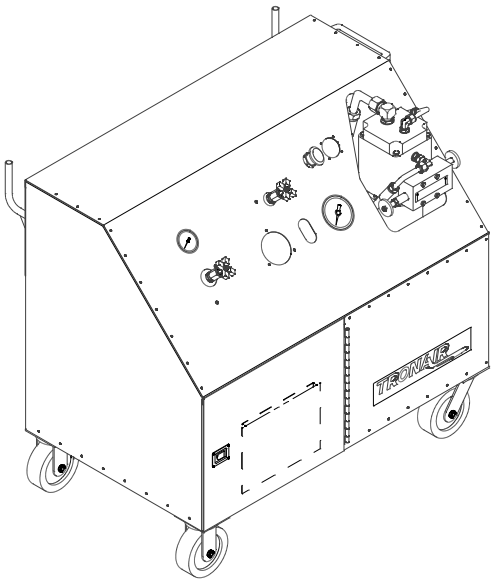
OPERATION & SERVICE MANUAL



Model: 5D10
Hydraulic Power Unit

08/2021 - Rev. 08

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

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

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Web: www.tronair.com
Email: sales@tronair.com

REVISION	DATE	TEXT AFFECTED
01	01/05/2004	pg 17 Electrical Components - Drawing changed, Modified Parts List
02	02/2004	pg 3 Replaced Electrical Schematic
03	05/2004	pg. 13 Modified part number for item 6 pg 17 Modified part numbers for 60 HZ application Modified part numbers for 50 HZ application
04	05/2005	pg 13 Modified part numbers for items 3 and 10
05	07/2011	Modified Electrical Components Parts List
06	08/2016	Major revision
07	01/2017	Modified Return Back-Pressure Valve Parts List
08	08/2021	Added section 5.9 Infrequent HPU Use and updated 7.0 Maintenance

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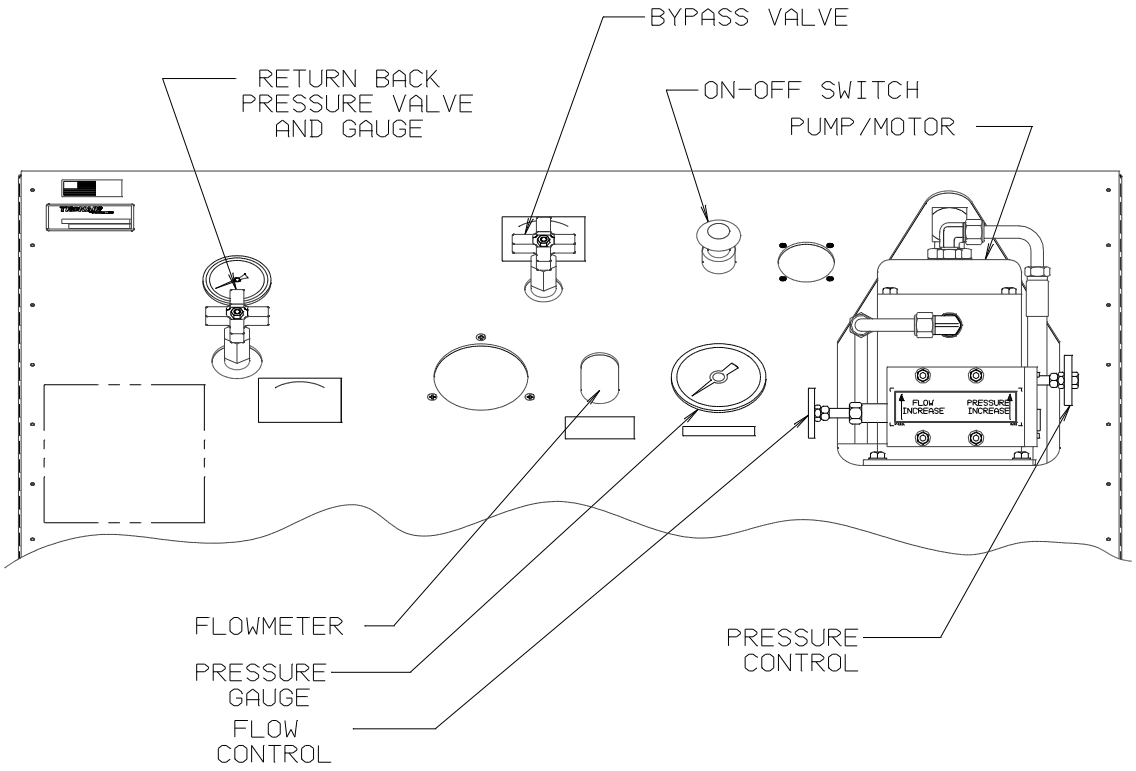
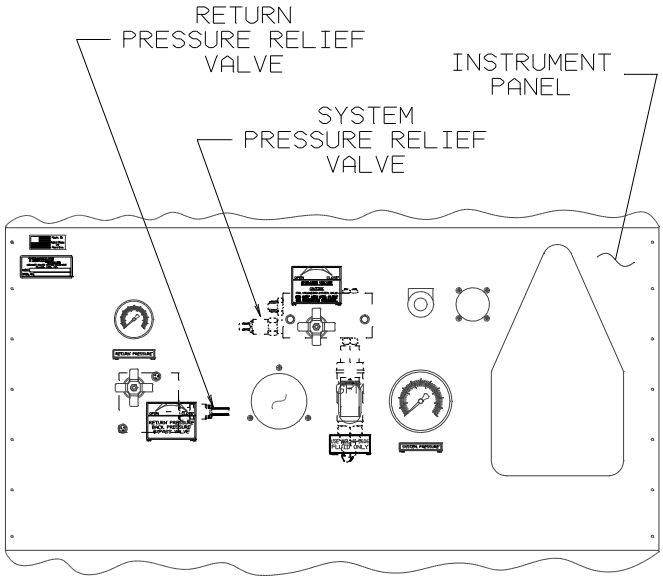
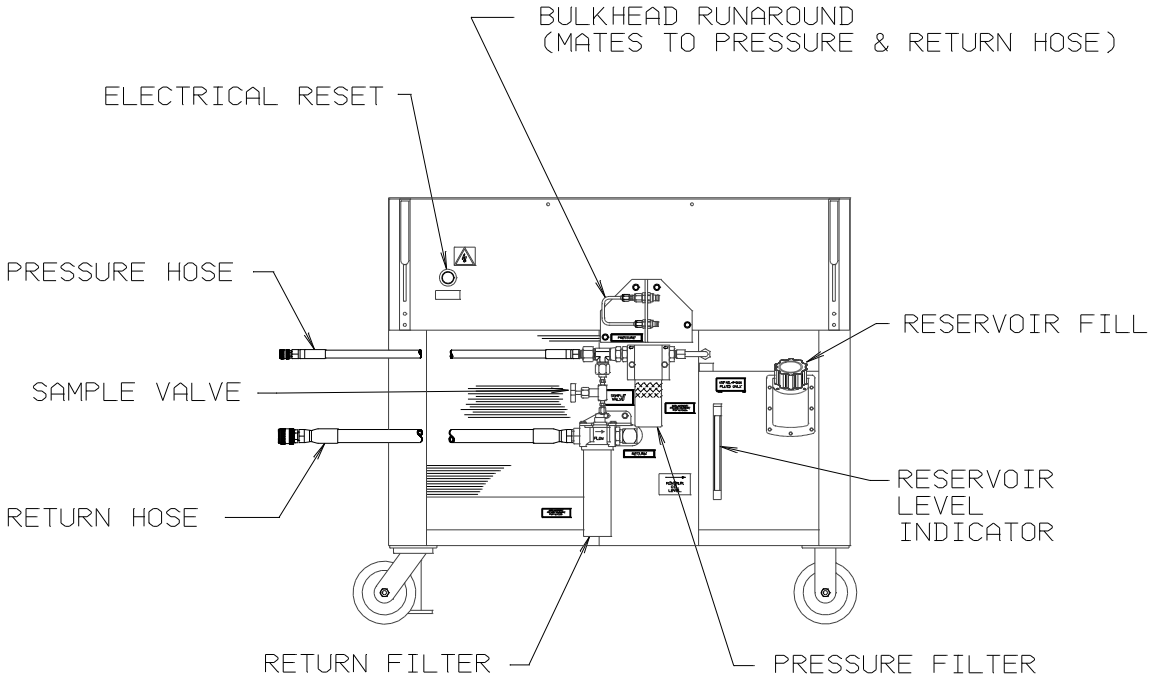


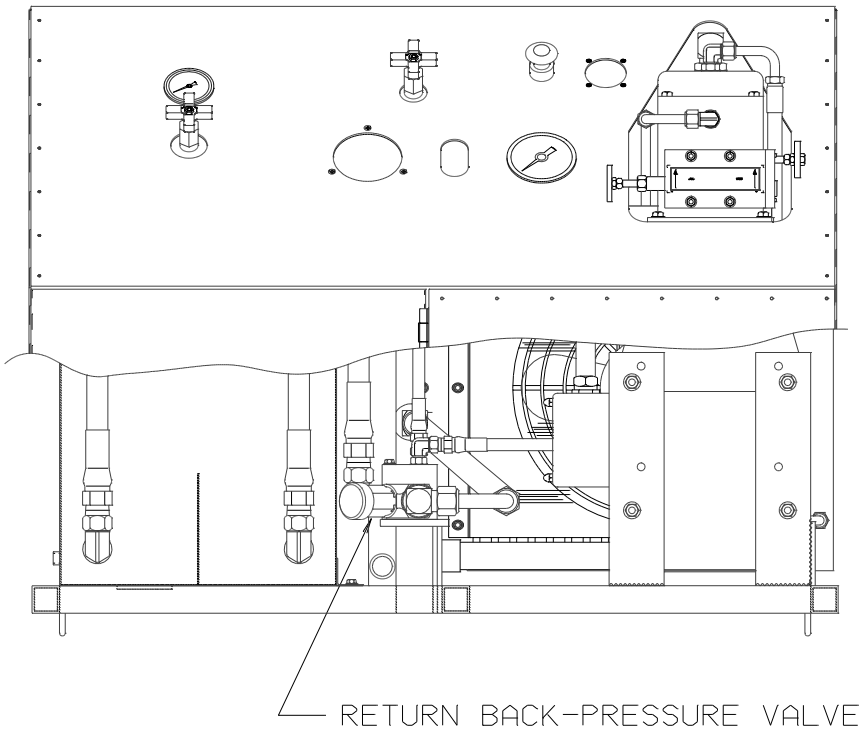
Internal Controls



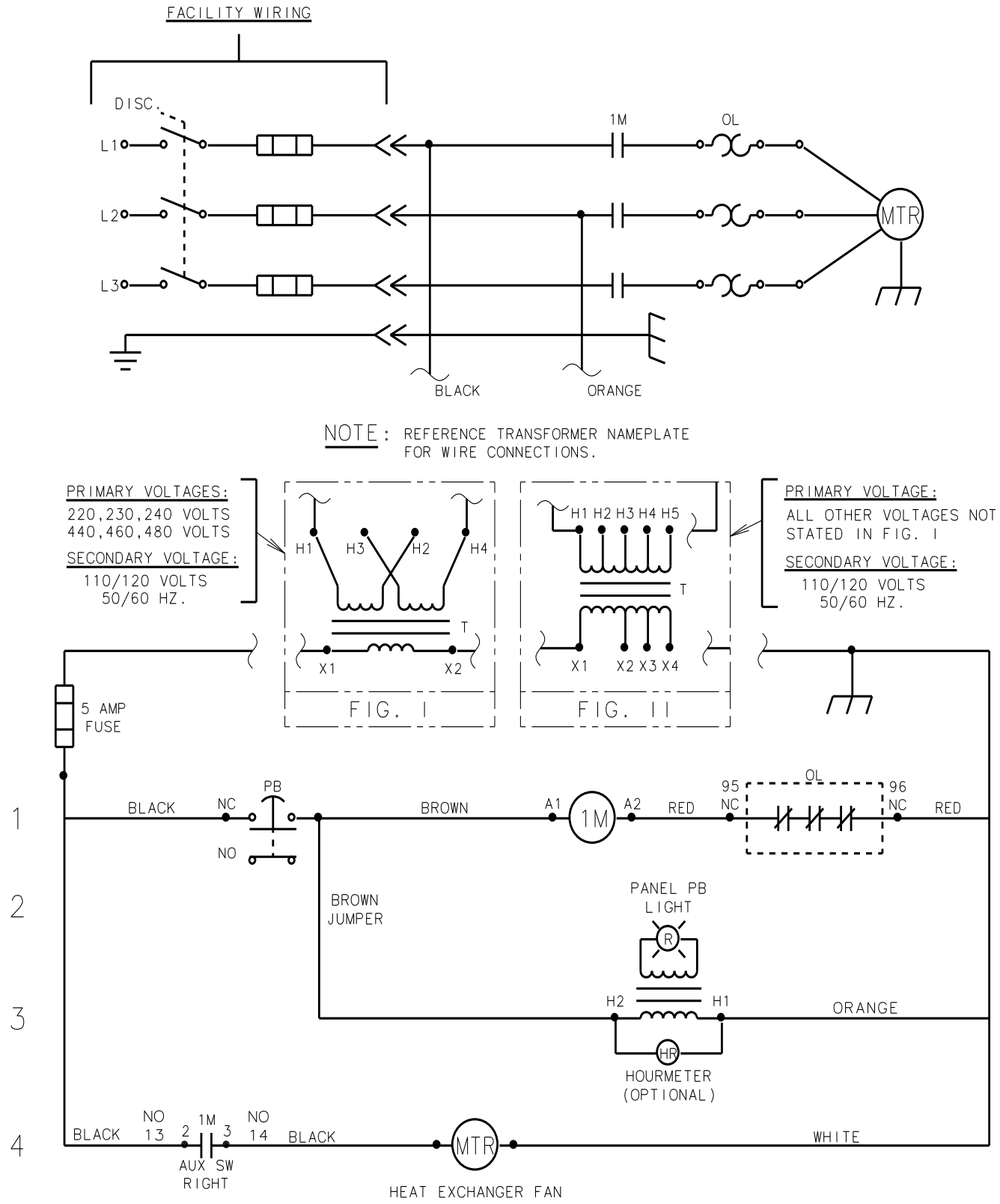
Rear Component Locations



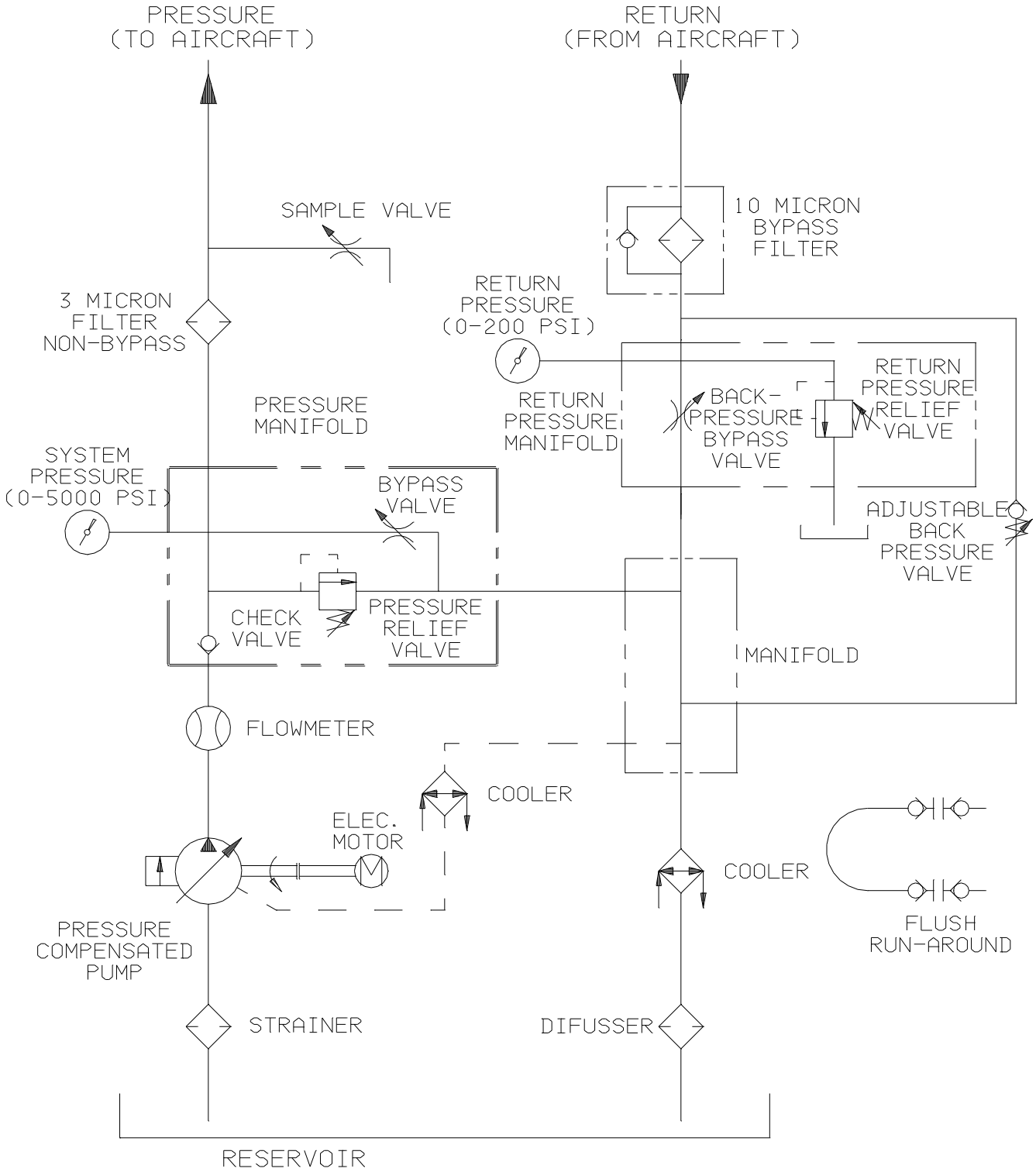
Return Back-Pressure Valve



Electrical Schematic



Hydraulic Schematic



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

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

The Tronair Hydraulic Power Unit (HPU) provides a source of clean, pressurized hydraulic fluid for performing required aircraft maintenance.

Some important features are:

- Pressure compensated pump with integral pressure and flow controls
- Stainless steel reservoir
- Bypass valve
- Case drain cooler
- Manual starter with overload protection
- Non bypass pressure filter with 2 micron filter element
- Return system back pressure valve with bypass and pressure relief

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 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

1.4 FUNCTION

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

1.5 REQUIREMENTS

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

1.6 TECHNICAL SPECIFICATIONS

1.6.1 Hydraulic

Fluid MIL-PRF-5606
Pressure Range ..... 250 – 3,000 psi
System Pressure Relief..... 3,250 psi
Flow Range ..... 0 – 6 gpm
Filtration ..... 2 Micron Absolute Pressure, 10 Micron Return
Reservoir Capacity..... 13 gallons

1.6.2 Electrical

Power Requirements: 3 Phase

60 Hz: 28.8 amps @ 208 VAC
26 amps @ 230 VAC
15.7 amps @ 380 VAC
13 amps @ 460 VAC
10.4 amps @ 575 VAC

50 Hz: 26 amps @ 200, 220 VAC
13 amps @ 380, 415, 440 VAC

1.6.3 Mechanical

Dimensions ..... 45 in (114 cm) Long
33 in (84 cm) Wide
42 in (107 cm) High
Weight..... 550 lbs (249.5 kg) Shipping only

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.

3.0 PREPARATION FOR USE

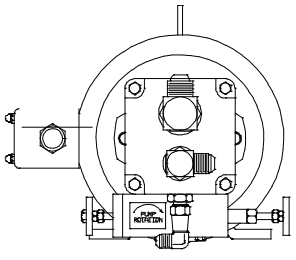
The HPU is shipped completely assembled, and only the following steps are required to make the unit operational.

3.1 SERVICING RESERVOIR

Fill the reservoir with the correct fluid until fluid level is above the minimum oil level mark.

3.2 CONNECTING ELECTRICAL LEADS

Install plug onto the electrical cord and check for proper motor rotation by "bumping" the on-off switch. Correct motor rotation is indicated by an arrow on pump motor adapter (***see Figure***). If rotation is not correct, change any two of the three input leads at the plug or inside the electrical component box.



TOP VIEW OF PUMP/MOTOR ASSEMBLY

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 phase to another. Some reasons for imbalance are:

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

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

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

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

4.2 TRAINING PROGRAM

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

4.3 OPERATOR TRAINING

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

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

5.0 GENERAL OPERATION

Due to the complexity, differences, and ongoing changes in aircraft hydraulic systems, no attempt has been made to relate to any specific aircraft operation. It is suggested that this manual and the HPU be studied thoroughly in order to obtain optimum benefit of the various features. By combining an understanding of the HPU and the aircraft hydraulic system, many services not mentioned in this manual may be performed. Refer to the Hydraulic Schematic, Front Panel Controls, and integral components (Pages 1 to 4) for clarification while reading this manual.

5.1 GENERAL COMMENTS

The following comments will aid in obtaining maximum benefits from the hydraulic power unit.

5.1.1 Training

Be sure that all personnel who will use the machine read the operating manual and receive training. We encourage customers to call Tronair to discuss any operating or testing requirements.

CAUTION!

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

5.2 PRELIMINARY ADJUSTMENTS AND OPERATION

The pressure and flow controls have lock nuts to prevent rotation of the control shaft during operation. These nuts should be moved away from the pump during adjustment of flow or pressure in order to eliminate binding of the control shafts. (See Front Panel Controls Illustration.)

NOTE: Steps 5.2.1 and 5.2.2 in the following section may be accomplished consecutively without shutting down the HPU between steps.

5.2.1 Flow Control Adjustment

1. Open bypass valve.
2. Start HPU.
3. Adjust flow control on pump for maximum desired flow. Observing the flowmeter, read flow (gallons per minute) directly from flowmeter scale. Be sure the control shaft lock nut is loose during adjustment. Tighten finger-tight after adjustment to maintain setting.

5.2.2 Pressure Control Adjustment

1. Open bypass valve.
2. Start HPU.
3. Close bypass valve.
4. Adjust pressure control for desired pressure. Be sure the control shaft lock nut is loose during adjustment. Tighten finger-tight after adjustment to maintain setting.

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

5.2.3 Bypass Valve Operation

The bypass valve is only used to unload the pump. DO NOT use to set system pressure or flow.

1. Start Up Operation: The bypass valve should be opened prior to starting the HPU in order to allow the motor to start under a no load condition.
2. Shut Down Operation: Prior to shutdown, the bypass valve should 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.

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

5.3 RETURN BACK-PRESSURE VALVE OPERATION

The back-pressure valve is used for maintaining a preset pressure (adjustable) in the return line from the aircraft. This valve is located inside the access panel on the front of the unit. The back-pressure bypass valve, located on the instrument panel with the return line pressure gauge, allows fluid to flow directly from the aircraft to the reservoir bypassing the back-pressure valve. This valve can also be used to slowly relieve the back-pressure in the return line.

5.3.1 Return Back Pressure Setting:

1. Disconnect electrical power from the HPU.
2. Connect the pressure and return lines to the bulkhead runaround on the rear of the unit.
3. Connect electrical power to the HPU.
4. Open the system bypass valve, start the HPU, set the flow to one (1) gpm (see Section 5.2.1.).
5. With the HPU running, close the system bypass valve and the return bypass valve.
6. Open the access panel on the front of the HPU and locate the return back-pressure valve inside. (See Front Panel Controls Illustration.)
7. Facing the front of the HPU, observe the return system pressure gauge located on the instrument panel. Adjust the **return back-pressure valve** to the desired pressure by turning the knob clockwise to increase pressure; counterclockwise to decrease pressure. (See Return Back-Pressure Valve Illustration.)

