Autoignition Temperature: >225°C (437°F)
Boiling Point / Range: N/D
Decomposition Temperature: N/D
Vapor Density (Air = 1): N/D
Vapor Pressure: [N/D at 20 °C]
Evaporation Rate (n-butyl acetate = 1): N/D
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): N/D
Solubility in Water: Negligible
Viscosity: 13.8 cSt (13.8 mm2/sec) at 40 °C | 5.1 cSt (5.1 mm2/sec) at 100°C [ASTM D 445]
Oxidizing Properties: See Hazards Identification Section.

OTHER INFORMATION

Freezing Point: N/D
Melting Point: N/A
Pour Point: -60°C (-76°F) [ASTM D97]
DMSO Extract (mineral oil only), IP-346: < 3 %wt

SECTION 10 STABILITY AND REACTIVITY

REACTIVITY: See sub-sections below.

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Open flames and high energy ignition sources.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

POSSIBILITY OF HAZARDOUS REACTIONS: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

INFORMATION ON TOXICOLOGICAL EFFECTS

Hazard Class	Conclusion / Remarks
Inhalation	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Irritation: No end point data for material.	Elevated temperatures or mechanical action may form vapors, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs.

Ingestion	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin	
Acute Toxicity: No end point data for material.	Minimally Toxic. Based on assessment of the components.
Skin Corrosion/Irritation: No end point data for material.	May dry the skin leading to discomfort and dermatitis. Based on assessment of the components.
Eye	
Serious Eye Damage/Irritation: No end point data for material.	May cause mild, short-lasting discomfort to eyes. Based on assessment of the components.
Sensitization	
Respiratory Sensitization: No end point data for material.	Not expected to be a respiratory sensitizer.
Skin Sensitization: No end point data for material.	Not expected to be a skin sensitizer. Based on assessment of the components.
Aspiration: Data available.	May be fatal if swallowed and enters airways. Based on physico-chemical properties of the material.
Germ Cell Mutagenicity: No end point data for material.	Not expected to be a germ cell mutagen. Based on assessment of the components.
Carcinogenicity: No end point data for material.	Not expected to cause cancer. Based on assessment of the components.
Reproductive Toxicity: No end point data for material.	Not expected to be a reproductive toxicant. Based on assessment of the components.
Lactation: No end point data for material.	Not expected to cause harm to breast-fed children.
Specific Target Organ Toxicity (STOT)	
Single Exposure: No end point data for material.	Not expected to cause organ damage from a single exposure.
Repeated Exposure: No end point data for material.	Not expected to cause organ damage from prolonged or repeated exposure. Based on assessment of the components.

TOXICITY FOR SUBSTANCES

NAME	ACUTE TOXICITY
2,6-DI-TERT-BUTYL-P-CRESOL	Oral Lethality: LD50 0.89 g/kg (Rat)

OTHER INFORMATION

For the product itself:

Repeated and/or prolonged exposure may cause irritation to the skin, eyes, or respiratory tract. Small amounts of liquid aspirated into the lungs during ingestion or from vomiting may cause chemical pneumonitis or pulmonary edema.

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = NTP CARC	3 = IARC 1	5 = IARC 2B
2 = NTP SUS	4 = IARC 2A	6 = OSHA CARC

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

More volatile component -- Highly volatile, will partition rapidly to air. Not expected to partition to sediment and wastewater solids.

Less volatile component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Components -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Majority of components -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products. Protect the environment. Dispose of used oil at designated sites. Minimize skin contact. Do not mix used oils with solvents, brake fluids or coolants.

REGULATORY DISPOSAL INFORMATION

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

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be

completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (DOT)

Proper Shipping Name: COMBUSTIBLE LIQUID, N.O.S. (Distillates (Petroleum), Hydrotreated Light)
Hazard Class & Division: COMBUSTIBLE LIQUID
ID Number: NA1993
Packing Group: III
ERG Number: 128
Label(s): NONE
Transport Document Name: NA1993, COMBUSTIBLE LIQUID, N.O.S. (Distillates (Petroleum), Hydrotreated Light), COMBUSTIBLE LIQUID, PG III

Footnote: This material is not regulated under 49 CFR in a container of 119 gallon capacity or less when transported solely by land, as long as the material is not a hazardous waste, a marine pollutant, or specifically listed as a hazardous substance.

LAND (TDG): Not Regulated for Land Transport

SEA (IMDG): Not Regulated for Sea Transport according to IMDG-Code

Marine Pollutant: No

AIR (IATA): Not Regulated for Air Transport

SECTION 15 REGULATORY INFORMATION

OSHA HAZARD COMMUNICATION STANDARD: This material is considered hazardous in accordance with OSHA HazCom 2012, 29 CFR 1910.1200.

Listed or exempt from listing/notification on the following chemical inventories: AICS, DSL, ENCS, IECSC, KECI, PICCS, TCSI, TSCA

EPCRA SECTION 302: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: Fire. Immediate Health. Delayed Health.

SARA (313) TOXIC RELEASE INVENTORY: This material contains no chemicals subject to the supplier notification requirements of the SARA 313 Toxic Release Program.

The following ingredients are cited on the lists below:

Chemical Name	CAS Number	List Citations
DISTILLATES (PETROLEUM), HYDROTREATED LIGHT	64742-47-8	1, 17, 18
HYDROTREATED LIGHT NAPHTHENIC DISTILLATE (PETROLEUM)	64742-53-6	1, 4, 13, 17, 18
HYDROTREATED MIDDLE DISTILLATE (PETROLEUM)	64742-46-7	1, 4, 17, 18

--REGULATORY LISTS SEARCHED--

1 = ACGIH ALL	6 = TSCA 5a2	11 = CA P65 REPRO	16 = MN RTK
2 = ACGIH A1	7 = TSCA 5e	12 = CA RTK	17 = NJ RTK
3 = ACGIH A2	8 = TSCA 6	13 = IL RTK	18 = PA RTK
4 = OSHA Z	9 = TSCA 12b	14 = LA RTK	19 = RI RTK
5 = TSCA 4	10 = CA P65 CARC	15 = MI 293	

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16 OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

KEY TO THE H-CODES CONTAINED IN SECTION 3 OF THIS DOCUMENT (for information only):
H227: Combustible liquid; Flammable Liquid, Cat 4
H304: May be fatal if swallowed and enters airways; Aspiration, Cat 1
H400: Very toxic to aquatic life; Acute Env Tox, Cat 1
H410: Very toxic to aquatic life with long lasting effects; Chronic Env Tox, Cat 1

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:
Revision Changes:
Section 01: Company Mailing Address information was modified.
Section 05: Hazardous Combustion Products information was modified.
Section 15: List Citations Table information was modified.
Section 15: National Chemical Inventory Listing information was modified.
Section 14: Marine Pollutant information was modified.
Composition: Component Table information was modified.
Section 08: Exposure Limits Table information was modified.
Section 16: Revision Information - Implementation of GHS requirements phrase. information was deleted.

The information and recommendations contained herein are, to the best of ExxonMobil's knowledge and belief, accurate and reliable as of the date issued. You can contact ExxonMobil to insure that this document is the most current available from ExxonMobil. The information and recommendations are offered for the user's consideration and examination. It is the user's responsibility to satisfy itself that the product is suitable for the intended use. If buyer repackages this product, it is the user's responsibility to insure proper health, safety and other necessary information is included with and/or on the container. Appropriate warnings and safe-handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law,

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Internal Use Only

MHC: 2A, 0, 0, 0, 1, 1 PPEC: C

DGN: 2005454XUS (552975)

APPENDIX VIII

Instrument Certification Notice

Instrument Certification Notice

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

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

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

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