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

5.4 RETURN PRESSURE RELIEF VALVE SETTING

1. Disconnect electrical power from the HPU.
2. Connect the pressure and return lines to the bulkhead runaround on the rear of the unit.
3. Connect electrical power to the HPU.
4. Open the **system bypass valve**, start the HPU.
5. Set the return back-pressure valve to a minimum of 25 psi above the desired **return pressure relief valve** setting. (see Section 4.3)
6. Locate the **return back-pressure manifold** inside the front access panel, behind the instrument panel. The return back-pressure bypass valve is located on this manifold. The return pressure relief valve is located on the right side of the manifold, looking into the front of the access panel. (See Internal Controls Illustration, Parts List Return Back Pressure Valve & Manifold Assembly Illustration and Pressure Relief Valve Illustration.
7. Loosen the locking nut on the threaded shaft of the pressure relief valve.
8. With the HPU running, close the **system bypass valve** and the **return bypass valve**.
9. While observing the **return system pressure gauge** located on the instrument panel, adjust the **return pressure relief valve** to the desired pressure. Turn the shaft clockwise looking into the shaft to increase pressure, counter-clockwise to decrease pressure. If pressure is too high, open the return system bypass valve and re-close to release residual pressure.
10. Record the pressure setting. Repeat the previous step until final setting is obtained.
11. Tighten the locking nut on the threaded shaft of the return pressure relief valve.

5.5 SAMPLE VALVE

A sample valve is provided on the rear of the unit to obtain a fluid sample for analysis or inspection. In order to obtain a representative fluid sample, it is suggested that American National Standard T2.24.1-1991 be followed. (See Rear Component Locations Illustration.)

5.6 BLEEDING AIR FROM SYSTEM

Rapid fluctuations of the pressure gauge and/or 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 coupling.

To Easily Purge the Unit of Air:

1. Fill reservoir to recommended level.
2. Connect the pressure and return lines to the bypass runaround on the rear of the unit.
3. Open bypass valve.
4. Start unit and adjust flow control to maximum position.
5. Close the system bypass valve
6. Run unit for five (5) minutes.
7. Open system bypass valve.
8. Shut off the HPU.

5.7 SYSTEM PRESSURE RELIEF VALVE SETTING

1. Disconnect electrical power from the HPU.
2. Cap the end of the system pressure hose.
3. Connect electrical power to the HPU.
4. Open the **system bypass valve**, start the HPU. (See Front Panel Controls Illustration.)
5. Locate the **control block manifold** inside the front access panel, behind the instrument panel. The system flowmeter and bypass valve are located on this manifold. The system pressure relief valve is located on the left side of the manifold, looking into the front of the assess panel. (See Internal Controls Illustration; Parts List Control Block Assembly Illustration, and Pressure Relief Valve Illustration.)
6. Loosen the locking nut on the threaded shaft of the pressure relief valve.
7. With the HPU running, close the **system bypass valve**.
8. While observing the **system pressure gauge** located on the instrument panel, adjust the **system pressure relief valve** to 3,250 psi. (Turn the shaft clockwise looking into the shaft to increase pressure, counter-clockwise to decrease pressure) If pressure is too high, open the system bypass valve and re-closing to release residual pressure.
9. Record the pressure setting. Repeat the previous step until final setting is obtained.
10. Tighten the locking nut on the threaded shaft of the system pressure relief valve.

5.8 ABBREVIATED OPERATING INSTRUCTIONS

These instructions may be used for fast reference after a thorough understanding of the HPU operation has been achieved.

5.8.1 Prior to Starting

a. Open bypass valve
b. Check reservoir level

5.8.2 Initial Adjustments

a. Set flow control (See Section 5.2.1)
b. Set pressure control (See Section 5.2.2)

5.8.3 Operation

a. Start HPU
b. Close bypass valve

5.8.4 Shutting Down

a. Open bypass valve
b. Stop HPU

5.9 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.

5.9.1 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 3.2 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 TROUBLE SHOOTING

6.1 NO FLOW OR PRESSURE

Possible Cause	Solution
Motor turning in wrong direction	See Section 3.2 Connecting Electrical Leads
Flow control set too low	Increase flow setting
Insufficient oil in reservoir	See Section 3.1 Servicing Reservoir
Air in hydraulic lines	See Section 5.6 Bleeding Air From System
Faulty pump	Repair or replace pump

6.2 FLUCTUATING PRESSURE OR FLOW

Possible Cause	Solution
Air in hydraulic lines	See Section 5.6 Bleeding Air From System

6.3 UNIT OVERHEATS

Possible Cause	Solution
Low fluid level in reservoir	See Section 3.2 Connecting Electrical Leads
Running unit for long time periods without operating aircraft components	Cycle landing gear or other components periodically or allow unit to cool
Bypass valve partially open	See Section 5.2.3 Bypass Valve Operation

6.4 REDUCED FLOW

Check filter and replace element as needed.

6.5 NOISE OR VIBRATION

Check for air in the system and purge if necessary. See Section 4.6, "To Easily Purge the Unit of Air"

CAUTION!

If this temperature rises to 150° F, do any of the following:

1. **Open the bypass valve.**
2. **Cycle the landing gear a few times.**
3. **Shut off the HPU.**

7.0 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 5.9 Infrequent Use Procedure.

7.1 GENERAL MAINTENANCE

The hydraulic power unit should be maintained in a safe and clean condition at all times.

- Locate and correct the source of any and all leaks.
- Inspect hoses and electrical cords periodically for damage and wear. Replace as required.

7.2 FILTER MAINTENANCE

The main pressure filter has a replaceable element that is **not** cleanable. It is recommended that this filter element be changed whenever the visual pop-up indicator button “pops up”, **annually**, or **whenever a reduced maximum flow** is noticed. Refer to the parts list for the correct filter element number.

7.3 LUBRICATION

The swivel casters are equipped with grease fittings which should be lubricated annually.

7.4 STORAGE

In the event that the HPU will not be used for 12 months or longer, the reservoir may be drained. The unit should then be appropriately covered in order to maintain cleanliness.

8.0 PROVISION OF SPARES

8.1 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

8.2 RECOMMENDED SPARE PARTS LISTS

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

Part Number	Description	Qty
HC-1763	DESICCANT FILTER ELEMENT	1
K-1414	KIT,REPL.FILTER ELEMENT	1
K-3096	KIT, FILTER ELEMENT	1
K-4008	KIT, TEST FLUID	1
HC-1385	GAUGE, PRESSURE 0-3000 PSI	1
TF-1037-01*180	ASSEMBLY, HOSE (#8 MB)	1
TF-1039-01*180	ASSEMBLY, HOSE (#12 MB)	1

9.0 IN SERVICE SUPPORT

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

10.0 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.

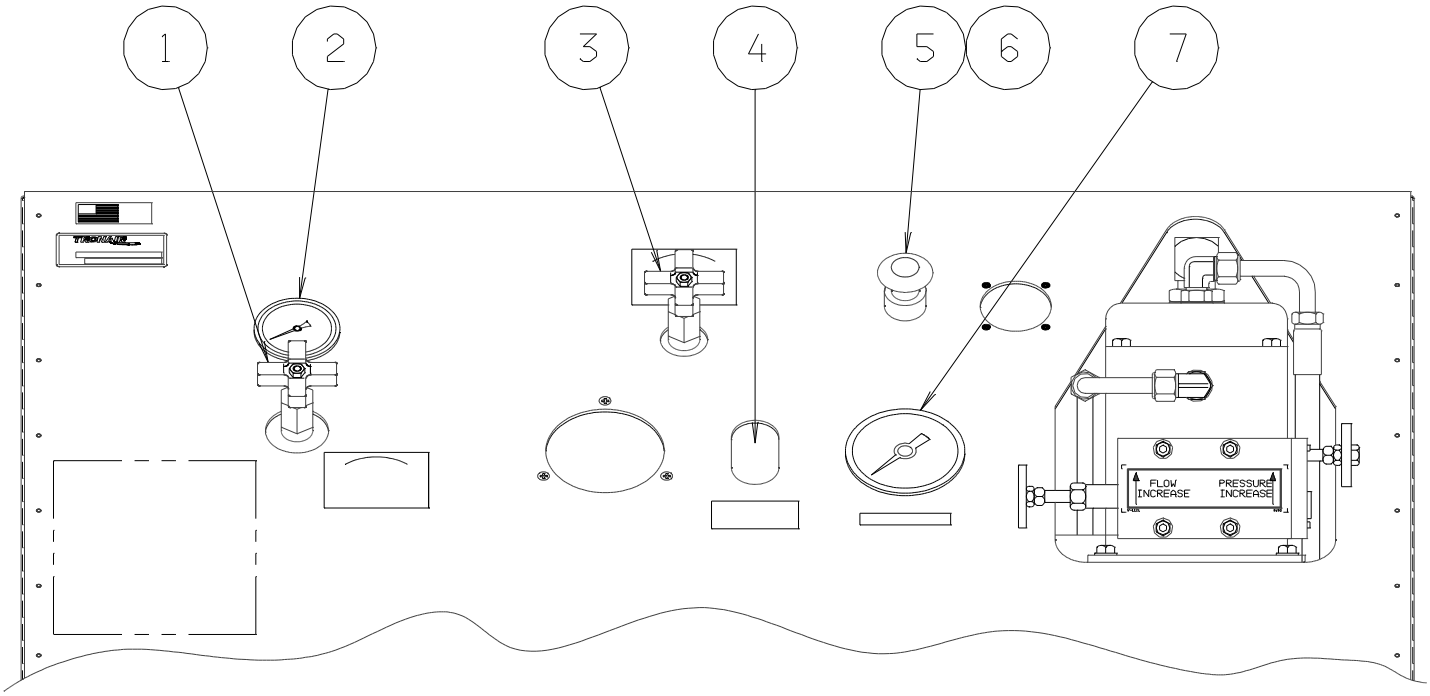
The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins 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*.**

11.0 APPENDICES

APPENDIX I Instrument Certification Notice
APPENDIX II Lincoln Motor Manual
APPENDIX III Oilgear Manual
APPENDIX IV Safety Data Sheet (SDS) Hydraulic Fluid

Instrument Panel Components Parts List

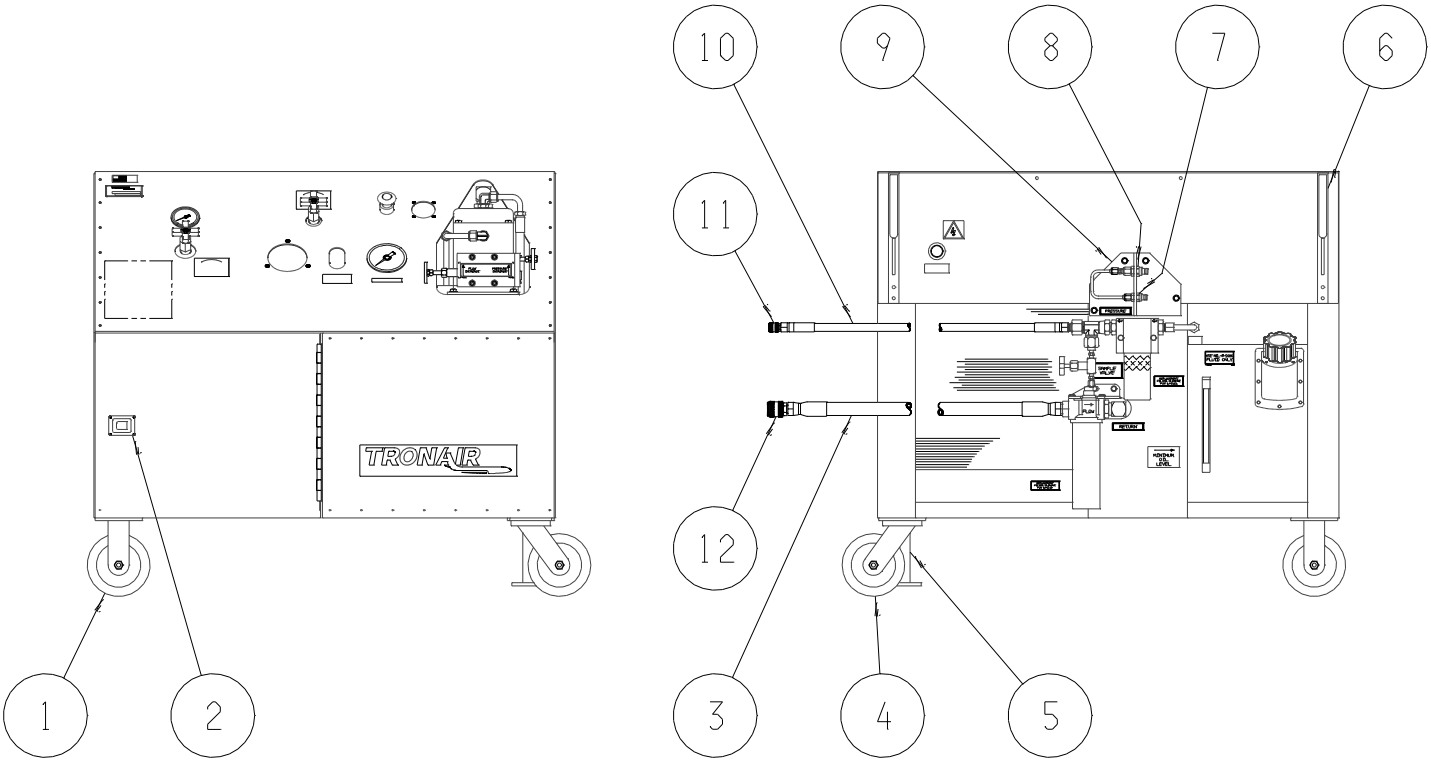
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1663	Valve, Return Back Pressure	1
2	HC-1787	Gauge, 2.50 * 200 psi	1
3	HC-1254	Valve, Bypass	1
4	HC-2150	Flowmeter	1
	HC-2150-A1	Flowmeter	1
5	EC-1058	Switch, On/Off	1
6	EC-1073	Lamp, Replacement	1
7	HC-1399	Gauge, 4.00 * 5,000 psi	1

External Components Parts List

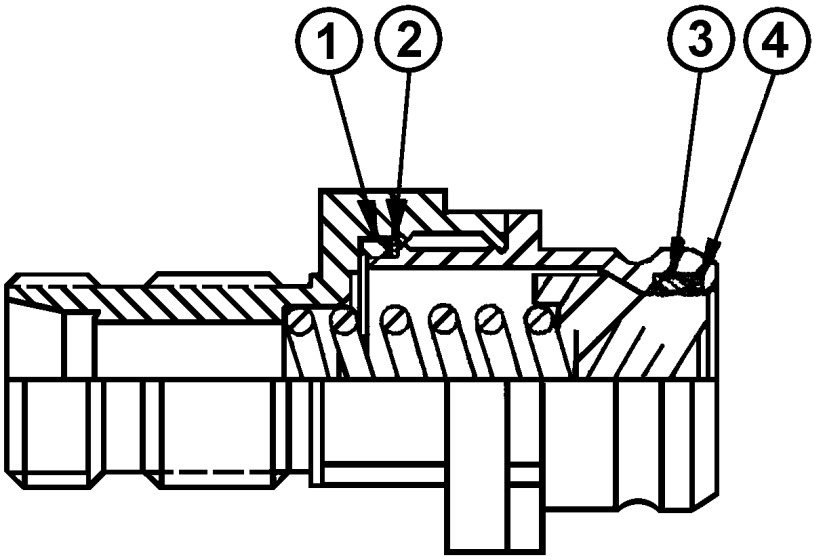
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	U-1013	Caster, Rigid	2
2	H-1207	Latch	1
3	TF-1039-01*180	Hose, Assembly (Return)	1
4	U-1014	Caster, Swivel	2
5	H-1175	Lock, Floor	1
6	Z-1296-01	Hanger, Hose	2
♦ 7	N-2598-01	Coupling, Quick Disconnect	1
♦ 8	N-2598-02	Coupling, Quick Disconnect	1
9	Z-4084	Assembly, Bulkhead Bypass (Includes Items 7 and 8)	1
10	TF-1037-01*180	Assembly, Hose (Pressure)	1
♦♦ 11	N-2566-04-B	Coupling, Quick Disconnect	1
♦♦ 12	N-2566-06-B	Coupling, Quick Disconnect	1

♦ ***See following page for exploded view and part numbers.***
♦♦ ***Replacement Kit: KHC-2675 contains Items 11 & 12.***

Parts List



N-2598-01 Quick Disconnect Coupling

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	HC-2000-015	O-ring, Series 2	1
2	HC-2020-015	Back-up Ring	1
3	HC-2000-011	O-ring, Series 2	1
4	HC-2020-011	Back-up Ring	1

N-2598-02 Quick Disconnect Coupling

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	HC-2000-016	O-ring, Series 2	1
2	HC-2020-016	Back-up Ring	1
3	HC-2000-013	O-ring, Series 2	1
4	HC-2020-013	Back-up Ring	1

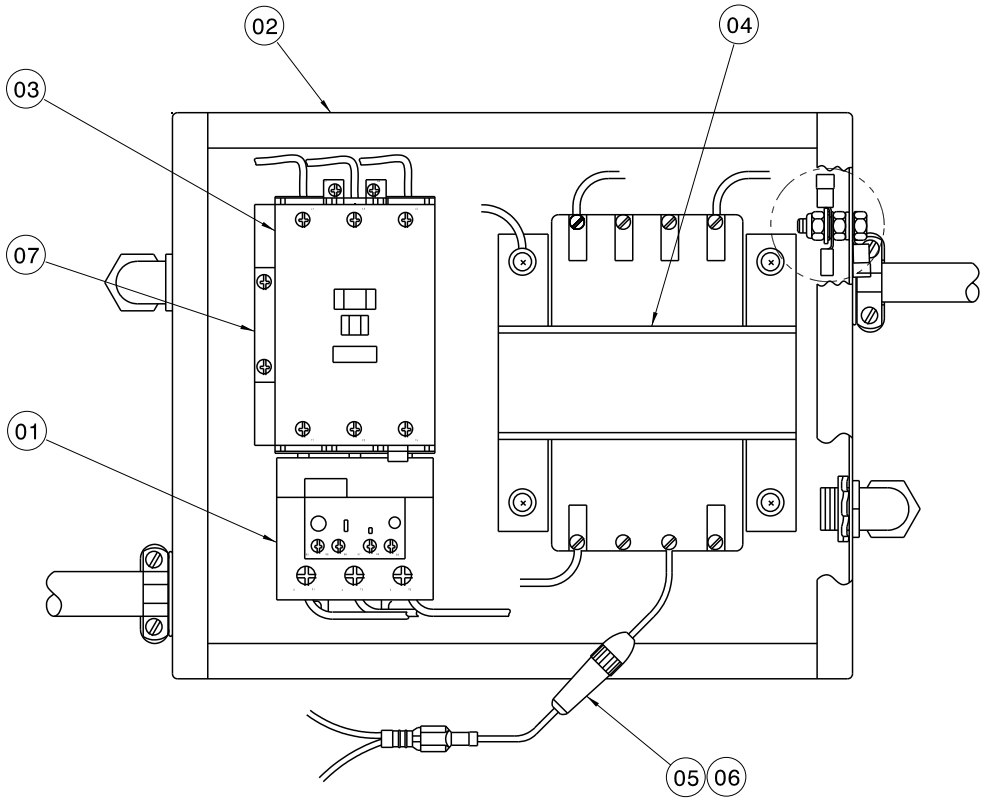
External/Internal Hoses Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Part Number	Description	Qty
TF-1039-05-60.0	Reservoir to Pump	1
TF-1037-07*30.0	Pump to Flowmeter	1
TF-1037-04*22.0	Control Block to Pressure Filter	1
TF-1037-03*16.0	Control Block to System Pressure Gauge	1
TF-1037-03*16.0	Control Block to Return Pressure Gauge	1
TF-1037-01*180	Pressure Filter to Aircraft	1
TF-1037-01*17.5	Control Block to Return Manifold	1
TF-1037-08*22.5	Pump to Small Cooler	1
TF-1037-12*24.0	Small Cooler to Return Manifold	1
TF-1039-01*180	Aircraft to Return Filter	1
TF-1039-05*24.0	Return Filter to Return Pressure Control Block	1
TF-1037-04*22.0	Return Pressure Control Block to Reservoir	1
TF-1039-02*09.0	Return Manifold to Large Cooler	1
TF-1039-02*36.0	Large Cooler to Reservoir	1
TF-1039-02*28.3	Return Pressure Control Block to Return Filter	1
TF-1039-02*28.3	Return Pressure Control Block to Return Manifold	1

Electrical Components Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Set Item 01 to "Auto" and set "A2" to its corresponding full load amps.

Item	Part Number	Description	Qty
2	EC-1310	Enclosure, Electrical	1
5	EC-1328	Holder, Fuse	1
6	EC-1210-08	Fuse, Slo-Blo	1
7	EC-1607	Contact, Auxiliary	1

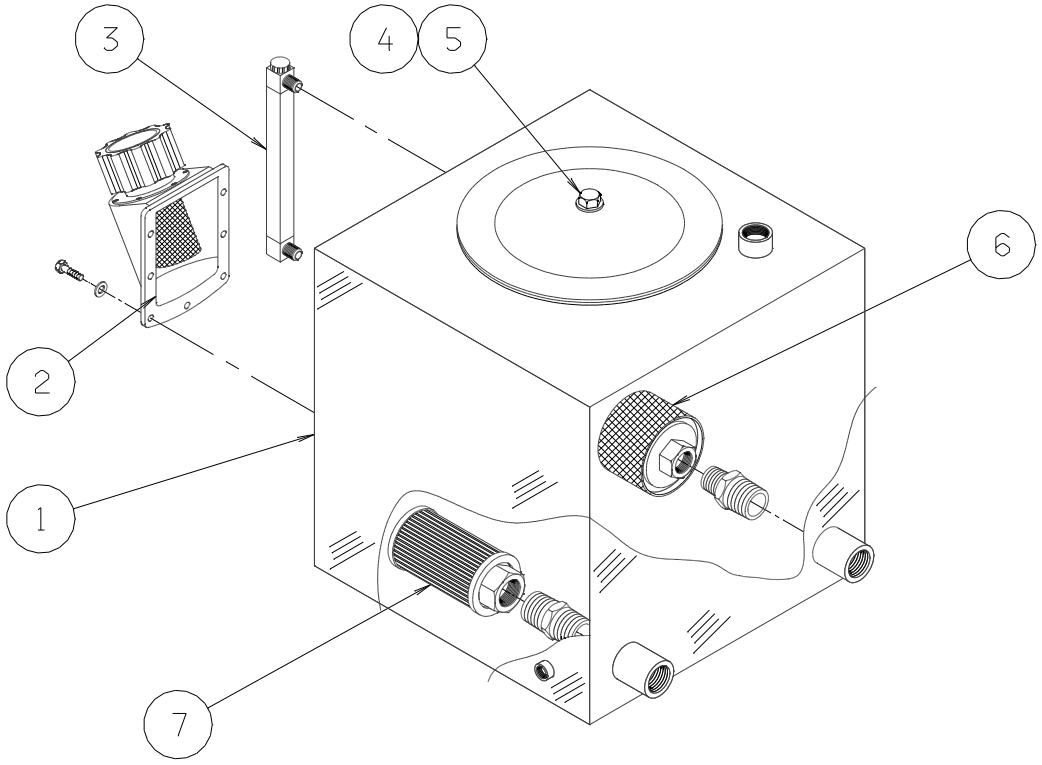
THE FOLLOWING PARTS ARE APPLICATION SPECIFIC
Be sure to locate the correct voltage and hertz of the unit before selecting the part

ITEM	60 HZ Applications						
	208	230	380	460	575	Description	Qty
1	N/A	N/A	N/A	EC-1834	EC-1834	Relay, IEC Overload	1
3	N/A	N/A	N/A	EC-1838	EC-1837	Contactor, IEC Motor	1
4	N/A	N/A	N/A	EC-1074	EC-1804-04	Transformer	1

ITEM	50 HZ Applications						
	200	220	380	415	440	Description	Qty
1	N/A	EC-1835	N/A	N/A	N/A	Relay, IEC Overload	1
3	N/A	EC-1840	N/A	N/A	N/A	Contactor, IEC Motor	1
4	N/A	EC-1074	N/A	N/A	N/A	Transformer	1

Reservoir Assembly Parts List

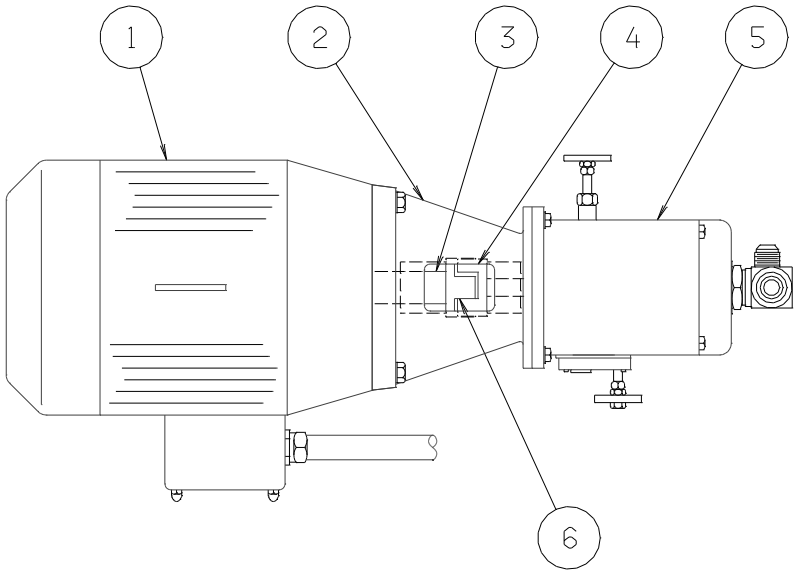
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	Z-3725	Reservoir, 15 Gallon, Stainless Steel	1
2	HC-1106	Breather, Filler	1
3	HC-1382-08	Gauge, Sight (Mineral Base)	1
4	H-1740	Gasket, Cover	1
5	H-1735-02	Washer, Nylon, 5/8	1
6	HC-1029	Diffuser, ¾" NPT	1
7	HC-1107	Strainer, Suction, 1" NPT	1

Pump/Motor Assembly Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	See Table	Motor, 10 Hp	1
2	HC-1393-11	Mount, Pump/Motor	1
3	H-2224-04	Half, Coupling (Motor)	1
4	H-2224-01	Half, Coupling (Pump)	1
♦ 5	K-1650	Assembly, Pump with Hardware	1
6	H-2227	Spider, Coupling	1

Part Number	Voltage
EC-1186-07	208V/60Hz, 380V/60Hz
EC-1186-08	230V/60Hz, 460V/60Hz, 220V/50Hz 380V/50Hz, 415V/50Hz, 440V/50Hz
EC-1186-09	575V/60Hz

PUMP REPLACEMENT PARTS

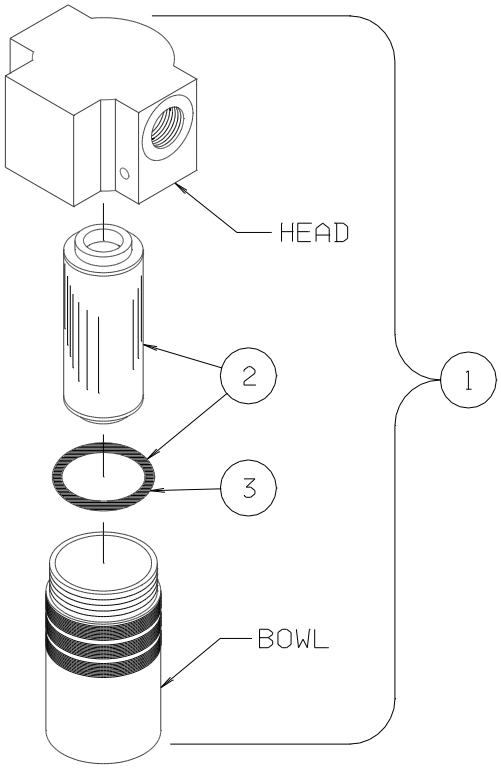
Item	Part Number	Description	Qty
7	HC-1543	Pump Shaft Seal	1
♦ 8	K-1994	Pump Gasket/O-ring Kit *(Mineral Base)*	1

NOTE: All bolts are Grade 5.

♦ ***See pump manufacturer's service booklet for servicing of Item #5 and additional repair kits.***

Pressure Filter Assembly Parts List

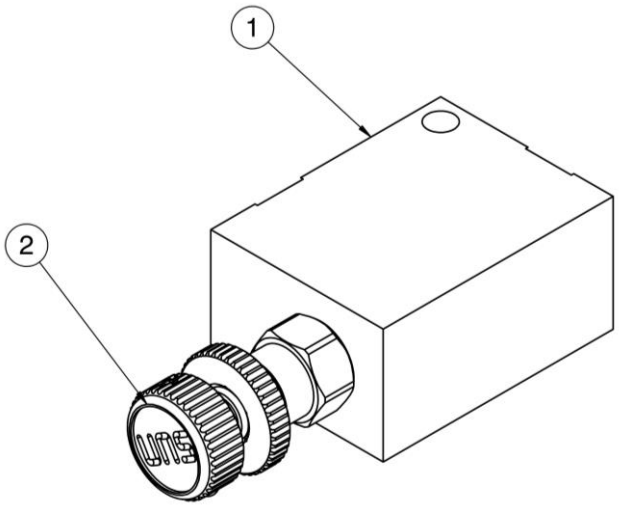
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1083	Assembly, Filter	1
2	K-1414	Kit, Filter Element	1
3	HC-2000-138	O-ring, Bowl	1

Return Back-Pressure Valve Parts List

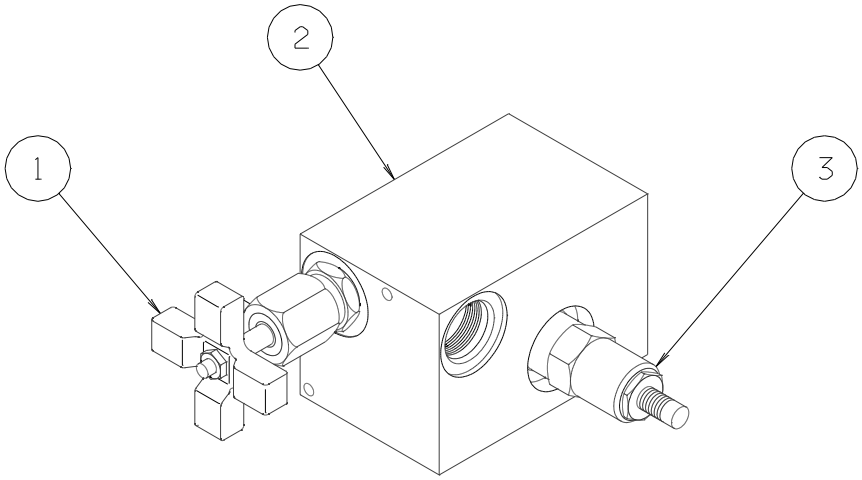
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-2729	Valve, Reducing/Relieving (MB)	1
2	HC-2749	Manifold, Backpressure	1

Return Back-Pressure Valve & Manifold Assembly Parts List

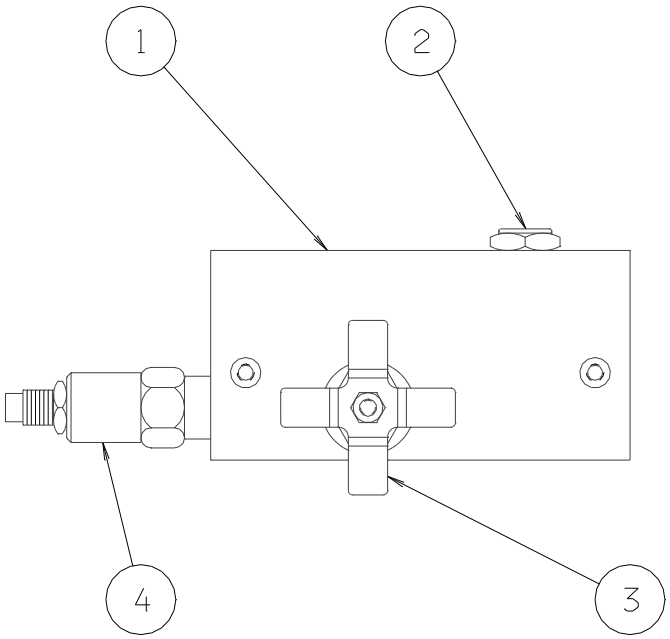
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1663	Valve, Needle	1
2	J-2674	Block, Return Control	1
3	HC-1623	Valve, Pressure Relief	1

Control Block Assembly Parts List

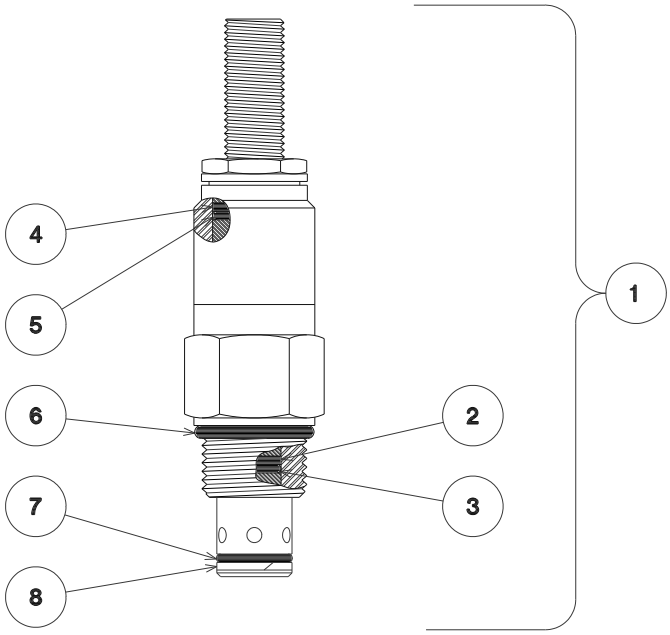
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	Z-2472-00	Control Block, Manifold	1
2	HC-1262	Valve, Check	1
3	HC-1254	Valve, Bypass	1
4	HC-1264-01	Valve, Pressure Relief	1

Pressure Relief Valve Parts List

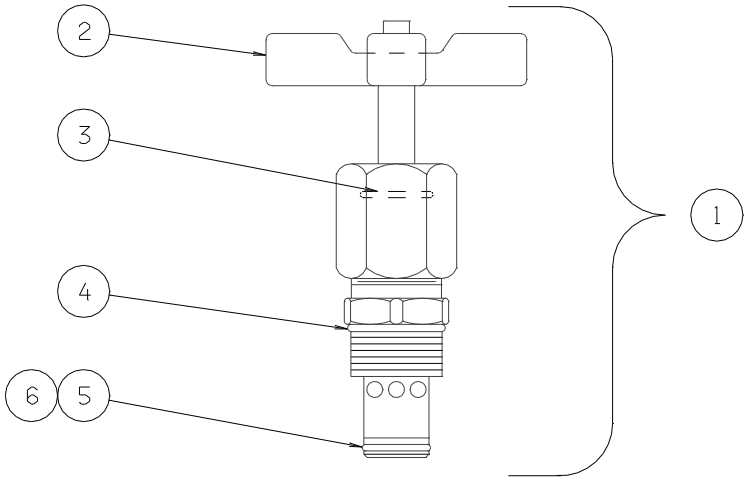
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1264-01	Valve, Pressure Relief	1
2	HC-2020-011	Ring, Back-up	*Ref.*
3	HC-2000-011	O-ring, Series 2	1
4	HC-2020-015	Ring, Backup	1
5	HC-2000-015	O-ring, Series 2	1
6	HC-2010-910	O-ring, Series 3	1
7	HC-2000-014	O-ring, Series 3	1
8	HC-2020-014	Ring, Backup	1

Bypass Valve Parts List

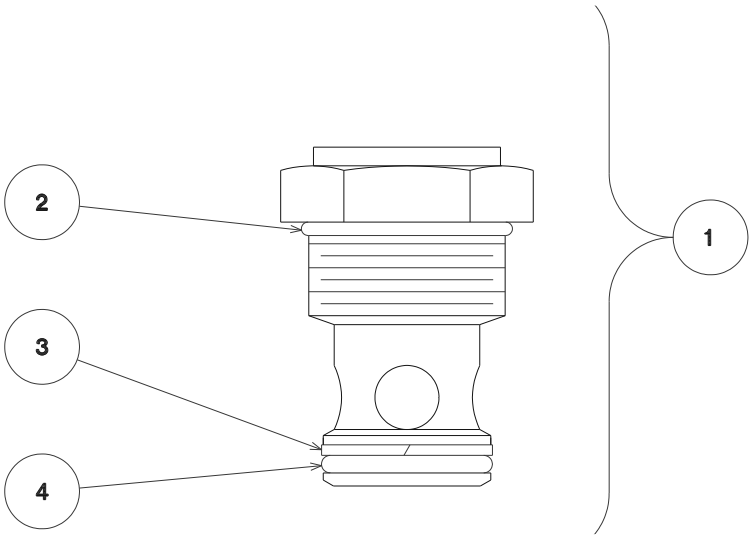
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1254	Assembly, Bypass Valve	1
2	HC-1130-016	Handle, Valve	1
3	HC-2000-012	O-ring	2
4	HC-2010-910	O-ring	1
5	HC-2020-014	Ring, Backup	1
6	HC-2000-014	O-ring	1

Check Valve Parts List

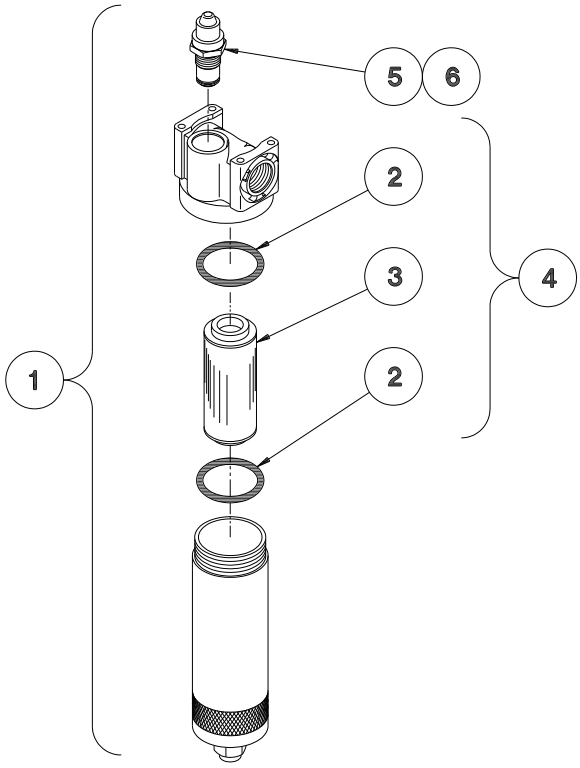
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1262	Valve, Check	1
2	HC-2010-910	O-ring	1
3	C-2000-014	O-ring	1
4	HC-2020-014	Ring, Backup	1

Return Filter Parts List

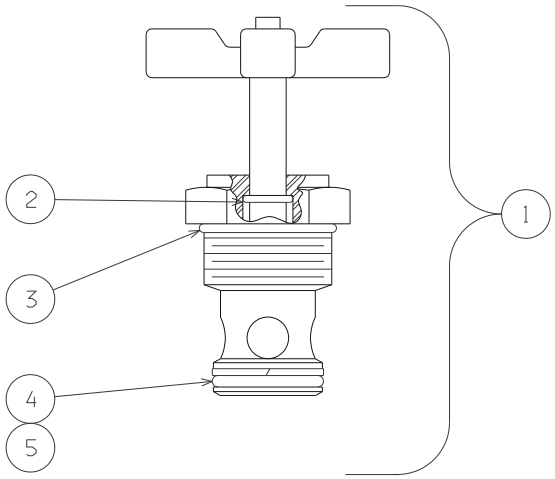
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1453	Assembly, Filter	1
2	HC-2000-142	O-ring	2
3	HC-1454	Element, Filter	1
4	K-3096	Kit, Filter Element	1
5	HC-1849	Indicator, Clogging	1
6	K-1509	Kit, O-ring	1

Needle (Return) Valve Parts List

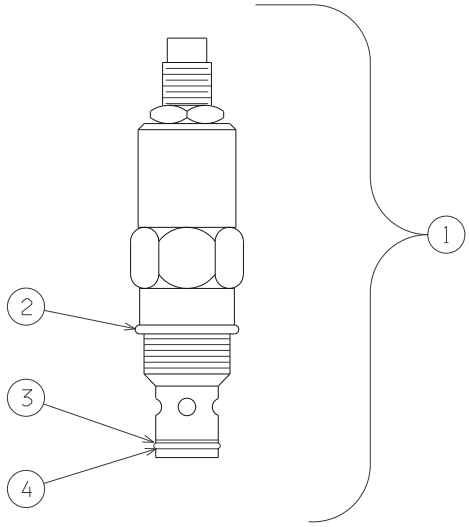
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1663	Valve, Needle	1
2	HC-2000-012	O-ring	1
3	HC-2010-916	O-ring	1
4	HC-2020-119	Ring, Backup	1
5	HC-2000-119	O-ring	1

Pressure Relief (Return) Valve Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	HC-1623	Valve, Pressure Relief	1
2	HC-2010-916	O-ring	1
3	HC-2000-119	O-ring	1
4	HC-2020-119	Ring, Backup	1

JPATS Initial Setting Instruction

1. Connect **return hose** to bulkhead runaround on rear of HPU.
2. Open system bypass valve.
3. Start HPU.
4. Adjust flow control for 1 to 2 gpm flow.
5. Close system bypass valve.
6. Adjust pressure control for desired pressure (3,000 psi).
7. Open system bypass valve.
8. Shut HPU off.
9. Connect **pressure hose** to bulkhead runaround on rear of HPU.
10. Open system bypass valve and return bypass valve.
11. Start HPU.
12. Close system bypass valve and return bypass valve.
13. Adjust back-pressure valve for desired back-pressure (50 to 60 psi).
14. Open system bypass valve.
15. Adjust flow control for desired flow (4 to 5 gpm).
16. Shut HPU off.
17. Attach hoses to aircraft.
18. Start HPU.
19. Test aircraft per maintenance manual.
20. Open system bypass valve.
21. Shut HPU off.
22. Disconnect hoses from aircraft.

APPENDIX I

Instrument Certification Notice

Instrument Certification Notice

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

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

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

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

TRONAIR®

APPENDIX II

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.

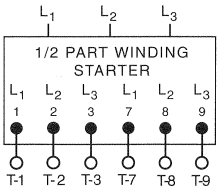
Number of Motor Leads	Number of Rated Voltages	Lead Numbers	YDS	PWS
3	Single	1-3	No	No
6	Single	1-3, 7-9	No	Yes
	Single	1-6	Yes	No
	Dual	1-6	Yes(1)	No
9	Dual	1-9	No	No
12	Single	1-12	Yes	Yes
	Dual	1-12	Yes	No(2)

(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.

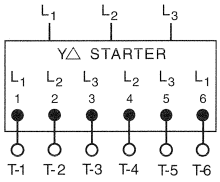
Connection Diagram 1

Single Voltage, 6 Leads
Part Winding Start Connection



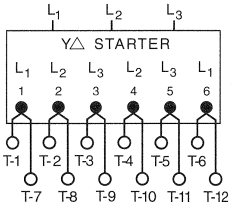
Connection Diagram 2

Single Voltage, 6 Leads
Y△ Start Connection



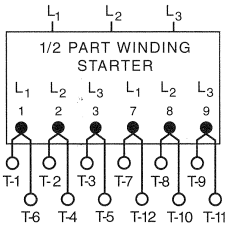
Connection Diagram 3

Single Voltage, 12 Leads
Y△ Start Connection



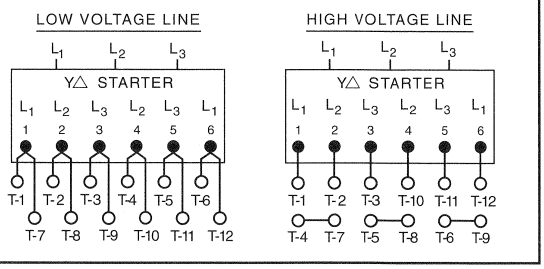
Connection Diagram 4

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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- indicates change since last printing.

TRONAIR®

APPENDIX III

Oilgear
Type PVWJ Pump Manual

OILGEAR TYPE "PVWJ" PUMPS - PVWJ-011/-014/-022/-025/-034/-046/-064/ -076/-098/-130 SERVICE INSTRUCTIONS

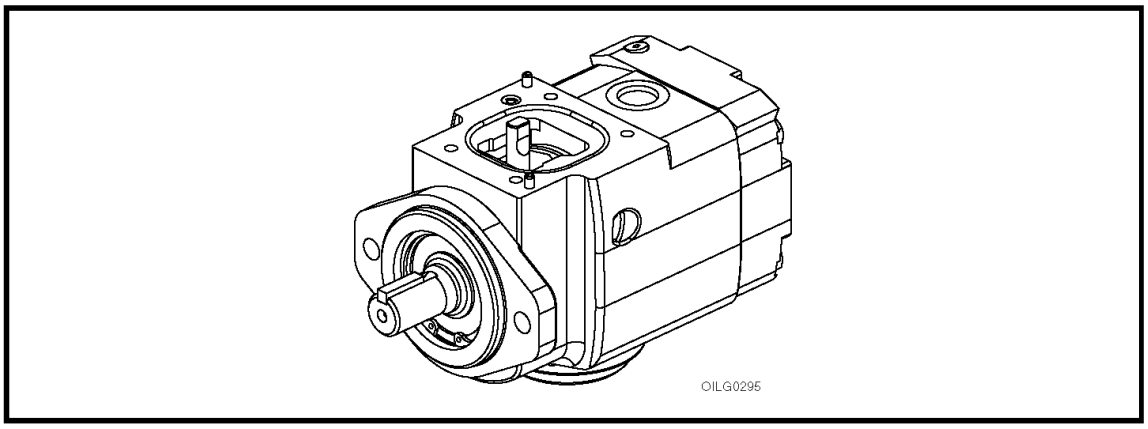

Figure 1. Typical Oilgear "PVWJ" Open Loop Pump

PURPOSE OF INSTRUCTIONS

These instructions will simplify the installation, operation, maintenance and troubleshooting of Oilgear type "PVWJ" pumps.

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

REFERENCE MATERIAL

Fluid Recommendations .....Bulletin 90000
Contamination Evaluation Guide.....Bulletin 90004
Filtration Recommendations .....Bulletin 90007
Piping Information .....Bulletin 90011
Proper Installation of Vertical Pumps .....Bulletin 90014
Alternate Remote Compensating of Single/Multiple Load Sense Pumps DS-47974-A
PVWJ Open Loop Pumps, Application Guidelines.....Bulletin 847085
PVWJ Open Loop Pumps, Sales .....Bulletin 47085

(continued)

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

Bulletin 947085

PVWJ BASIC PUMP INSTALLATIONS

PVWJ A Frame (PVWJ-011/-014/-022) w/ Rear Ports DS-47480
PVWJ A Frame (PVWJ-011/-014/-022) w/ Side Ports DS-47481
PVWJ A Frame (PVWJ-011/-014/-022) w/ Side Ports & Thru Shaft DS-47482
PVWJ B Frame (PVWJ-025/-034/-046) w/ Rear Ports DS-47483
PVWJ B Frame (PVWJ-025/-034/-046) w/ Side Ports DS-47484
PVWJ B Frame (PVWJ-025/-034/-046) w/ Side Ports & Thru Shaft DS-47485
PVWJ C Frame (PVWJ-064) w/ Rear Ports DS-47486
PVWJ C Frame (PVWJ-064) w/ Side Ports & w/ or w/o Thru Shaft DS-47487
PVWJ C Frame (PVWJ-076/-098/-130) w/ Rear Ports DS-47488
PVWJ C Frame (PVWJ-076/-098/-130) w/ Side Ports & w/ or w/o Thru Shaft DS-47489

PVWJ PUMP CONTROL INSTRUCTIONS

"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-011/-014/-022 ..... Bulletin 947633
"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-025/-034/-046 ..... Bulletin 947634
"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-064/-076/-098/-130 .. Bulletin 947635
"P-1NN/F" and "P-LNN/F" Pressure Compensator w/ Load Sense for
PVWJ-011/-014/-022 ..... Bulletin 947636
"P-1NN/F" and "P-LNN/F" Pressure Compensator w/ Load Sense for
PVWJ-025/-034/-046 ..... Bulletin 947637
"P-1NN/F" and "P-LNN/F" Pressure Compensator w/ Load Sense for
PVWJ-064/-076/-098/-130 ..... Bulletin 947638
"P-CNN" and "P-KNN" Soft Start Pressure Compensator for
PVWJ-011/-014/-022 ..... Bulletin 947639
"P-CNN" and "P-KNN" Soft Start Pressure Compensator for
PVWJ-025/-034/-046 ..... Bulletin 947640
"P-CNN" and "P-KNN" Soft Start Pressure Compensator for
PVWJ-064/-076/-098/-130 ..... Bulletin 947641
Dual Pump Adapters for PVWJ Pumps (all sizes) DS-47490
Alternate Remote Compensating of Single or Multiple Load Sense Pump DS-47974-A

PVWJ PUMP CONTROL INSTALLATIONS

"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-011/-014/-022 ..... DS-47984
"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-025/-034/-046 ..... DS-47985
"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-064/-076/-098/-130 ..... DS-47986
"P-1NN/F" and "P-LNN/F" Pressure Compensator w/ Load Sense for
PVWJ-011/-014/-022 ..... DS-47987
"P-1NN/F" and "P-LNN/F" Pressure Compensator w/ Load Sense for
PVWJ-025/-034/-046 ..... DS-47988
"P-1NN/F" and "P-LNN/F" Pressure Compensator w/ Load Sense for
PVWJ-064/-076/-098/-130 ..... DS-47989
"P-CNN" and "P-KNN" Soft Start Pressure Compensator for
PVWJ-011/-014/-022 ..... DS-47990
"P-CNN" and "P-KNN" Soft Start Pressure Compensator for
PVWJ-025/-034/-046 ..... DS-47991
"P-CNN" and "P-KNN" Soft Start Pressure Compensator for
PVWJ-064/-076/-098/-130 ..... DS-47992
PVWJ Remote Circuit Drawing "P-1NN/F" or "P-LNN/F" Single Pressure
w/ Load Sense Control DS-47491

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

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

SAFETY SYMBOLS

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

⚠ DANGER ⚠

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

⚠ WARNING

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

CAUTION

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

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

⚠ WARNING

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

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

PREPARATION AND INSTALLATION

MOUNTING

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

Pump With Reservoir - These pumps are usually fully piped and equipped. It may be necessary to connect to a super-charge circuit when used. Mount reservoir on level foundation with the reservoir bottom at least 6 inches (152 mm) above floor level to facilitate fluid changes.

PIPING AND FITTINGS

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

NOTE *DO NOT use an inlet strainer.*

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

⚠ WARNING

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

POWER

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

CAUTION

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

DRIVE

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

CAUTION

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

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

FILTRATION

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

FLUID COOLING

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

AIR BREATHER

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

FLUID, FILLING AND STARTING RECOMMENDATIONS

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

1. Pump all fluid into reservoir through a clean (beta 10 ratio of 4 or more) filter. Fill reservoir to, but not above, "high level" mark on the sight gauge.
2. **Remove case drain line and fill pump case with hydraulic fluid.**
3. Turn drive shaft a few times by hand with a spanner wrench to make sure parts rotate.

Unit	Approximate torque to turn drive shaft
-011/-014/-022	1.7-2.1 ft·lbs (2,3-2,8 N·m)
-025/-034/-046	2.9-3.3 ft·lbs (4,0-4,5 N·m)
-064/-076/-098/-130	7.9-8.3 ft·lbs (18,8-11,3 N·m)

Table 1. Torque to Turn Shaft

With pump under "no load" or with pump control at NEUTRAL:

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

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

SPECIFICATIONS

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

FRAME	UNIT	THEORETICAL MAXIMUM DISPLACEMENT		RATED CONTINUOUS PRESSURE		MAXIMUM PRESSURE		FLOW RATE at 1800 rpm, rated continuous pressure and 14,7 psia (1.0 bar) inlet condition		MAXIMUM INLET PRESSURE* psia (bar)			MAXIMUM SPEED**	POWER INPUT at rated continuous pressure & 1800 rpm	
		in^3/rev	ml/rev	psi	bar	psi	bar	gpm	l/mi	1200 rpm	1500 rpm	1800 rpm	rpm	hp	kw
A	011	0.66	10,8	5000	344,8	5800	400,0	4.2	15,9	5.4 (,37)	5.7 (,39)	6.1 (,42)	3000	16.3	12,2
	014	0.86	14,1	4000	275,9	4500	310,3	5.9	22,4	5.5 (,38)	5.9 (,41)	6.4 (,44)	3000	17.7	13,2
	022	1.35	22,1	3000	206,9	3500	241,4	9.5	36,0	5.5 (,38)	6.0 (,41)	7.0 (,48)	3000	20.2	15,1
B	025	1.55	25,4	5000	344,8	5800	400,0	10.9	41,3	7.0 (,48)	7.3 (,50)	8.2 (,57)	3000	36.5	27,2
	034	2.06	33,8	3500	241,4	4000	275,9	14.7	55,7	7.0 (,48)	7.6 (,52)	8.4 (,58)	3000	35.5	26,5
	046	2.83	46,4	2500	172,4	3000	206,9	20.6	78,1	7.2 (,50)	7.9 (,54)	9.0 (,62)	2400	35.0	26,1
C	064	3.88	63,6	5000	344,8	5800	400,0	27.4	103,8	7.6 (,59)	8.5 (,59)	9.5 (,66)	2400	95.1	70,9
	076	4.67	76,5	3500	241,4	4000	275,9	33.7	127,7	8.0 (,55)	8.6 (,59)	9.6 (,66)	2400	80.4	60,0
	098	6.00	98,3	2500	172,4	3000	206,9	43.3	164,1	7.6 (,52)	8.6 (,59)	9.8 (,68)	2400	74.1	55,3
	130	7.94	130,2	1500	103,4	2000	137,9	58.2	220,3	8.0 (,55)	9.3 (,64)	14.5 (1,00)	1800	64.0	47,8

* For higher speeds see suction curves.
** Minimum speed 600 rpm

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

Table 2. Nominal Performance Data with 150-300 SSU viscosity fluids.

Frame	Unit	Length		Width		Height		Weight	
		inches	mm	inches	mm	inches	mm	lbs.	kg
A	011/-014/-022	7.20	182,9	4.32	109,7	4.50	114,3	32	14,5
B	025/-034/-046	8.50	215,9	5.80	147,3	6.11	155,2	68	30,9
C	064/-076/-098/-130	10.44	265,2	6.76	171,7	7.18	182,4	103	46,8

All dimensions (without controls) are for rear ported units. For dimensions of other configurations, contact your Oilgear Representative or see the appropriate Data Sheet.

Table 3. Nominal Dimensions and Weights without controls.

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

TROUBLESHOOTING

PROBLEM	CAUSES	REMEDY
Unresponsive or Unstable Control	Swashblock (201) bearing surface and/or saddle bearings (204) worn or damaged.	Inspect and replace if necessary.
	Control pin (721) and/or hole in swashblock (201) worn significantly.	
	Saddle bearing locating pins (207) broken.	
	Fluid is contaminated.	Inspect and clean if necessary. See bulletin 90007.
	Control piston orifice plugged.	See appropriate control service bulletin.
	Contamination trapped between control piston and piston bore is not allowing piston to move smoothly.	
	Contamination trapped between control spool and spool bore is not allowing spool to move smoothly.	
	Faulty remote pressure compensator circuit components.	Inspect and replace if necessary.
	Hydraulic line between remote pressure compensator components and RP port of control is too long.	Shorten line length.
	Insufficient control flow.	Increase size of control piston orifice (732).
Insufficient Outlet Volume	Swashblock (201) not stroking to desired displacement.	Inspect for obstruction and remove. Replace worn or damaged parts.
	Low input drive speed.	Refer to appropriate pump performance specifications.
	Worn or grooved cylinder barrel (101) and/or valve plate (401) mating surfaces.	Inspect and replace if necessary.
	Failed drive shaft (301).	
	Worn or damaged piston shoes (102) or swashblock (201).	
	Worn pistons and/or piston bores.	
	Excessive wear or inadequately supported hydrodynamic bearing (202).	
	Maximum volume stop adjusted incorrectly.	Adjust maximum volume stop CCW to increase outlet flow.
	Control piston stuck off stroke.	See appropriate control service bulletin.
	Pressure compensator is set too close to operating pressure.	
De-strokes at Low Pressure	Pressure compensator adjustment not set correctly.	See appropriate control service bulletin.
	Control piston orifice (732) plugged.	
	Damaged or fractured control spring.	
	Severely worn control spool and/or spool bore.	
	Damaged or fractured control piston spring.	
	Faulty remote pressure compensator circuit components.	
Excessive Peak Pressure	Pressure compensator is set too high.	See appropriate control service bulletin.
	Minimum volume stop is set too high.	
	Fluid is contaminated.	Inspect and clean if necessary. See bulletin 90007.
	Swashblock (201) bearing surface and/or saddle bearings (204) worn or damaged.	Inspect and replace if necessary.
	Contamination trapped between control piston and piston bore is not allowing piston to move smoothly.	See appropriate control service bulletin.
	Contamination trapped between control spool and spool bore is not allowing spool to move smoothly.	
	Hydraulic line between remote pressure compensator components and RP port of control is too long.	Shorten line length.
	Faulty remote pressure compensator circuit components.	Inspect and replace if necessary.
	Restriction in drilled passages between pump outlet port and control spool.	Inspect and clean if necessary.

Excessive Heating	Operating pump above rated or peak pressure.	Consult appropriate pump specification for pressure limitations.
	Low fluid level in reservoir.	Verify fluid level is above reservoir suction line.
	Insufficient pump inlet pressure.	Eliminate any obstructions or other pressure drops in pump inlet plumbing. Consult appropriate pump specification for inlet pressure requirements.
	Air entering pump inlet plumbing.	Eliminate leaks that would allow air to enter the fluid stream.
	Worn pistons (102) or cylinder barrel (101).	Inspect and replace if necessary.
	Worn or damaged cylinder barrel (101) and/or valve plate (401) mating surfaces.	
	Faulty circuit components (continuously blowing relief valve or a high-pressure leak).	Eliminate leak or replace faulty components.
	Insufficient cooling provisions.	Inspect heat exchanger for obstructions and remove.
	Reservoir is too small.	Consult Bulletin 90050-B, Reservoir Design.
Excessive Noise	Pump stopped or started incorrectly under load.	Verify operator procedure.
	Low fluid level in reservoir.	Verify fluid level is above reservoir suction line.
	Air entering pump inlet plumbing.	Eliminate leaks that would allow air to enter the fluid stream.
	Broken shoe/piston assembly (102).	Inspect and replace if necessary.
	Worn or damaged cylinder barrel (101) and/or hydrodynamic bearing (202) running surface.	
	Faulty circuit components (continuously blowing relief valve or a high-pressure leak).	Eliminate leak or replace faulty components.
	Insufficient pump inlet pressure.	Consult appropriate pump specification for inlet pressure requirements.
	Excessive fluid viscosity.	Consult Application Guidelines (Bulletin 847085) for maximum viscosity limitations.
	Insufficient pump inlet pressure.	Eliminate any obstructions or other pressure drops in pump inlet plumbing. Consult appropriate pump specification for inlet pressure requirements.
	Pump input shaft rotating in wrong direction.	Inspect and correct drive rotation.

PRINCIPLE OF OPERATION

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

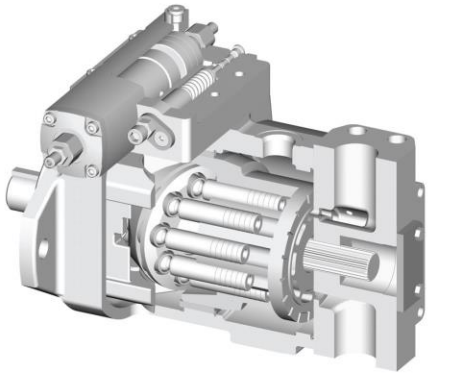

Figure 2. Cut-a-way of a Typical "PVWJ" Pump with Typical Control

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

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

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

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

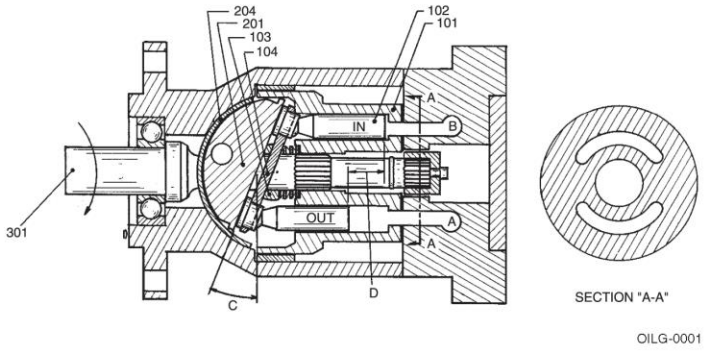

Figure 3. Position B, Pump During Full Delivery From Port B

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

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

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

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

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

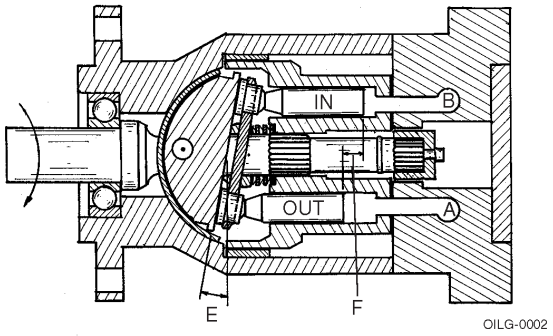

Figure 4. Position B/2, Pump During One Half Delivery From Port B

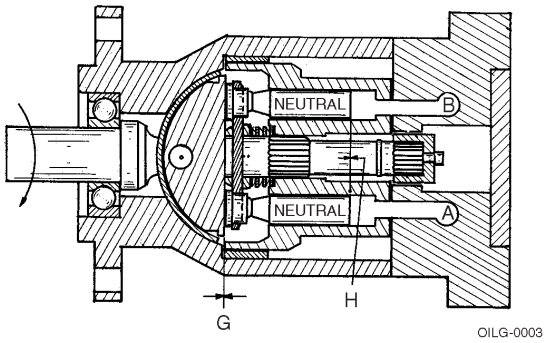

Figure 5. Position N, Pump In Neutral, No Stroke, No Delivery

TESTING AND ADJUSTING

PISTON PUMP

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

⚠ WARNING

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

With an accurate high-pressure gauge in the pressure line, start the pump and stall (or block) output device to raise system pressure to maximum (as set by system relief valve). Read the measurement on the flow meter or time and measure the case drain flow used to fill a known size container and calculate the flow rate in terms of cubic inches per minute (cipm). The leakage should conform to **Table 4**.

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.

NOTE *Increasing shaft speed or a decrease in fluid viscosity will increase leakage. Manually or mechanically de-stroking the pump has a negligible effect on leakage.*

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

NOTE *If testing a unit with a pressure compensator control, make sure the compensator setting is at least 500 psi above the pump outlet pressure to assure the pump is at full stroke.*

Unit	Full Stroke Leakage @ Pump Outlet Pressure (psi)											
	1500 psi		2500 psi		3000 psi		3500 psi		4000 psi		5000 psi	
	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm	cipm	lpm
011	50	2.08	70	1.1	80	1.3	100	1.6	120	2.0	200	3.3
014	90	1.5	120	2.0	140	2.3	165	2.7	200	3.3	-	-
022	120	2.0	170	2.8	200	3.3	-	-	-	-	-	-
025	105	1.7	135	2.2	150	2.4	175	2.9	210	3.4	300	4.9
034	150	2.4	210	3.4	250	4.1	300	4.9	-	-	-	-
046	230	3.8	300	4.9	-	-	-	-	-	-	-	-
064	150	2.4	205	3.4	240	3.9	275	4.5	320	5.2	460	7.6
076	200	3.3	305	5.0	375	6.1	460	7.6	-	-	-	-
098	270	4.4	460	7.6	-	-	-	-	-	-	-	-
130	530	8.7	-	-	-	-	-	-	-	-	-	-

Table 4. Nominal Case Slip at full stroke and 1800 RPM, fluid viscosity 160 SSU.

DISASSEMBLY

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

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

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

⚠ WARNING

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

1. Disconnect case drain line from port **1** or **1A**.
2. Drain pump case through the remaining (port **1** or **1A**) on the bottom of case. If plugs are inaccessible, it may be necessary to remove the pump from the mounting and drive motor before draining it.
3. After removing the pump from the mounting and before disassembly, cap or plug all ports and clean the outside of unit thoroughly to prevent dust from entering the system. See **Figures 10** and **18**.

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

CONTROL GROUP

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

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

VALVE PLATE GROUP

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

1. Block the pump on a bench with the drive shaft facing down.
2. If applicable, remove relief valve block from valve plate.
3. Remove the valve plate **(401)** by removing four hex head cap screws **(403)** and lifting it straight up.
4. Remove O-rings.

ROTATING GROUP

⚠ WARNING

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

1. Place the pump in a horizontal position.
2. Remove the rotating group by turning shaft **(301)** slowly, while pulling the cylinder barrel **(101)** from the housing.
3. Identify (number) each pump piston shoe assembly **(102)** and its respective bore in the cylinder barrel **(101)** and shoe retainer **(104)** for easy reassembly.
4. See **Figure 6**. Lift out shoe retainer **(104)** with pistons **(102)** and remove the fulcrum ball **(103)** and shoe retainer spring **(105)**.

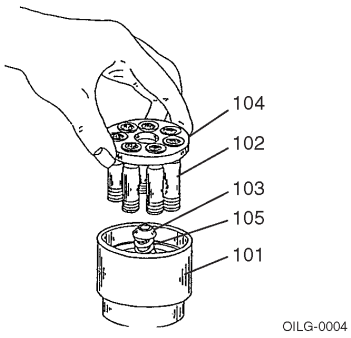

Figure 6. Rotating Group Disassembly.

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

DRIVE SHAFT GROUP

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

SWASHBLOCK GROUP

1. Reach inside the housing and remove the swashblock **(201)** and saddle bearings **(204)**.
2. If applicable, remove the saddle block **(216)** from the housing.

INSPECTION

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

⚠ WARNING

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

CONTROL GROUP

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

VALVE PLATE GROUP

Inspect the valve plate **(401)** surface which mates with the cylinder barrel **(101)** for excessive wear or scoring. Remove minor defects by lightly stoning the surface with a hard stone which is flat to within 0.001 inches (0,025 mm).

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

ROTATING GROUP

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

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

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

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

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

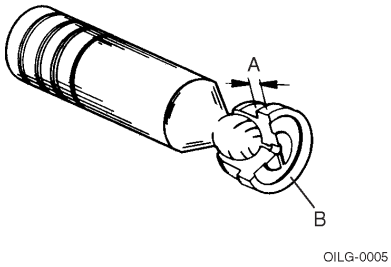

Figure 7. Piston and Shoe Inspection

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

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

SWASHBLOCK GROUP

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

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

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

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

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

DRIVE SHAFT GROUP

Check:

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

ASSEMBLY

See **Figures 8, 9 and 10**. Follow the disassembly procedures in reverse for re-assembling the pump.

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

SWASHBLOCK GROUP

If removed,

1. Press shaft seal **(007)** into front of pump housing.
2. Place housing on a bench with the mounting flange side down.
3. If applicable, install the saddle block **(216)** into the housing. Make sure the anti-rotating pin **(217)** aligns the saddle block correctly.
4. Grease the back side of each saddle bearing **(204)** and place on the pin to locate the bearings in the pump case. Make sure the pins do not protrude.
5. Insert swashblock **(201)** into the pump housing. Once in place, be sure the swashblock swivels in the saddle bearings. With new bearings, swiveling may be stiff and not always smooth.
6. Make sure the roll pin **(205)** is inserted into the cylinder bearing **(202)**. Position the cylinder bearing so the pin is located at the same location as it was when the pump was disassembled. The bearing should fit into place with a little difficulty and be square to the axis of the pump.
7. Tap bearing into place if necessary using extreme care not to damage the bearing.
8. Insert retaining ring **(208)** to hold bearing in place.

NOTE *Refer to **Figure 8** and **Figure 9** for the correct orientation of the pins for the appropriate frame size.*

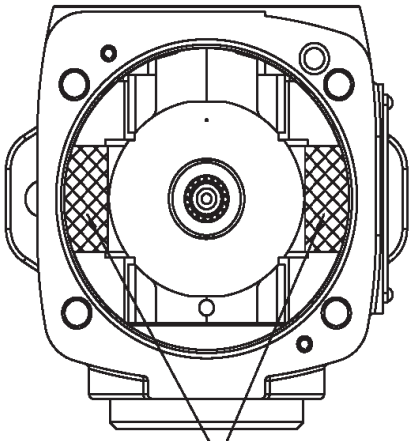

Figure 8. A-Frame Orientation of Pins

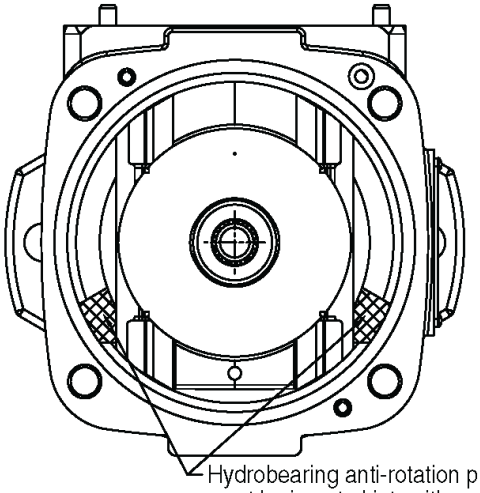

Figure 9. B-Frame and C-Frame Orientation of Pins

DRIVE SHAFT GROUP

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

ROTATING GROUP

See **Figure 6.**

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

⚠ WARNING

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

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

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

4. Push cylinder forward until the cylinder spline reaches the drive shaft spline and rotate slightly to engage shaft splines. Continue to slide cylinder forward until it encounters the cylinder bearing **(202)**. Lifting the tailshaft slightly helps the cylinder **(101)** and the cylinder bearing **(202)** engagement. Continue pushing the cylinder forward until the piston shoes contact the swashblock. The back of the cylinder should slightly protrude outside the back of the pump housing.
5. Install and torque the four control screws to the appropriate value shown in **Table 5**.

RELIEF VALVE BLOCK

1. Install new O-rings on the relief block.
2. Position the relief valve block over the outlet port of the valve plate.
3. Install and torque the four screws to the appropriate value shown in **Table 5**.

VALVE PLATE GROUP

1. Place the partially assembled pump housing on a bench with the open end facing up.
2. Install new O-rings on the housing.
3. Position the valve plate **(401)** over the tailshaft and on pins **(005)** and housing.
4. Install and torque the four valve plate screws to the appropriate value shown in **Table 5**.
5. If any plugs were removed, reinstall and torque them to the appropriate value shown in **Table 5**.

CONTROL GROUP

1. Place the assembled pump on its side with the axis horizontal.
2. Install new O-rings on the housing.
3. Install the control pin into the swashblock.
4. Position the control assembly so the control pin fits into the annular slot of the control piston.
5. Assemble the control assembly to the pump assembly, making sure that both alignment pins **(006)** are correctly inserted into their respective holes of the control body.

NOTE *It may be necessary to mechanically position the control piston to correctly align the control on the pump.*

PVWJ PUMP TORQUES

	Item Number	Description	Head Type & Size	Tightening Torque
A-Frame PVWJ-011 PVWJ-014 PVWJ-022	002	Housing Plug	3/4" Internal Hex	100 ft-lbs (136 N·m)
	403	Valve Plate Screws	3/8" Internal Hex or 9/16" External Hex	15 ft-lbs (20 N·m)
	507	Tandem Cover Screws	1/2" Internal Hex	325 in.-lbs (5 N·m)
	601	SAE #2 Plug	1/8" Internal Hex	45 in.-lbs (5 N·m)
	626	SAE #10 Plug	1" External Hex	90 ft-lbs (122 N·m)
B-Frame PVWJ-025 PVWJ-034 PVWJ-046	403	Valve Plate Screws	3/4" External Hex	37 in.-lbs (50 N·m)
	405	SAE #2 Plug	1/8" Internal Hex	45 in.-lbs (5 N·m)
	503	SAE A Tandem Mounting Screws	9/16" External Hex	28 ft-lbs (38 N·m)
		SAE B Tandem Mounting Screws	3/4" External Hex	37 ft-lbs (50 N·m)
	507	Cover Plate or Adapter Screws	1/2" External Hex	325 in.-lbs (37 N·m)
	902	Relief Valve Block Screws	3/8" Internal Hex	44 ft-lbs (60 N·m)
C-Frame PVWJ-064 PVWJ-076 PVWJ-098 PVWJ-130	403	Valve Plate Screws	14 mm Internal Hex	56 ft-lbs (76 N·m)
	503	SAE A Tandem Mounting Screws	9/16" External Hex	28 ft-lbs (38 N·m)
		SAE B Tandem Mounting Screws	3/4" External Hex	37 ft-lbs (50 N·m)
		SAE C Tandem Mounting Screws	15/16" External Hex	74 ft-lbs (100 N·m)
	507	Cover Plate Screws	1/2" External Hex	325 in.-lbs (37 N·m)
		Adapter Screws	9/16" External Hex	28 ft-lbs (38 N·m)
	601	SAE #2 Plug	1/8" Internal Hex	45 in.-lbs (5 N·m)
	902	Relief Valve Block Screws (PVWH-076/-098/-130)	3/8" Internal Hex	68 ft-lbs (92 N·m)
		Relief Valve Block Screws (PVWH-064)	1/2" Internal Hex	138 ft-lbs (187 N·m)

Table 5. PVWJ Pump Assembly Torques

CONTROL O-RING SEALS

Item Number	ARP 568 Uniform Size Number	Shore A Durometer
1008	008	70
1010	010	90
1012	012	90
1042	042	70
1138	138	70
1145	145	70
1155	155	70
1159	159	70
1219	219	90
1222	222	90
1225	225	90
1228	228	90
1237	237	70
1242	242	70
1252	252	70
1257	257	70
1500	See note 1	80
1902	902	90
1910	910	90

Note 1. 94 mm OD x 2.5 mm

Table 6. PVWJ Pump O-Ring Seals

NOTES

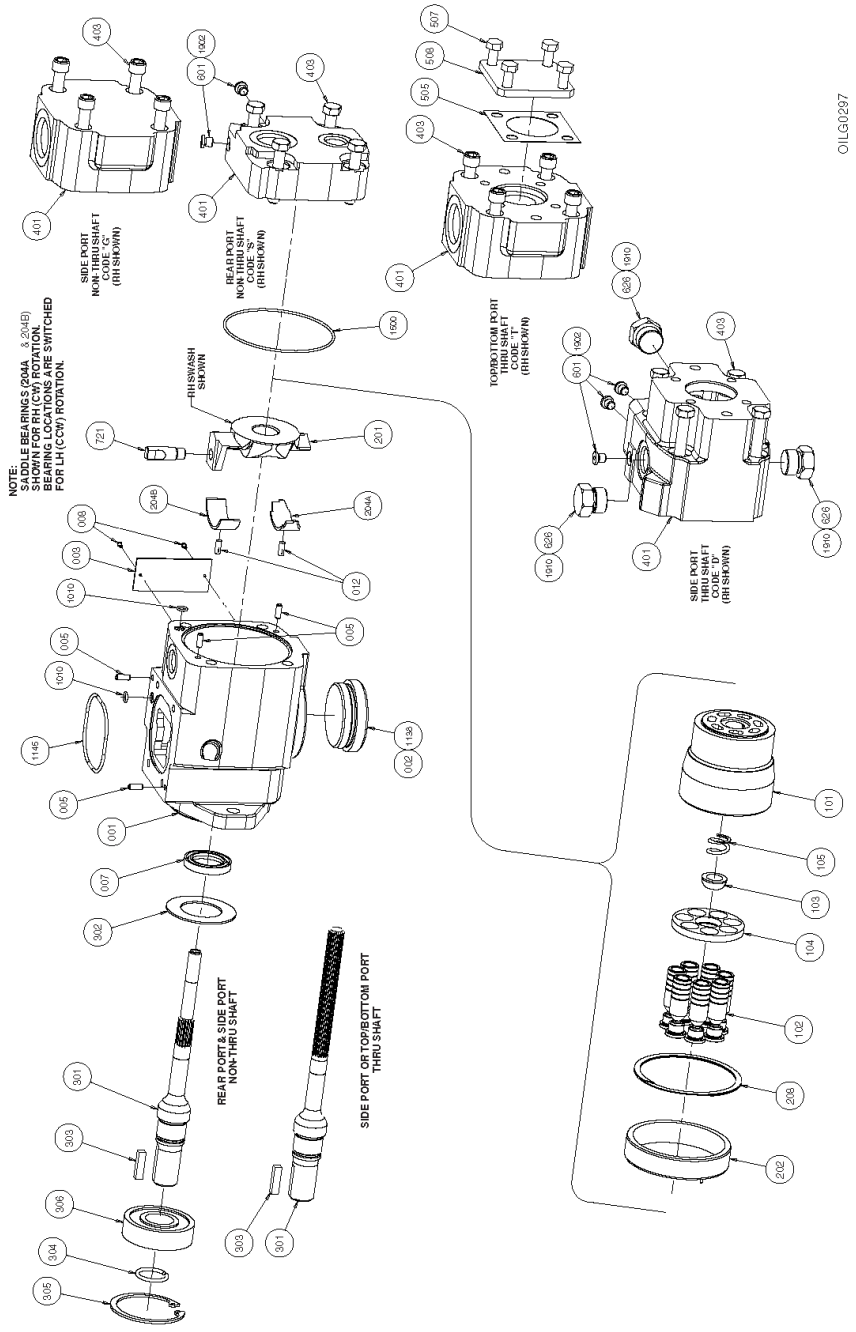

Figure 10. Exploded parts drawing, PVWJ-011/-014/-022 A-Frame (520024-101 sheet 2 of 4).

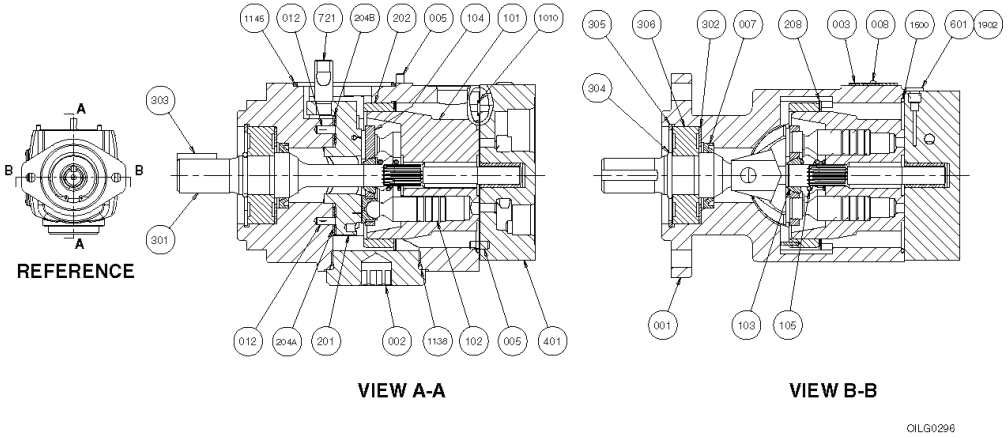

Figure 11. Cross section and plan view parts drawing, PVWJ-011/-014/-022 A-Frame (520024-101 sheet 1 of 4).

PVWJ-011/-014/-022 A-FRAME PUMP PARTS LIST

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

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

Item	Qty.	Description
HOUSING ASSEMBLY GROUP		
001	1	Pump Housing
002	1	Plug
003	1	Name Tag
005	4	Roll Pin
007	1	Shaft Seal
008	2	Drive Screws
012	2	Saddle Bearing Locating Pin
1010	2	O-Ring
1138	1	O-Ring
1145	1	O-Ring
1500	1	O-Ring
ROTARY ASSEMBLY GROUP		
101	1	Barrel
102	7	Piston & Shoe Assembly
103	1	Fulcrum Ball
104	1	Shoe Retainer
105	1	Shoe Retainer Spring
SWASHBLOCK ASSEMBLY GROUP		
201	1	Swashblock
202	1	Hydrodynamic Bearing
204A	1	Saddle Bearing (pressure side)
204B	1	Saddle Bearing (suction side)
208	1	Retaining Ring
721	1	Control Pin
DRIVE SHAFT ASSEMBLY GROUP		
301	1	Drive Shaft
302	1	Seal Retainer
303	1	Key
304	1	Shaft Retainer Ring
305	1	Shaft Bearing Retainer Ring
306	1	Front Drive Shaft Bearing
VALVE PLATE ASSEMBLY GROUP		
401	1	Valve Plate
403	4	Screw
601	Note 1	Plug
626	Note 1	Plug
1902	Note 1	O-Ring
1910	Note 1	O-Ring
COVER PLATE PARTS		
505	1	Gasket
507	4	Screw
508	1	Cover Plate

Note 1. Qty is 0, 1, 2 or 3 dependent on Valve Plate type.

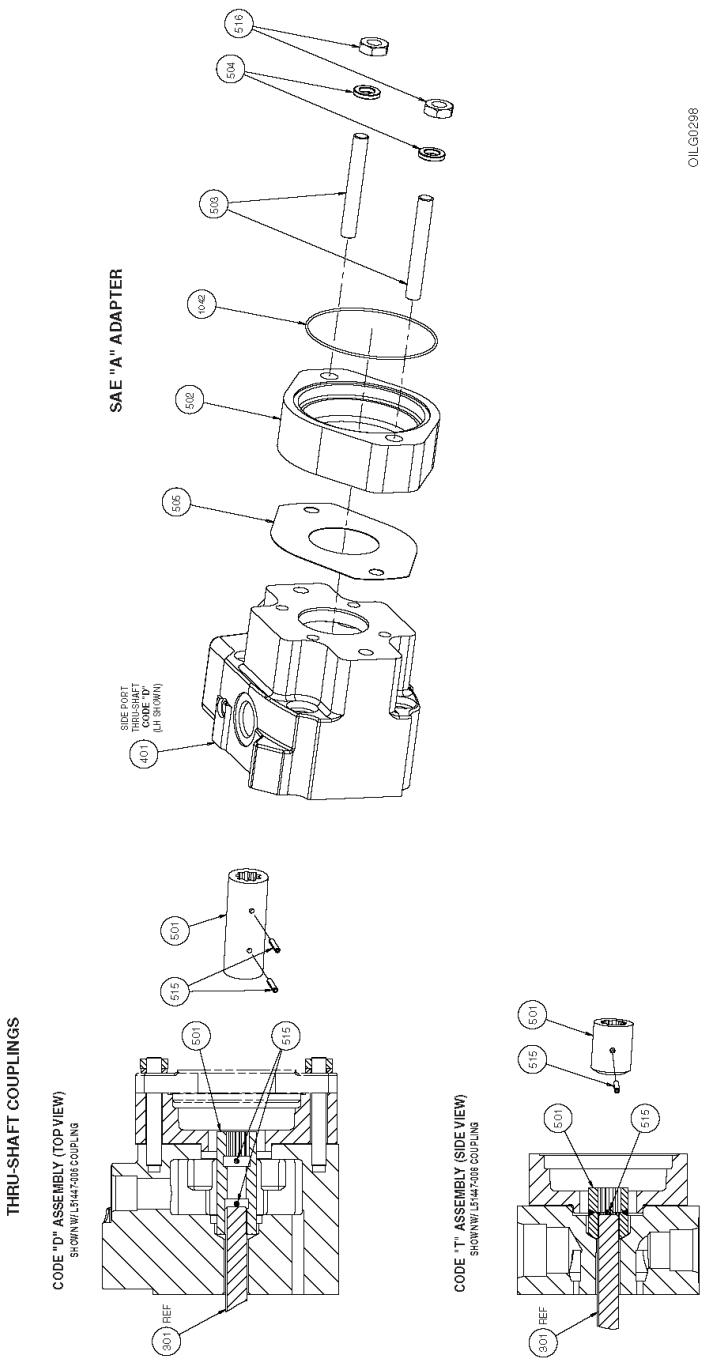

Figure 12. Exploded parts drawing, PVWJ-011/-014/-022 A-Frame,Thru-Shaft Couplings and SAE "A" Adapter (520024-101 sheet 3 of 4).

Item	Qty.	Description
DRIVE SHAFT ASSEMBLY GROUP		
301	1	Drive Shaft
VALVE PLATE ASSEMBLY GROUP		
401	1	Valve Plate

DUAL PUMP ADAPTER PARTS		
501	1	Coupling
502	1	Adapter
503	2	Stud
504	2	Washer
505	1	Gasket
515	1	Roll Pin
516	2	Hex Nut
1042	1	O-Ring

SERVICE KITS

Reference 520024-101
SERVICE KIT Drawings figures 10-12

Document Number: 520024-SK1
Revision: New

PVWJ A-Frame Units (PVWJ-011/-014/-022)

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Housing Kits			
All Models	L51116-30	A1	001, 005(4), 007, 012, 1010(2), 1145, 1500
Rotating Group Bearing Kit			
All Models	L51203-1	A1	202, 208
Shaft & Bearing Kits			
Kits for Non Thru-Shaft Models			
3/4" Dia. Keyed (Code "Y")	L51128-11	A1	301, 302, 303, 304, 305, 306
7/8" Dia. Keyed (Code "B")	L51128-15	A1	301, 302, 303, 304, 305, 306
5/8" 9T SAE Spline (Code "S")	L51128-13	A1	301, 302, 304, 305, 306
7/8" 13T Industrial Spline (Code "C")	L51128-17	A1	301, 302, 304, 305, 306
Kits for Thru-Shaft Models with Code "DA" Valve Plates			
3/4" Dia. Keyed (Code "Y")	L51518-11A	A1	301, 302, 303, 304, 305, 306
7/8" Dia. Keyed (Code "B")	L51518-11	A1	301, 302, 303, 304, 305, 306
5/8" 9T SAE Spline (Code "S")	L51518-10	A1	301, 302, 304, 305, 306
5/8" 9T Industrial Spline (Code "D")	L51518-12Z	A1	301, 302, 304, 305, 306
7/8" 13T Industrial Spline (Code "C")	L51518-12	A1	301, 302, 304, 305, 306
Kits for Thru-Shaft Models with Code "TA" Valve Plates			
3/4" Dia. Keyed (Code "Y")	L51518-33A	A1	301, 302, 303, 304, 305, 306
7/8" Dia. Keyed (Code "B")	L51518-39A	A1	301, 302, 303, 304, 305, 306
5/8" 9T SAE Spline (Code "S")	L51518-35A	A1	301, 302, 304, 305, 306
5/8" 9T Industrial Spline (Code "D")	L51518-37A	A1	301, 302, 304, 305, 306
7/8" 13T Industrial Spline (Code "C")	L51518-57	A1	301, 302, 304, 305, 306
Swashblock Kits			
LH (CCW) Models	L50488-3	A1	201, 721
RH (CW) Models	L50488-5	A1	201, 721
Rotating Group Kits			
PVWJ-011	L50052-8	A1	101, 102(7), 103, 104, 105
PVWJ-014	L50052-7	A1	101, 102(7), 103, 104, 105
PVWJ-022	L50053-7	A1	101, 102(7), 103, 104, 105
Saddle Bearing Kit			
All Models	L51053-4	A1	204A, 204B

Valve Plate Kits			
PVWJ-011			
LH Rear Port (Code "SA")	K51101-500	A1	401, 403(4), 601(2), 1010, 1500, 1902(2)
RH Rear Port (Code "SA")	K51101-501	A1	401, 403(4), 601(2), 1010, 1500, 1902(2)
LH Side Port, Non Thru-Shaft (Code "GA")	K51101-502	A1	401, 403(4), 650(2), 1010, 1500
RH Side Port, Non Thru-Shaft (Code "GA")	K51101-503	A1	401, 403(4), 650(2), 1010, 1500
LH Side Port, Thru-Shaft (Code "DA")	K51101-504	A1	401, 403(4), 601(2), 626(3), 1010, 1500, 1902(2), 1910(3)
RH Side Port, Thru-Shaft (Code "DA")	K51101-505	A1	401, 403(4), 601(2), 626(3), 1010, 1500, 1902(2), 1910(3)
LH Top/Bottom Port, Thru-Shaft (Code "TA")	K51101-506	A1	401, 403(4), 650(2), 1010, 1500
LH Top/Bottom Port, Thru-Shaft (Code "TA")	K51101-507	A1	401, 403(4), 650(2), 1010, 1500
PVWJ-014			
LH Rear Port (Code "SA")	K51101-508	A1	401, 403(4), 601(2), 1010, 1500, 1902(2)
RH Rear Port (Code "SA")	K51101-509	A1	401, 403(4), 601(2), 1010, 1500, 1902(2)
LH Side Port, Non Thru-Shaft (Code "GA")	K51101-510	A1	401, 403(4), 650(2), 1010, 1500
RH Side Port, Non Thru-Shaft (Code "GA")	K51101-511	A1	401, 403(4), 650(2), 1010, 1500
LH Side Port, Thru-Shaft (Code "DA")	K51101-512	A1	401, 403(4), 601(2), 626(3), 1010, 1500, 1902(2), 1910(3)
RH Side Port, Thru-Shaft (Code "DA")	K51101-513	A1	401, 403(4), 601(2), 626(3), 1010, 1500, 1902(3), 1910(3)
LH Top/Bottom Port, Thru-Shaft (Code "TA")	K51101-514	A1	401, 403(4), 650(2), 1010, 1500
LH Top/Bottom Port, Thru-Shaft (Code "TA")	K51101-515	A1	401, 403(4), 650(2), 1010, 1500
PVWJ-022			
LH Rear Port (Code "SA")	K51101-516	A1	401, 403(4), 601(2), 1010, 1500, 1902(2)
RH Rear Port (Code "SA")	K51101-517	A1	401, 403(4), 601(2), 1010, 1500, 1902(2)
LH Side Port, Non Thru-Shaft (Code "GA")	K51101-518	A1	401, 403(4), 650(2), 1010, 1500
RH Side Port, Non Thru-Shaft (Code "GA")	K51101-519	A1	401, 403(4), 650(2), 1010, 1500
LH Side Port, Thru-Shaft (Code "DA")	K51101-520	A1	401, 403(4), 601(2), 626(3), 1010, 1500, 1902(2), 1910(2)
RH Side Port, Thru-Shaft (Code "DA")	K51101-521	A1	401, 403(4), 601(3), 626(3), 1010, 1500, 1902(2), 1910(3)
LH Top/Bottom Port, Thru-Shaft (Code "TA")	K51101-522	A1	401, 403(4), 650(2), 1010, 1500
LH Top/Bottom Port, Thru-Shaft(Code "TA")	K51101-523	A1	401, 403(4), 650(2), 1010, 1500
Pump Seal Kit			
All models	L50824-24	A1	007, 1010(2), 1138, 1145, 1500, 1902(3), 1910(3)
Piston & Shoe Kits			
PVWJ-011	L51363-900	A1	102(7)
PVWJ-014	L50021-900	A1	102(7)
PVWJ-022	L50021-901	A1	102(7)
Shoe Retainer & Holddown Ball Kit			
All models	L50019	A1	103, 104
Tag Kit			
All models	L50921	A1	003, 008(2)

Control Pin			
All models	50623-5	A1	721
Cover Plate Kit			
All models	L50671	A1	505, 507(4), 508
Coupling & Adapter Kits			
All models using code "DA" Valve Plate	L51081-48	A1	501, 502, 503(2), 504(2), 505, 506, 515(2), 516(2)
All models using code "TA" Valve Plate	L51081-113	A1	501, 502, 503(2), 504(2), 505, 506, 515, 516(2)

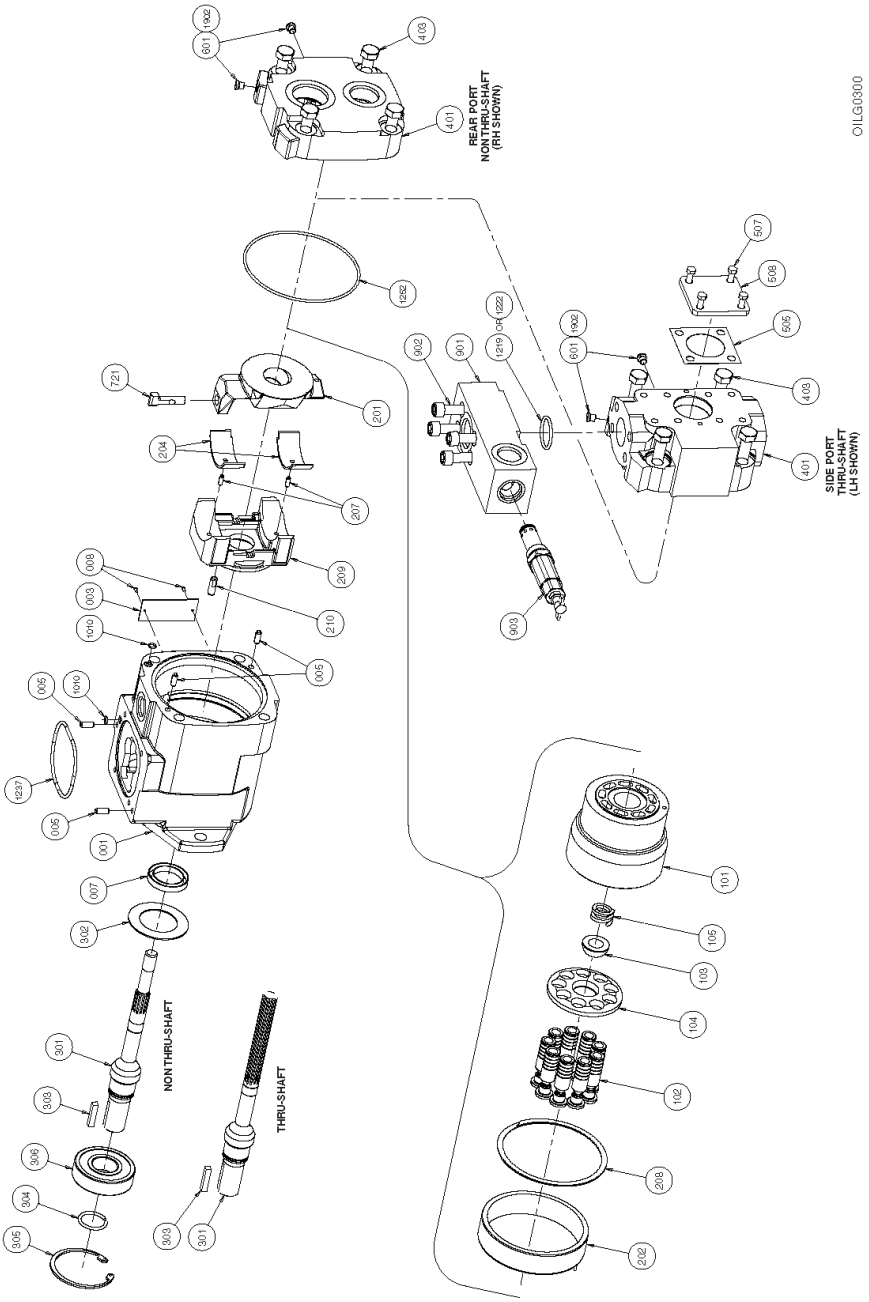

Figure 13. Exploded parts drawing, PVWJ-025/-034/-046 B-Frame (520024-201 sheet 2 of 4).

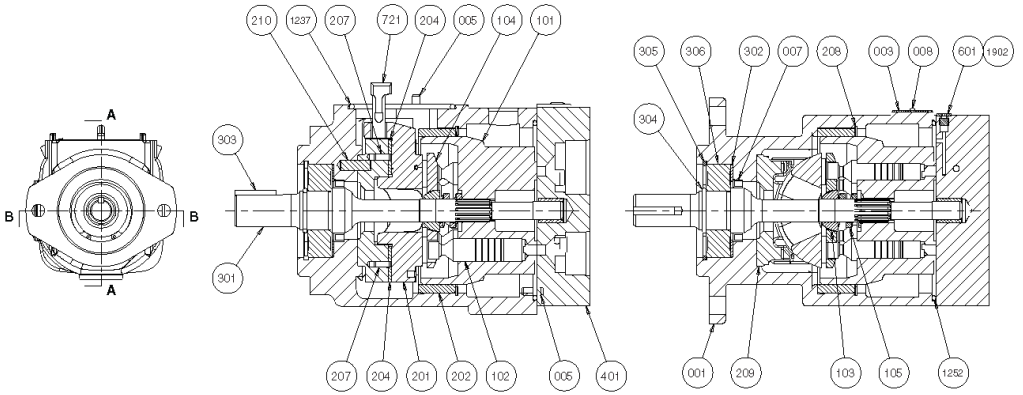

Figure 14. Cross section and plan view parts drawing, PVWJ-025/-034/-046 B-Frame (520024-201 sheet 1 of 4).

PVWJ-025/-034/-046 B-FRAME PUMP PARTS LIST

Item	Qty.	Description
HOUSING ASSEMBLY GROUP		
001	1	Pump Housing
003	1	Name Tag
005	4	Roll Pin
007	1	Shaft Seal
008	2	Drive Screws
1010	2	O-Ring
1237	1	O-Ring
1252	1	O-Ring
ROTARY ASSEMBLY GROUP		
101	1	Barrel
102	9	Piston & Shoe Assembly
103	1	Fulcrum Ball
104	1	Shoe Retainer
105	1	Shoe Retainer Spring

SWASHBLOCK ASSEMBLY GROUP		
201	1	Swashblock
202	1	Hydrodynamic Bearing
204	2	Saddle Bearing
207	2	Saddle Bearing Locating Pin
208	1	Retaining Ring
209	1	Saddle Block
210	1	Saddle Block Locating Ring
721	1	Control Pin
DRIVE SHAFT ASSEMBLY GROUP		
301	1	Drive Shaft
302	1	Seal Retainer
303	1	Key
304	1	Shaft Retainer Ring
305	1	Shaft Bearing Retainer Ring
306	1	Front Drive Shaft Bearing
VALVE PLATE ASSEMBLY GROUP		
401	1	Valve Plate
403	4	Screw
601	2	Plug
1902	2	O-Ring

COVER PLATE PARTS		
505	1	Gasket
507	4	Screw
508	1	Cover Plate
RELIEF VALVE ASSEMBLY GROUP-OPTIONAL		
901	1	Block
902	1	Screw
903	1	Relief Valve Cartridge
1219	1	O-Ring (PVWJ-025)
1222	1	O-Ring (PVWJ-034/-046)

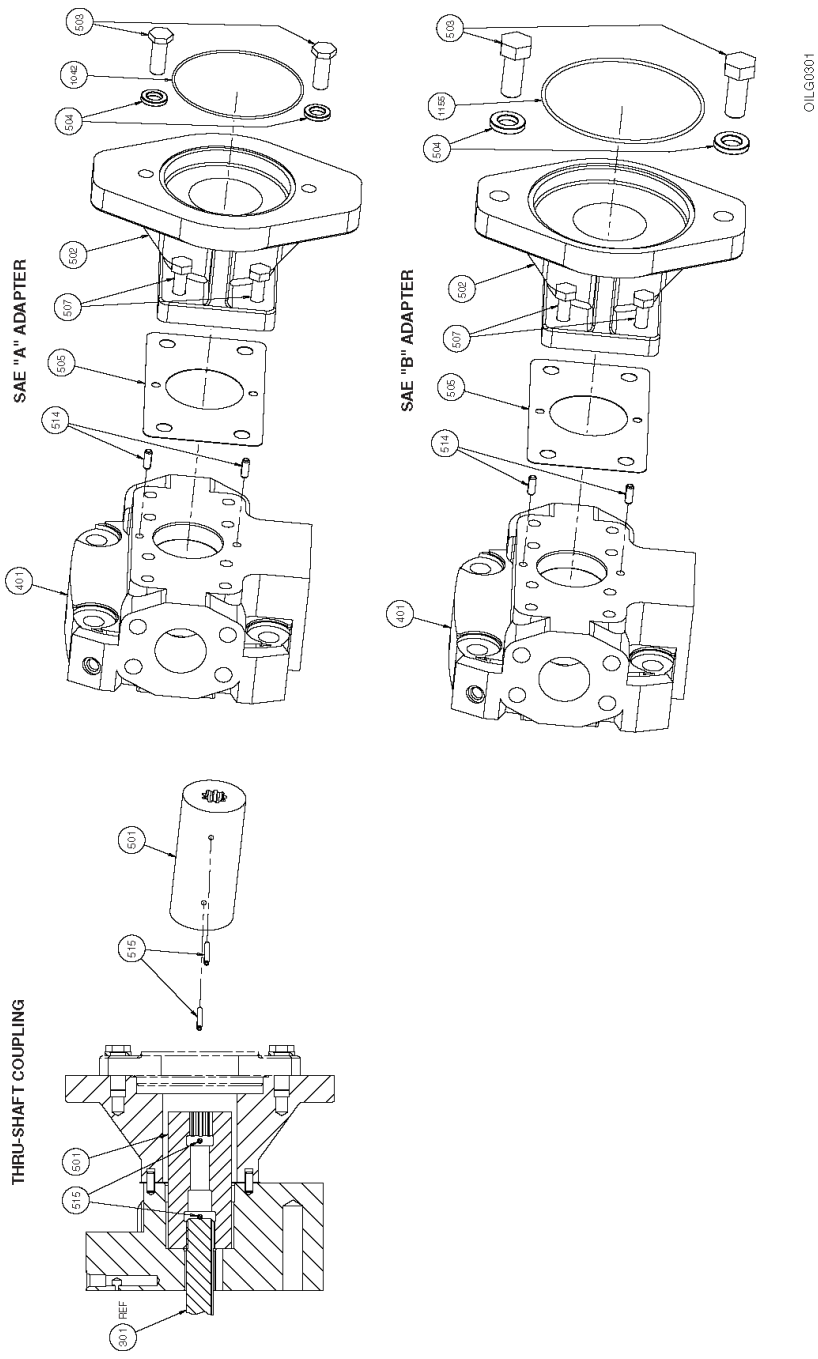

Figure 15. Exploded parts drawing, PVWJ-025/-034/-046 B-Frame,Thru-Shaft Coupling, SAE "A" and SAE "B" Adapter (520024-201 sheet 3 of 4).

Item	Qty.	Description
DRIVE SHAFT ASSEMBLY GROUP		
301	1	Drive Shaft
VALVE PLATE ASSEMBLY GROUP		
401	1	Valve Plate

DUAL PUMP ADAPTER PARTS		
501	1	Coupling
502	1	Adapter
503	2	Screw
504	2	Washer
505	1	Gasket
507	4	Screw
514	1	Roll Pin
515	1	Roll Pin
1042	1	O-Ring
1155	1	O-Ring

SERVICE KITS

PVWJ B-Frame Units (PVWJ-025/-034/-046)

Reference 520024-201
SERVICE KIT Drawings figures 13-15

Document Number: 520024-SK2
Revision: New

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Housing Kits			
All Models	K51121-101	A1	001, 005(4), 007, 1010(2), 1237, 1252
Rotating Group Bearing Kit			
All Models	L51065-1	A1	202, 208
Shaft & Bearing Kits			
PVWJ-025/-034/-046			
7/8" Dia. Keyed (Code Y)	L51129-11	A1	301, 302, 303, 304, 305, 306
1" Dia. Keyed (Code B)	L51129-15	A1	301, 302, 303, 304, 305, 306
7/8" 13T Spline (Code S)	L51129-13	A1	301, 302, 304, 305, 306
1" 15T Spline (Code C)	L51129-17	A1	301, 302, 304, 305, 306
7/8" 13T Spline (Code D) (Industrial)	L51129-39Z	A1	301, 302, 304, 305, 306
7/8" Dia. Keyed (Code Y)	L51519-11A	A1	301, 302, 303, 304, 305, 306
1" Dia. Keyed (Code B)	L51519-11	A1	301, 302, 303, 304, 305, 306
7/8" 13T Spline (Code S)(SAE)	L51519-10	A1	301, 302, 304, 305, 306
7/8" 13T Spline (Code D) (Industrial)	L51519-12Z	A1	301, 302, 304, 305, 306
Swashblock Kits			
LH (CCW) Models	L50480-1	A1	201, 721
RH (CW) Models	L50480-2	A1	201, 721
Saddle Bearing Kit			
All models	L51053-5	A1	204(2)
Rotating Group Kits			
PVWJ-025	L50167-10	A1	101, 102(9), 103, 104, 105
PVWJ-034	L50167-7	A1	101, 102(9), 103, 104, 105
PVWJ-046	L50168-7	A1	101, 102(9), 103, 104, 105

Saddle Kit			
All models	L51052-7	A1	204(2), 207(2), 209
Valve Plate Kits			
PVWJ-025			
LH Rear Port (Code "SA")	K51102-201	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
RH Rear Port (Code "SA")	K51102-202	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
LH Side Port, Thru-Shaft (Code "DF" & "DR")	K51102-203	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
RH Side Port, Thru-Shaft (Code "DF" & "DR")	K51102-204	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
PVWJ-034			
LH Rear Port (Code "SA"	K51102-205	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
RH Rear Port (Code "SA")	K51102-206	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
LH Side Port, Thru-Shaft (Code "DF" & "DR")	K51102-207	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
RH Side Port, Thru-Shaft (Code "DF" & "DR")	K51102-208	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
PVWJ-046			
LH Rear Port (Code "SA")	K51102-209	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
RH Rear Port (Code "SA")	K51102-210	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
LH Side Port, Thru-Shaft (Code "DF" & "DR")	K51102-211	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
RH Side Port, Thru-Shaft (Code "DF" & "DR")	K51102-212	A1	401, 403(4), 601(2), 1010, 1252, 1902(2)
Pump Seal Kit			
All models	K50825-200	A1	007, 1010(2), 1237, 1252, 1902(2)
Piston & Shoe Kits			
PVWJ-025	L51349-900	A1	102(9)
PVWJ-034	L50146-900	A1	102(9)
PVWJ-046	L50175-900	A1	102(9)
Shoe Retainer & Holddown Ball Kit			
All models	L50132	A1	103, 104
Tag Kit			
All models	L50921	A1	003, 008(2)
Control Pin			
All models	51339-5	A1	721
Cover Plate Kit			
All models	L50671	A1	505, 507(4), 508
Coupling & Adapter Kits			
SAE A Adapter	L51081-53	A1	501, 502, 503(2), 504(2), 505, 507(4), 514(2), 515(2), 1042
SAE B Adapter	L51081-43	A1	501, 502, 503(2), 504(2), 505, 507(4), 514(2), 515(2), 1155

NOTES

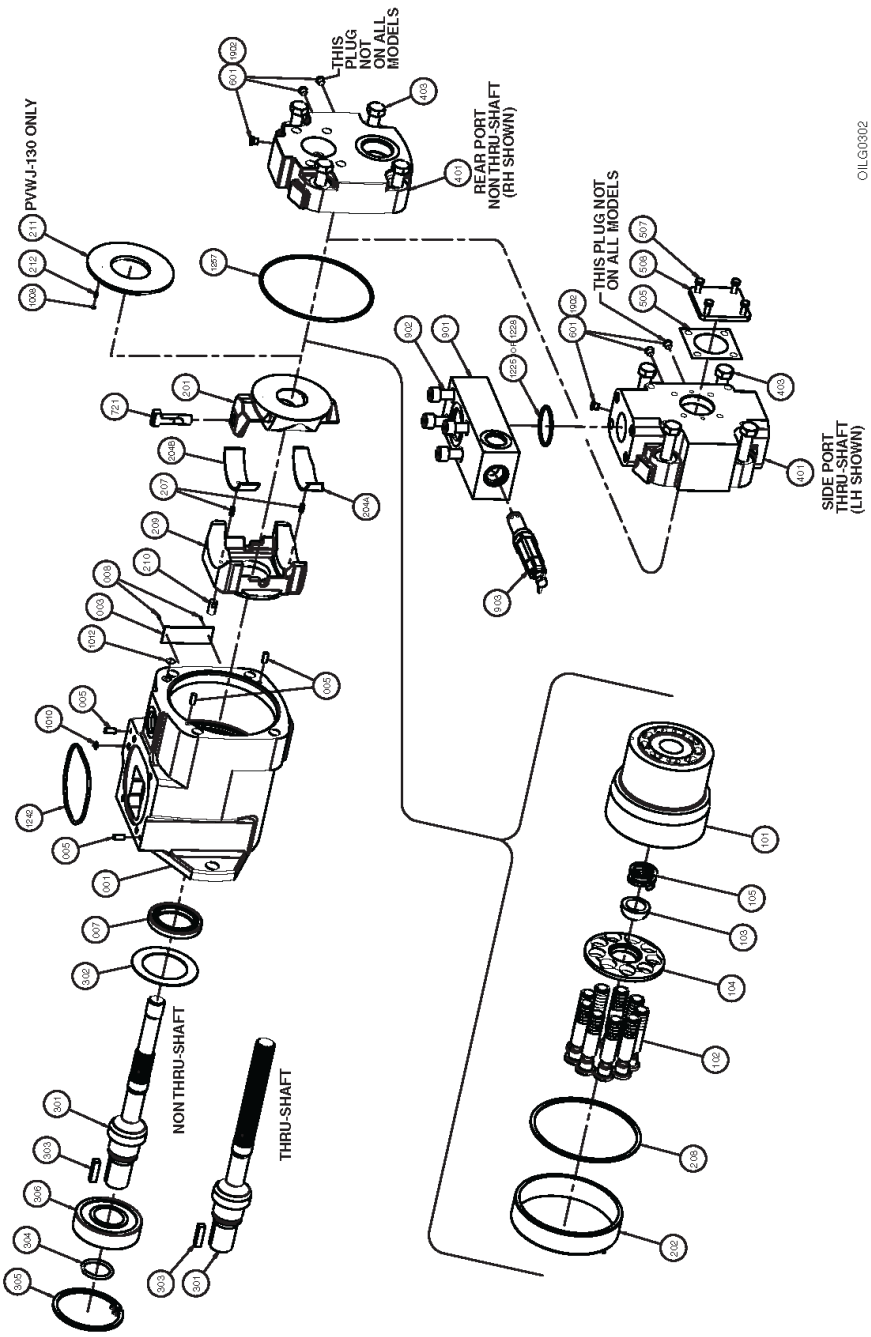

Figure 16. Exploded parts drawing, PVWJ-064/-076/-098/-130 C-Frame (520024-301 sheet 2 of 4).

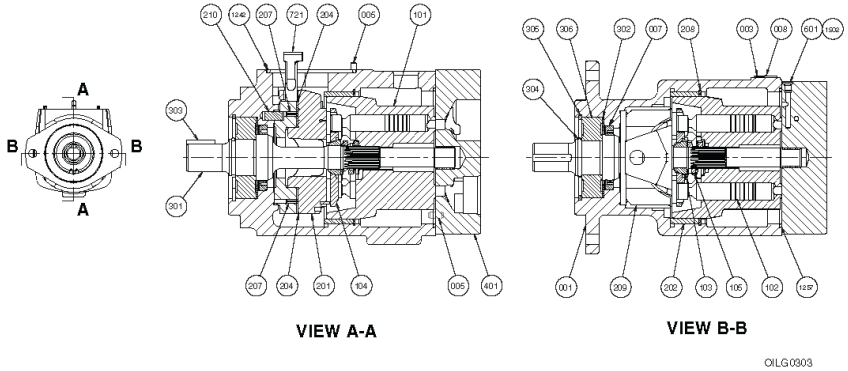

Figure 17. Cross section and plan view parts drawing, -064/-076/-098/-130 C-Frame (520024-301 sheet 1 of 4).

PVWJ-064-076/-098/-130 C-FRAME PUMP PARTS LIST

Item	Qty.	Description
HOUSING ASSEMBLY GROUP		
001	1	Pump Housing
003	1	Name Tag
005	4	Roll Pin
007	1	Shaft Seal
008	2	Drive Screws
1010	1	O-Ring
1012	1	O-Ring
1242	1	O-Ring
1257	1	O-Ring
ROTARY ASSEMBLY GROUP		
101	1	Barrel
102	9	Piston & Shoe Assembly
103	1	Fulcrum Ball
104	1	Shoe Retainer
105	1	Shoe Retainer Spring

SWASHBLOCK ASSEMBLY GROUP		
201	1	Swashblock
202	1	Hydrodynamic Bearing
204A	1	Saddle Bearing (PVWJ-064)
204B	1 or 2	Saddle Bearing (PVWJ-064/-076/-098)
204C	2	Saddle Bearing (PVWJ-130)
207	2	Saddle Bearing Locating Pin
208	1	Retaining Ring
209	1	Saddle Block
210	1	Saddle Block Locating Ring
211	1	Wear Plate (PVWJ-130 only)
212	1	Wear Plate Locating Pin (PVWJ-130 only)
721	1	Control Pin
1008	1	O-Ring (PVWJ-130 only)
DRIVE SHAFT ASSEMBLY GROUP		
301	1	Drive Shaft
302	1	Seal Retainer
303	1	Key
304	1	Shaft Retainer Ring
305	1	Shaft Bearing Retainer Ring
306	1	Front Drive Shaft Bearing

VALVE PLATE ASSEMBLY GROUP		
401	1	Valve Plate
403	4	Screw
601	2 or 3	Plug
1902	2 or 3	O-Ring
COVER PLATE PARTS		
505	1	Gasket
507	4	Screw
508	1	Cover Plate
RELIEF VALVE ASSEMBLY GROUP-OPTIONAL		
901	1	Block
902	1	Screw
903	1	Relief Valve Cartridge
1225	1	O-Ring (PVWJ-064)
1228	1	O-Ring (PVWJ-076/-098/-130)

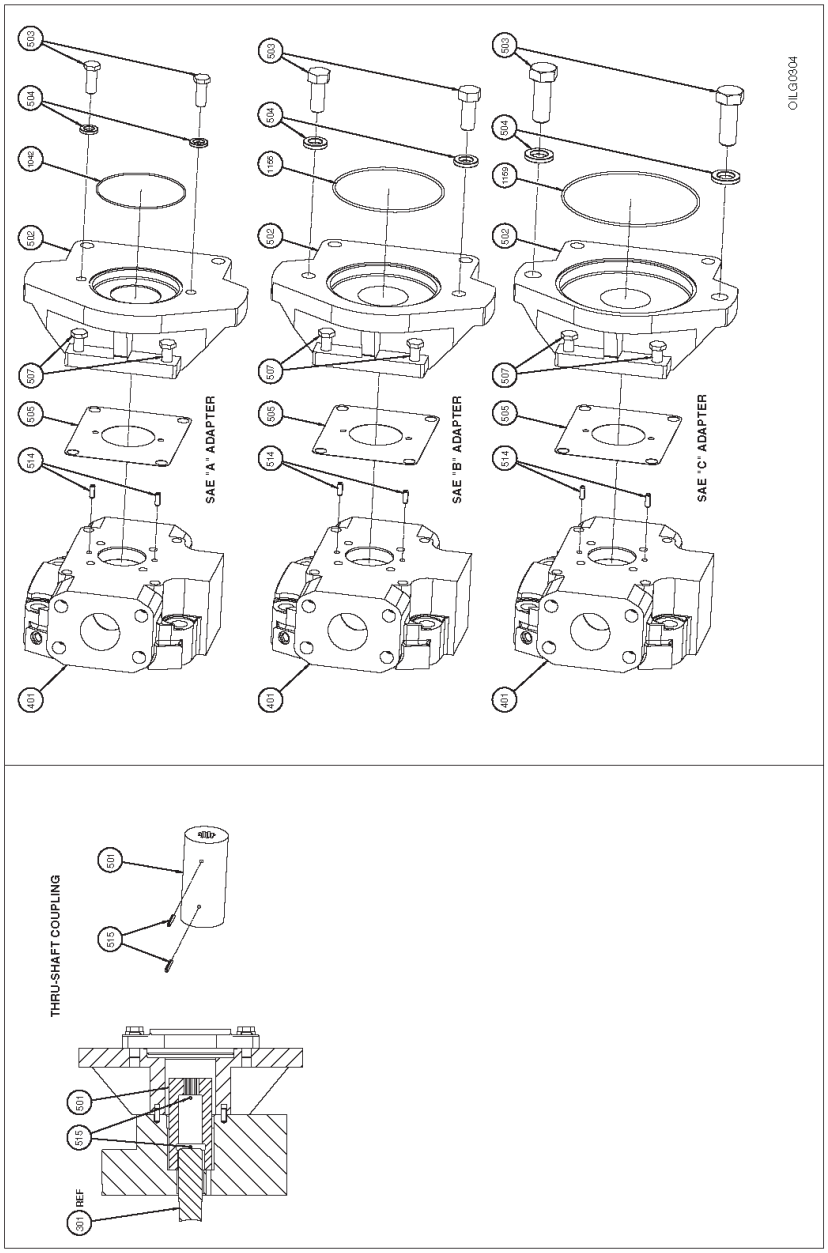

Figure 18. Exploded parts drawing, PVWJ-064/-076/-098/-130 C-Frame, Thru-Shaft Coupling, SAE "A", SAE "B" and SAE "C" Adapter (520024-301 sheet 3 of 4).

Item	Qty.	Description
DRIVE SHAFT ASSEMBLY GROUP		
301	1	Drive Shaft
VALVE PLATE ASSEMBLY GROUP		
401	1	Valve Plate

DUAL PUMP ADAPTER		
501	1	Coupling
502	1	Adapter
503	2	Screw
504	2	Washer
505	1	Gasket
507	4	Screw
514	2	Roll Pin
515	2	Roll Pin
1042	1	O-Ring
1155	1	O-Ring
1159	1	O-Ring

SERVICE KITS

PVWJ C-Frame Units (PVWJ-064/-076/-098/-130)

Reference 520024-301
SERVICE KIT Drawings figures 16-18

Document Number: 520024-SK3
Revision: New

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Housing Kits			
All Models	K51114-101	A1	001, 005(4), 007, 1010(2), 1242, 1257
Rotating Group Bearing Kit			
All Models	L51066-1	A1	202, 208
Shaft & Bearing Kits			
1 1/4" Dia. Keyed (Code Y) Standard	L51130-11	A1	301, 302, 303, 304, 305, 306
1 1/4" 14T Spline (Code S) Standard (SAE)	L51130-13	A1	301, 302, 304, 305, 306
1 1/4" 14T Spline (Code D) Standard (Industrial)	L51130-13Z	A1	301, 302, 304, 305, 306
1 1/4" Dia. Keyed (Code Y) T-S	L51520-11	A1	301, 302, 303, 304, 305, 306
1 1/4" 14T Spline (Code S) T-S (SAE)	L51520-10	A1	301, 302, 304, 305, 306
1 1/4" 14T Spline (Code D) T-S (Industrial)	L51520-12Z	A1	301, 302, 304, 305, 306
Swashblock Kits			
PVWJ-064/-076/-098 LH (CCW) Models	L50481-3	A1	201, 721
PVWJ-064/-076/-098 RH (CW) Models	L50481-5	A1	201, 721
PVWJ-130 LH (CCW) Models	L50481-4	A1	201, 211, 212, 213, 721
PVWJ-130 RH (CW) Models	L50481-6	A1	201, 211, 212, 213, 721
Saddle Bearing Kits			
PVWJ-064	L51053-8	A1	204A, 204B
PVWJ-076 & -098	L51053-6	A1	204B(2)
PVWJ-130	L51053-7	A1	204C(2)
Rotating Group Kits			
PVWJ-064	L50108-11	A1	101, 102(9), 103, 104, 105
PVWJ-076	L50087-7	A1	101, 102(9), 103, 104, 105
PVWJ-098	L50108-7	A1	101, 102(9), 103, 104, 105
PVWJ-130	L50108-8	A1	101, 102(9), 103, 104, 105
Saddle Kits			
PVWJ-064	L51052-13	A1	204A, 204B, 207(2), 209
PVWJ-076 & -098	L51052-8	A1	204B(2), 207(2), 209
PVWJ-130	L51052-9	A1	204C(2), 207(2), 209

Valve Plate Kits			
PVWJ-064			
LH Rear Port (Code "SA")	K51103-213	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Rear Port (Code "SA")	K51103-214	A1	401, 403(4), 405(3), 408(3), 1012, 1257
LH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-215	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-216	A1	401, 403(4), 405(3), 408(3), 1012, 1257
PVWJ-076			
LH Rear Port (Code "SA"	K51103-201	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Rear Port (Code "SA")	K51103-202	A1	401, 403(4), 405(3), 408(3), 1012, 1257
LH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-207	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-208	A1	401, 403(4), 405(3), 408(3), 1012, 1257
PVWJ-098			
LH Rear Port (Code "SA")	K51103-203	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Rear Port (Code "SA")	K51103-204	A1	401, 403(4), 405(3), 408(3), 1012, 1257
LH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-209	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-210	A1	401, 403(4), 405(3), 408(3), 1012, 1257
PVWJ-130			
LH Rear Port (Code "SA")	K51103-205	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Rear Port (Code "SA")	K51103-206	A1	401, 403(4), 405(3), 408(3), 1012, 1257
LH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-211	A1	401, 403(4), 405(2), 408(2), 1012, 1257
RH Side Port, Thru Shaft (Code "DF" & "DR")	K51103-212	A1	401, 403(4), 405(3), 408(3), 1012, 1257
Pump Seal Kit			
All models	K50826-200	A1	007, 1008, 1010, 1012, 1242, 1257, 1902(3)
Piston & Shoe Kits			
PVWJ-064	L51109-900	A1	102(9)
PVWJ-076	L51107-900	A1	102(9)
PVWJ-098	L51109-901	A1	102(9)
PVWJ-130	L51303-900	A1	102(9)
Shoe Retainer & Holddown Ball Kits			
PVWJ-064/-076/-098	L50071	A1	103, 104
PVWJ-130	L51305-2	A1	103, 104
Tag Kit			
All models	L50921	A1	003, 008(2)
Control Pin			
All models	51339-2	A1	721

Cover Plate Kit			
All models	L50671	A1	505, 507(4), 508
Coupling & Adapter Kits			
SAE A Adapter	L51081-52	A1	501, 502, 503(2), 504(2), 505, 507(4), 514(2), 515(2), 1042
SAE B Adapter	L51081-51	A1	501, 502, 503(2), 504(2), 505, 507(4), 514(2), 515(2), 1155
SAE C Adapter	L51081-49	A1	501, 502, 503(2), 504(2), 505, 507(4), 514(2), 1159

AFTER SALES SERVICES

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

STAY-ON-STREAM SERVICE

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

SERVICE SCHOOLS

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

SPARE PARTS AVAILABILITY

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

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Issued: August 2006

Bulletin 947085

SERVICE INSTRUCTIONS "PVWJ" A-FRAME PUMPS -011/-014/-022 FOR TYPE "P-1NN" AND "P-LNN" PRESSURE COMPENSATING CONTROLS

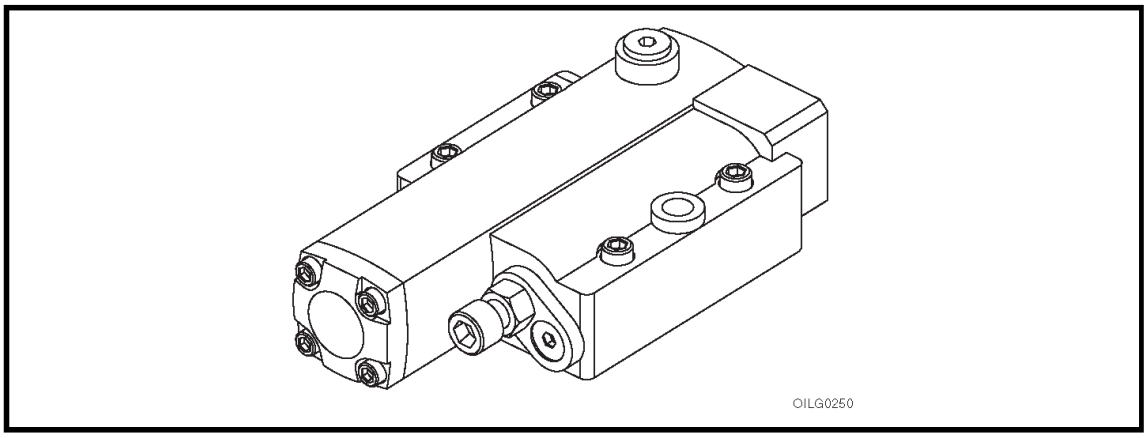

Figure 1. Typical Oilgear Type "P-1NN" and "P-LNN" Pressure Compensator Controls for "PVWJ" A-Frame Pump

PURPOSE OF INSTRUCTIONS

These instructions will simplify the installation, operation and maintenance of Oilgear type "P-1NN" and "P-LNN" controlled units.

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

GENERAL REFERENCE MATERIAL

Fluid Recommendations ..... Bulletin 90000
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Filtration Recommendations ..... Bulletin 90007
Piping Information ..... Bulletin 90011
Proper Installation of Vertical Pumps ..... Bulletin 90014
PVWJ Open Loop Pumps, Application Guidelines ..... Bulletin 847085
PVWJ Open Loop Pumps (All Frame Sizes) Service Instructions ..... Bulletin 947085
PVWJ Open Loop Pumps, Sales ..... Bulletin 47085

PVWJ PUMP INSTALLATIONS

PVWJ A Frame (PVWJ-011/-014/-022) w/ Rear Ports DS-47480
PVWJ A Frame (PVWJ-011/-014/-022) w/ Side Ports DS-47481
PVWJ A Frame (PVWJ-011/-014/-022) w/ Side Ports & Thru Shaft DS-47482

PVWJ PUMP CONTROL INSTALLATIONS

"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-011/-014/-022 ..... DS-47984

THE OILGEAR COMPANY
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Issued: August 2006

Safety First

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

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

SAFETY SYMBOLS

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

⚠ DANGER ⚠

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

⚠ WARNING

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

CAUTION

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

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

⚠ WARNING

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

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

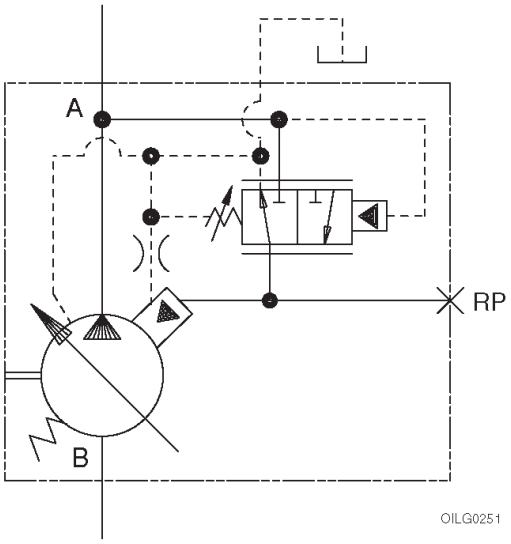

Figure 2. ASA Diagram for "P-1NN" or "P-LNN" Controls Shown with Typical Pump

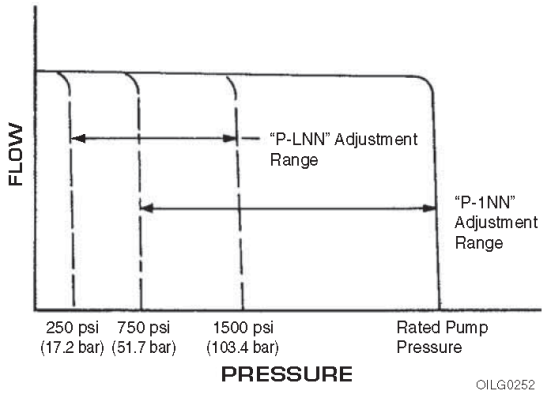

Figure 3. Curve Indicating Flow Versus Pressure for "P-1NN" or "P-LNN" Type Controls

TROUBLESHOOTING

PROBLEM	CAUSES	REMEDY
Unresponsive or Unstable Control	Swashblock bearing surface and/or Saddle Bearings worn or damaged.	See appropriate pump service bulletin.
	Control Pin and/or hole in Swashblock worn significantly.	
	Saddle Bearing Locating Pins broken.	
	Fluid is contaminated.	Inspect and clean if necessary. See bulletin 90007.
	Control Piston orifice (732) plugged.	Inspect and clean if necessary.
	Contamination trapped between control piston (702) and piston bore is not allowing piston to move smoothly.	Inspect and clean if necessary. Replace scored or damaged parts.
	Contamination trapped between control spool (706) and spool bore is not allowing spool to move smoothly.	
	Faulty remote pressure compensator circuit components.	Inspect and replace if necessary.
	Hydraulic line between remote pressure compensator components and RP port of control is too long.	Shorten line length.
	Insufficient control flow.	Increase size of control piston orifice (732).
Insufficient Outlet Volume	Swashblock not stroking to desired displacement.	See appropriate pump service bulletin.
	Low input drive speed.	
	Worn or grooved Cylinder Barrel and/or Valve Plate mating surfaces.	
	Failed Driveshaft.	
	Worn or damaged Piston Shoes or Swashblock.	
	Worn Pistons and/or piston bores.	
	Control Piston stuck off stroke.	Inspect and replace if necessary.
	Maximum Volume Stop adjusted incorrectly.	Adjust Maximum Volume Stop CCW to increase outlet flow.
	Pressure Compensator is set too close to operating pressure.	Adjust Pressure Compensator setting CW to increase setting.
Destrokes at low pressure	Pressure compensator adjustment not set correctly.	Adjust Pressure Compensator setting CW to increase setting and retorque jam nut (715).
	Control Piston orifice (732) plugged.	Inspect and clean if necessary.
	Damaged or fractured control spring (items 708 and/or 709).	Inspect and replace if necessary.
	Severely worn control spool (706) and/or spool bore.	
	Damaged or fractured control piston spring (item 703).	
	Faulty remote pressure compensator circuit components.	
Excessive peak pressure	Pressure Compensator is set too high.	Adjust Pressure Compensator setting CCW to decrease setting.
	Minimum Volume Stop is set too high.	Adjust Minimum Volume Stop CCW to decrease outlet flow.
	Fluid is contaminated.	Inspect and clean if necessary. See bulletin 90007.
	Swashblock bearing surface and/or Saddle Bearings worn or damaged.	See appropriate pump service bulletin.
	Contamination trapped between control piston (702) and piston bore is not allowing piston to move smoothly.	Inspect and clean if necessary. Replace scored or damaged parts.
	Contamination trapped between control spool (706) and spool bore is not allowing spool to move smoothly.	
	Hydraulic line between remote pressure compensator components and RP port of control is too long.	Shorten line length.
	Faulty remote pressure compensator circuit components.	Inspect and replace if necessary.
	Restriction in drilled passages between pump outlet port and control spool.	Inspect and clean if necessary.

PRINCIPLE OF OPERATION

The pressure compensator control ensures maximum pump flow until the system reaches the controls preset pressure setting. The control then regulates the pump output flow to match the flow requirements of the system, while maintaining the preset output pressure.

When the system pressure exceeds the compensator control setting, or the system no longer requires flow, the control de-strokes the pump while maintaining the preset pressure.

"P-1NN" controls can be adjusted from 750 psi (51,7 bar) working pressure up to the maximum pressure rating of the applicable pump. "P-LNN" controls can be adjusted from 250 psi (17,2 bar) up to a maximum of 1500 psi (103,4 bar).

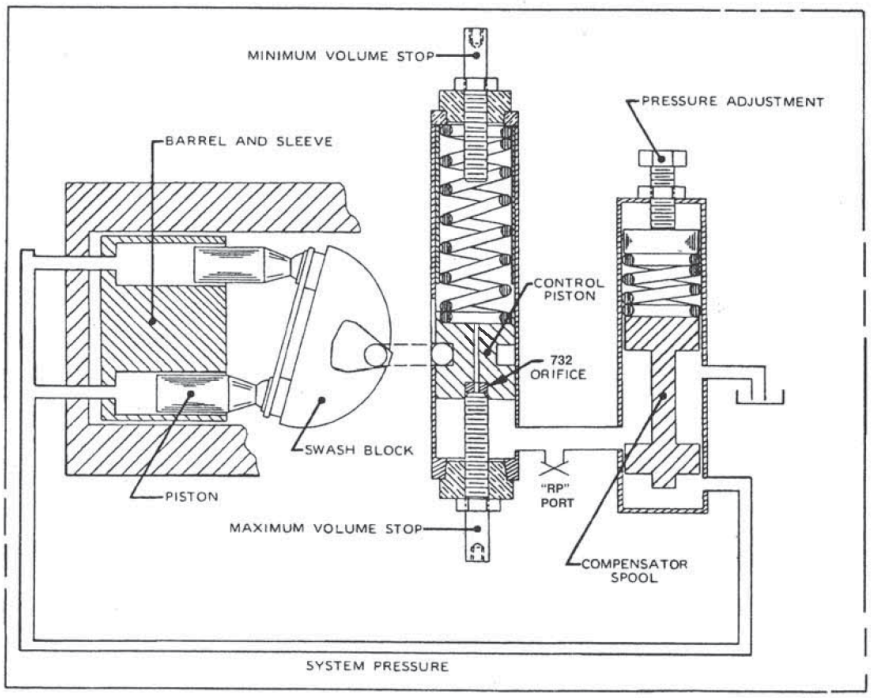

Figure 4. Swashblock at Full Delivery and "P-1NN" or "P-LNN" Controls at Maximum Volume Stop

LINE MOUNTED REMOTE PRESSURE CONTROL FOR TYPE "P-1NN" AND "P-LNN" PUMP CONTROLS - VSR (REMOTE SEQUENCE VALVE)

Remote operation of "P-1NN" and "P-LNN" controls can be accomplished by installing an Oilgear VSR Module at the location shown in the control circuit. Use module L51542 for units rated continuously for 4000 psi (275,8 bar) or less. Use L51542-1 for units rated above 4000 psi (275,8 bar).

NOTE *To minimize case leakage and power loss, plug the control drain port with a #10-24 UNC setscrew to maintain the standard "P-1NN" or "P-LNN" control case leakage. The plug will increase response time. Standard response time can be obtained by installing a .040 inch (1,0 mm) orifice instead of plugging it.*

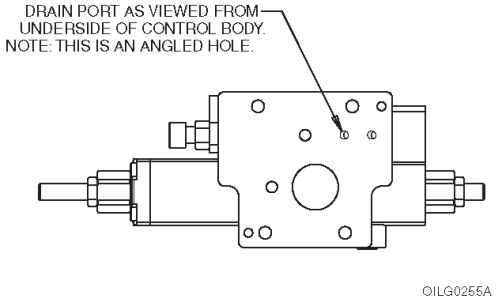

Figure 7. "P-1NN" and "P-LNN" Control Drain Port Location

NOTE *The compensator setting on the pump control must be set at least 200 psi (13,8 bar) higher than the required pressure setting of the remote compensator module to prevent the pump compensator control from interacting with the remote compensator module.*

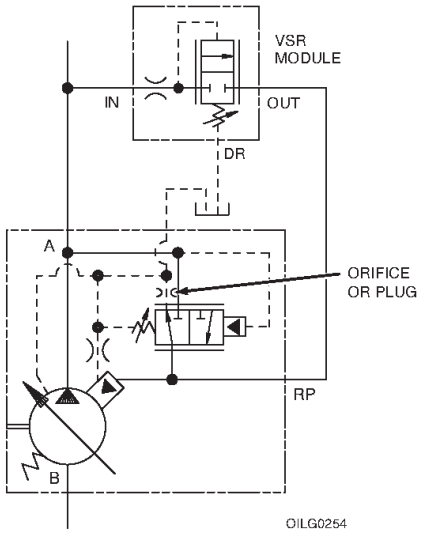

Figure 5. "P-1NN" and "P-LNN" Control Circuit with Remote Pressure Control

SCREW AND PLUG TORQUES FOR CONTROLS

Item Number	Description	Head Type & Size	Tightening Torque
601	SAE #2 Plug	1/8" Internal Hex	45 in.-lbs (5 N·m)
603	SAE #4 Plug	3/16" Internal Hex	120 in.-lbs (14 N·m)
606	SAE #8 Plug	5/16" Internal Hex	45 ft-lbs (61 N·m)
711	PC Adjuster Screw LHCS	3/32" Internal Hex	57 in.-lbs (6 N·m)
714	Adjuster Plate Screw	5/32" Internal Hex	80 in.-lbs (9 N·m)
720	Max. or Min. Volume Stop Housing	7/8" External Hex	50 ft-lbs (68 N·m)
722	End Cap Screws	5/32" Internal Hex	80 in.-lbs (9 N·m)
723	Control Body Screws	3/16" Internal Hex	120 in.-lbs (14 N·m)
732	Control Piston Orifice	3/32" Internal Hex	20 in.-lbs (2.3 N·m)

CONTROL O-RING SEALS

Item Number	ARP 568 Uniform Size Number	Shore A Durometer
1010	-010	90
1011	-011	90
1020	-020	90
1113	-113	90
1145	-145	70
1902	-902	90
1904	-904	90
1908	-908	90

PARTS LIST

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

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

PVWJ A-FRAME -011/-014/-022 PRESSURE COMPENSATOR CONTROLS ("P-1NN" STANDARD & "P-LNN" LOW PRESSURE CONTROLS)

Item	Description
	COMMON PARTS GROUP
601	SAE#2 Plug
603	SAE#4 Plug
606	SAE#8 Plug
701	Control Block
702	Control Piston
703	Control Piston Spring
705	End Cap
706	Pressure Compensator Control Spool
707	Spring Seat
708	Pressure Compensator Spring (Outer)
709*	Pressure Compensator Spring (Inner)
710	Control Plug
711	Screw
712	Shims
713	Adjuster Plate
714	Screw
715	Jam Nut
716	Pressure Compensator Adjustment Screw
717	Min. Volume Stop Stem
718	Max. Volume Stop Stem
719	Jam Nut
720	Volume Stop Housing
721	Control Pin
722	Screw, End Cap
723	Screw, Control Body
732	Orifice
1010	O-Ring
1011	O-Ring
1020	O-Ring
1113	O-Ring
1145	O-Ring
1902	O-Ring
1904	O-Ring
1908	O-Ring

*Only used in P-1 Control.

SERVICE KITS

Document Number: 519975-SK1
Revision: New

PVWJ Service Kits

Reference 519975-101
SERVICE KIT, Figures 8 & 9

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Main Control Body Kits			
PVWJ-011	K50460-100	A1	701, 706
PVWJ-014/-022	K50460-200	A1	701, 706
Control Piston Kits			
All Models	K50521	A1	702, 732
Pressure Compensator Spools			
PVWJ-011	50015-100	A1	706
PVWJ-014/-022	50015-200	A1	706
Control Spring Kits			
P-LNN (All Models)	K50036-103	A1	703, 708
PVWJ-011 P-1NN	K50036-106	A1	703, 708
PVWJ-014/-022 P-1NN	K50036-109	A1	703, 708, 709
Control Pins			
All Models	50623-5	A1	721
Volume Stop Kits			
Maximum Volume Stop (All Models)	K50590	A1	718, 719, 720, 1011, 1908
Minimum Volume Stop (All Models)	K50590-100	A1	705, 717, 719, 720, 1011, 1020, 1908
Pressure Compensator Adjuster Kits			
All Models	K50660-100	A1	710, 711, 712, 713, 715, 716, 1113
Control Seal Kit			
All Models	K50824-100	A1	1010, 1011, 1020, 1113, 1145, 1902, 1904, 1908

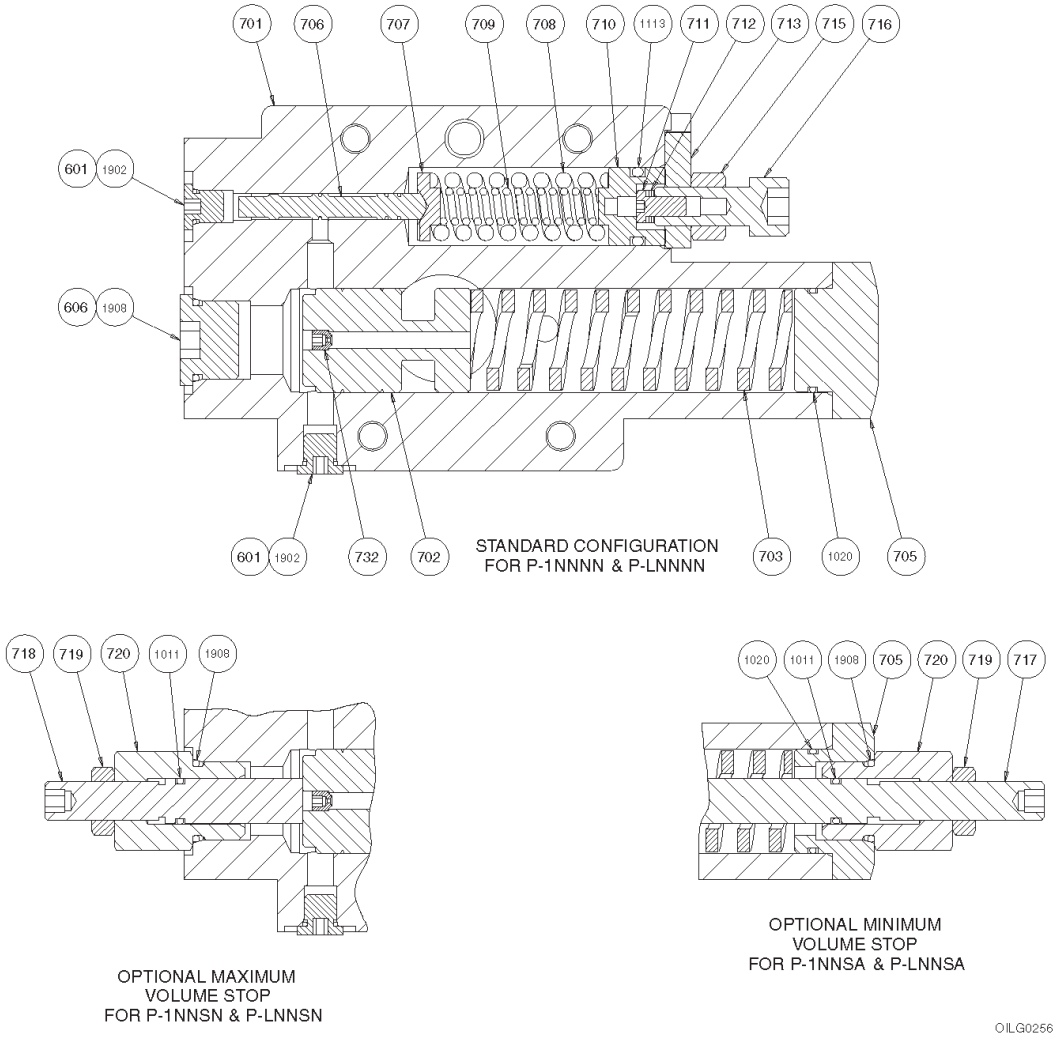

Figure 8. Parts Drawing for “P-1NN” and “P-LNN” Control (519975-101 sheet 1)

MAXIMUM AND MINIMUM VOLUME STOP

The maximum volume stop can be adjusted to attain a maximum volume from full to 25% of full flow. The pump can be de-stroked from full to 25% flow with eight half-turns of the volume stop. One turn clockwise will decrease maximum pump outlet flow 9%.

The minimum volume stop can be adjusted to attain a minimum volume from zero to full flow. One turn clockwise will increase minimum pump outlet flow 9%.

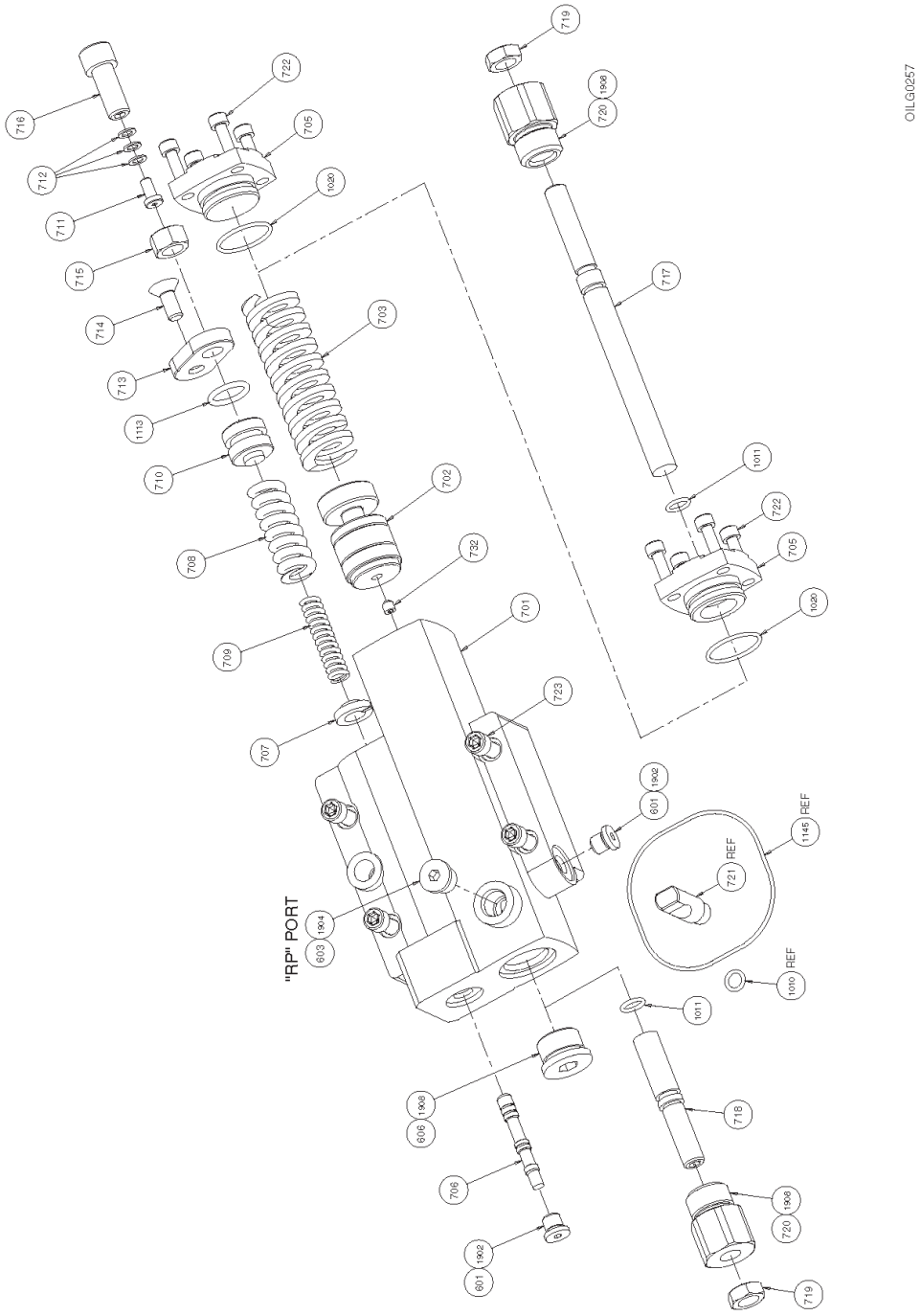

Figure 9. Exploded Parts Drawing for “P-1NN” and “P-LNN” Control (519975-101 sheet 2)

NOTES

NOTES

AFTER SALES SERVICES

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

STAY-ON-STREAM SERVICE

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

SERVICE SCHOOLS

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

SPARE PARTS AVAILABILITY

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

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Issued: August 2006

Bulletin 947633

SERVICE INSTRUCTIONS "PVWJ" B-FRAME PUMPS -025/-034/-046 FOR TYPE "P-1NN" AND "P-LNN" PRESSURE COMPENSATING CONTROLS

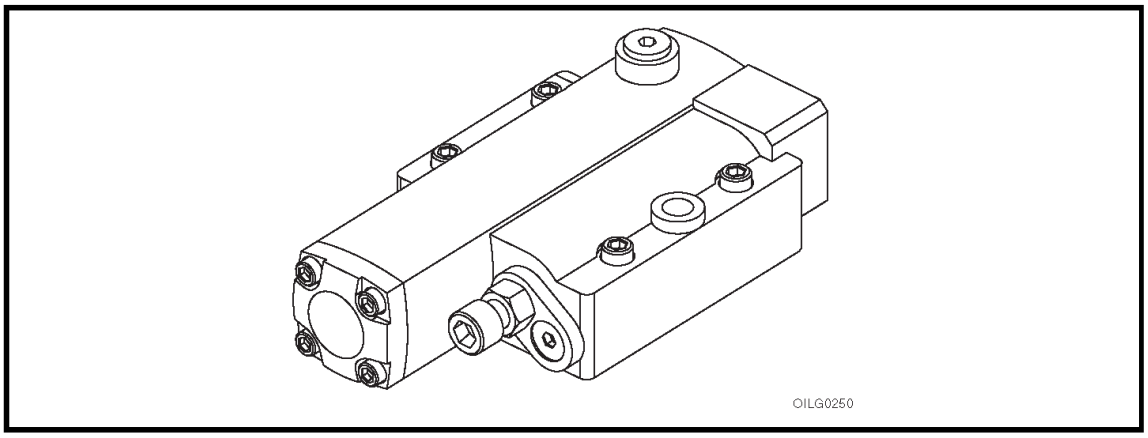

Figure 1. Typical Oilgear Type "P-1NN" and "P-LNN" Pressure Compensator Controls for "PVWJ" B-Frame Pump

PURPOSE OF INSTRUCTIONS

These instructions will simplify the installation, operation and maintenance of Oilgear type "P-1NN" and "P-LNN" controlled units.

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

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PVWJ Open Loop Pumps, Application Guidelines ..... Bulletin 847085
PVWJ Open Loop Pumps (All Frame Sizes) Service Instructions ..... Bulletin 947085
PVWJ Open Loop Pumps, Sales ..... Bulletin 47085

PVWJ PUMP INSTALLATIONS

PVWJ B Frame (PVWJ-025/-034/-046) w/ Rear Ports DS-47483
PVWJ B Frame (PVWJ-025/-034/-046) w/ Side Ports DS-47484
PVWJ B Frame (PVWJ-025/-034/-046) w/ Side Ports & Thru Shaft DS-47485

PVWJ PUMP CONTROL INSTALLATIONS

"P-1NN" and "P-LNN" Pressure Compensator for PVWJ-025/-034/-046 ..... DS-47985

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

Issued: August 2006

Safety First

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

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

SAFETY SYMBOLS

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

⚠ DANGER ⚠

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

⚠ WARNING

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

CAUTION

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

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

⚠ WARNING

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

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

⚠ WARNING

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

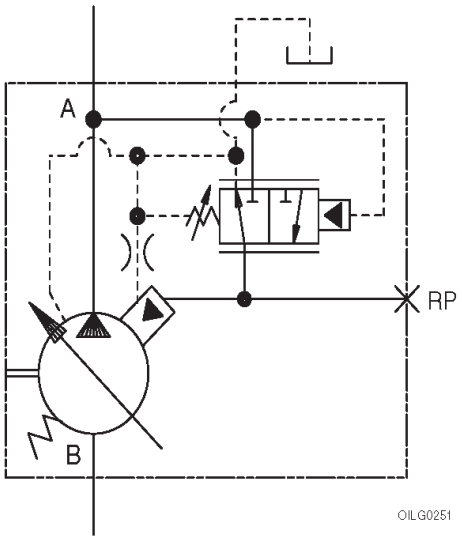

Figure 2. ASA Diagram for "P-1NN" or "P-LNN" Controls Shown with Typical Pump

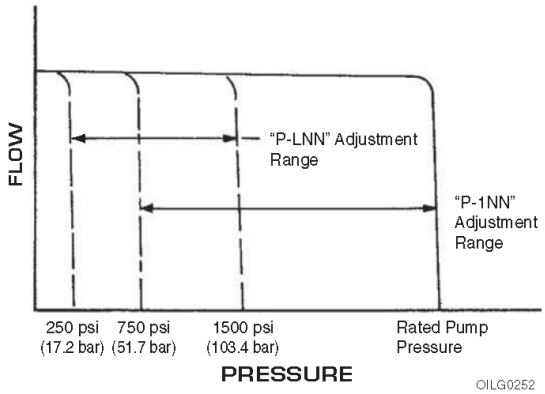

Figure 3. Curve Indicating Flow Versus Pressure for "P-1NN" or "P-LNN" Type Controls

TROUBLESHOOTING

PROBLEM	CAUSES	REMEDY
Unresponsive or Unstable Control	Swashblock bearing surface and/or Saddle Bearings worn or damaged.	See appropriate pump service bulletin.
	Control Pin and/or hole in Swashblock worn significantly.	
	Saddle Bearing Locating Pins broken.	
	Fluid is contaminated.	Inspect and clean if necessary. See bulletin 90007.
	Control Piston orifice (732) plugged.	Inspect and clean if necessary.
	Contamination trapped between control piston (702) and piston bore is not allowing piston to move smoothly.	Inspect and clean if necessary. Replace scored or damaged parts.
	Contamination trapped between control spool (706) and spool bore is not allowing spool to move smoothly.	
	Faulty remote pressure compensator circuit components.	Inspect and replace if necessary.
	Hydraulic line between remote pressure compensator components and RP port of control is too long.	Shorten line length.
	Insufficient control flow.	Increase size of control piston orifice (732).
Insufficient Outlet Volume	Swashblock not stroking to desired displacement.	See appropriate pump service bulletin.
	Low input drive speed.	
	Worn or grooved Cylinder Barrel and/or Valve Plate mating surfaces.	
	Failed Driveshaft.	
	Worn or damaged Piston Shoes or Swashblock.	
	Worn Pistons and/or piston bores.	
	Control Piston stuck off stroke.	Inspect and replace if necessary.
	Maximum Volume Stop adjusted incorrectly.	Adjust Maximum Volume Stop CCW to increase outlet flow.
	Pressure Compensator is set too close to operating pressure.	Adjust Pressure Compensator setting CW to increase setting.
Destrokes at low pressure	Pressure compensator adjustment not set correctly.	Adjust Pressure Compensator setting CW to increase setting and retorque jam nut (715).
	Control Piston orifice (732) plugged.	Inspect and clean if necessary.
	Damaged or fractured control spring (items 708 and/or 709).	Inspect and replace if necessary.
	Severely worn control spool (706) and/or spool bore.	
	Damaged or fractured control piston spring (item 703).	
	Faulty remote pressure compensator circuit components.	
Excessive peak pressure	Pressure Compensator is set too high.	Adjust Pressure Compensator setting CCW to decrease setting.
	Minimum Volume Stop is set too high.	Adjust Minimum Volume Stop CCW to decrease outlet flow.
	Fluid is contaminated.	Inspect and clean if necessary. See bulletin 90007.
	Swashblock bearing surface and/or Saddle Bearings worn or damaged.	See appropriate pump service bulletin.
	Contamination trapped between control piston (702) and piston bore is not allowing piston to move smoothly.	Inspect and clean if necessary. Replace scored or damaged parts.
	Contamination trapped between control spool (706) and spool bore is not allowing spool to move smoothly.	
	Hydraulic line between remote pressure compensator components and RP port of control is too long.	Shorten line length.
	Faulty remote pressure compensator circuit components.	Inspect and replace if necessary.
	Restriction in drilled passages between pump outlet port and control spool.	Inspect and clean if necessary.

PRINCIPLE OF OPERATION

The pressure compensator control ensures maximum pump flow until the system reaches the controls preset pressure setting. The control then regulates the pump output flow to match the flow requirements of the system, while maintaining the preset output pressure.

When the system pressure exceeds the compensator control setting, or the system no longer requires flow, the control de-strokes the pump while maintaining the preset pressure.

"P-1NN" controls can be adjusted from 750 psi (51,7 bar) working pressure up to the maximum pressure rating of the applicable pump. "P-LNN" controls can be adjusted from 250 psi (17,2 bar) up to a maximum of 1500 psi (103,4 bar).

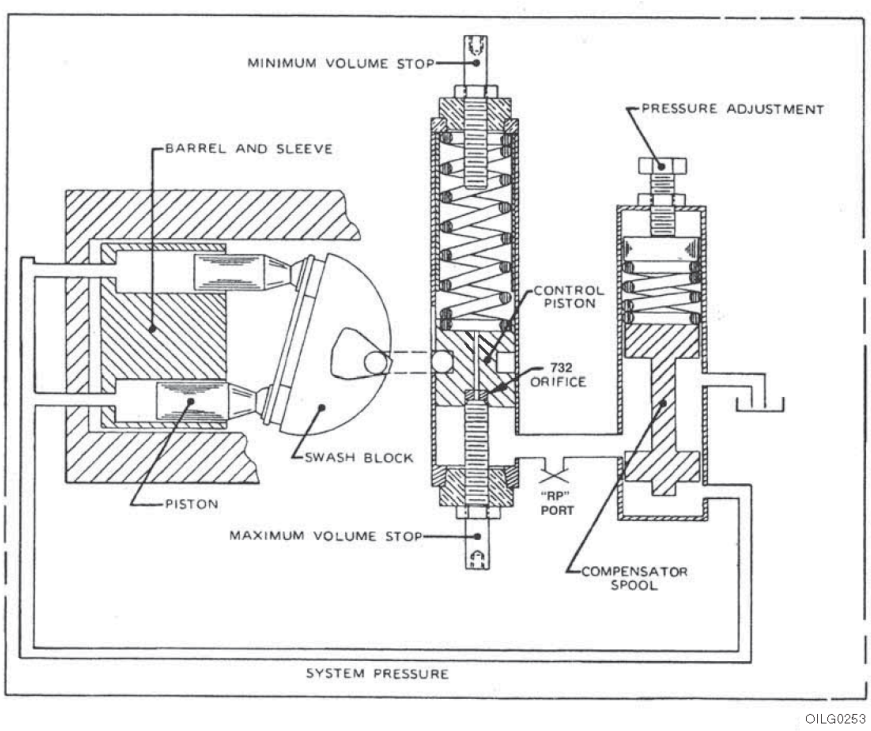

Figure 4. Swashblock at Full Delivery and "P-1NN" or "P-LNN" Controls at Maximum Volume Stop

LINE MOUNTED REMOTE PRESSURE CONTROL FOR TYPE "P-1NN" AND "P-LNN" PUMP CONTROLS - VSR (REMOTE SEQUENCE VALVE)

Remote operation of "P-1NN" and "P-LNN" controls can be accomplished by installing an Oilgear VSR Module at the location shown in the control circuit. Use module L51542 for units rated continuously for 4000 psi (275,8 bar) or less. Use L51542-1 for units rated above 4000 psi (275,8 bar).

NOTE *To minimize case leakage and power loss, plug the control drain port with a #10-24 UNC setscrew to maintain the standard "P-1NN" or "P-LNN" control case leakage. The plug will increase response time. Standard response time can be obtained by installing a .040 inch (1,0 mm) orifice instead of plugging it.*

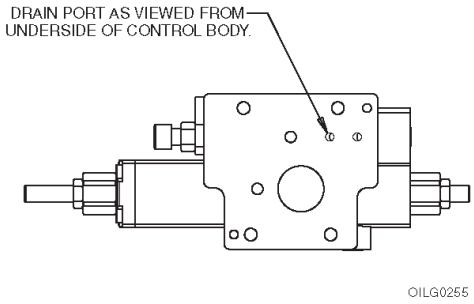

Figure 7. "P-1NN" and "P-LNN" Control Drain Port Location

NOTE *The compensator setting on the pump control must be set at least 200 psi (13,8 bar) higher than the required pressure setting of the remote compensator module to prevent the pump compensator control from interacting with the remote compensator module.*

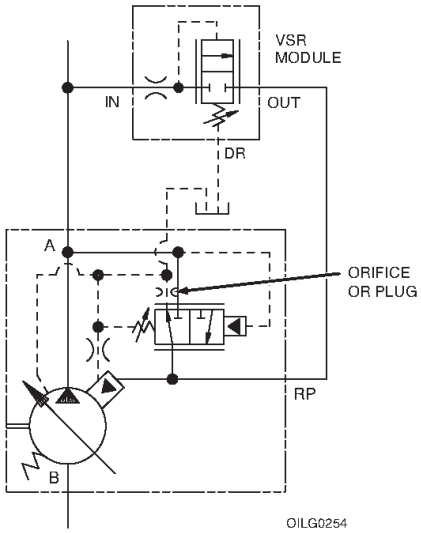

Figure 5. "P-1NN" and "P-LNN" Control Circuit with Remote Pressure Control

SCREW AND PLUG TORQUES FOR CONTROLS

Item Number	Description	Head Type & Size	Tightening Torque
601	SAE #2 Plug	1/8" Internal Hex	45 in.-lbs (5 N·m)
603	SAE #4 Plug	3/16" Internal Hex	120 in.-lbs (14 N·m)
606	SAE #8 Plug	5/16" Internal Hex	45 ft-lbs (61 N·m)
711	PC Adjuster Screw LHCS	3/32" Internal Hex	57 in.-lbs (6 N·m)
714	Adjuster Plate Screw	5/32" Internal Hex	80 in.-lbs (9 N·m)
720	Max. or Min. Volume Stop Housing	7/8" External Hex	50 ft-lbs (68 N·m)
722	End Cap Screws	3/16" Internal Hex	120 in.-lbs (14 N·m)
723	Control Body Screws	3/16" Internal Hex	120 in.-lbs (14 N·m)
732	Control Piston Orifice	3/32" Internal Hex	20 in.-lbs (2.3 N·m)

CONTROL O-RING SEALS

Item Number	ARP 568 Uniform Size Number	Shore A Durometer
1010	-010	90
1011	-011	90
1113	-113	90
1125	-125	90
1237	-237	70
1902	-902	90
1904	-904	90
1908	-908	90

PARTS LIST

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

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

PVWJ-025/-034/-046 PRESSURE COMPENSATOR CONTROLS (“P-1NN” STANDARD & “P-LNN” LOW PRESSURE CONTROLS)

Item	Description
	COMMON PARTS GROUP
601	SAE#2 Plug
603	SAE#4 Plug
606	SAE#8 Plug
701	Control Block
702	Control Piston
703	Control Piston Spring
704	Piston Stop
705	End Cap
706	Pressure Compensator Control Spool
707	Spring Seat
708	Pressure Compensator Spring (Outer)
709*	Pressure Compensator Spring (Inner)
710	Control Plug
711	Screw
712	Shims
713	Adjuster Plate
714	Screw
715	Jam Nut
716	Pressure Compensator Adjustment Screw
717	Min. Volume Stop Stem
718	Max. Volume Stop Stem
719	Jam Nut
720	Volume Stop Housing
721	Control Pin
722	Screw, End Cap
723	Screw, Control Body
732	Orifice
1010	O-Ring
1011	O-Ring
1113	O-Ring
1125	O-Ring
1237	O-Ring
1902	O-Ring
1904	O-Ring
1908	O-Ring

*Only used in P-1 Control.

SERVICE KITS

Document Number: 519975-SK2
Revision: New

PVWJ Service Kits

Reference 519975-201
SERVICE KIT, Figures 8 & 9

Description	Kit No.	Design Series	Items Included (quantity is 1 unless noted)
Main Control Body Kits			
PVWJ-025	K50432-100	A1	701, 706
PVWJ-034/-046	K50432-200	A1	701, 706
Control Piston Kits			
All Models	K50484	A1	702, 732
Pressure Compensator Spools			
PVWJ-025	50015-100	A1	706
PVWJ-034/-046	50015-200	A1	706
Control Spring Kits			
P-LNN (All Models)	K50036-104	A1	703, 708
PVWJ-025 P-1NN	K50036-107	A1	703, 708
PVWJ-034/-046 P-1NN	K50036-110	A1	703, 708, 709
Control Pins			
All Models	51339-5	A1	721
Volume Stop Kits			
Maximum Volume Stop (All Models)	K50590	A1	718, 719, 720, 1011, 1908
Minimum Volume Stop (All Models)	K50590-200	A1	705, 717, 719, 720, 1011, 1020, 1908
Pressure Compensator Adjuster Kits			
All Models	K50660-200	A1	710, 711, 712, 713, 715, 716, 1113
Control Seal Kit			
All Models	K50824-200	A1	1010, 1011, 1113, 1125, 1237, 1902, 1904, 1908

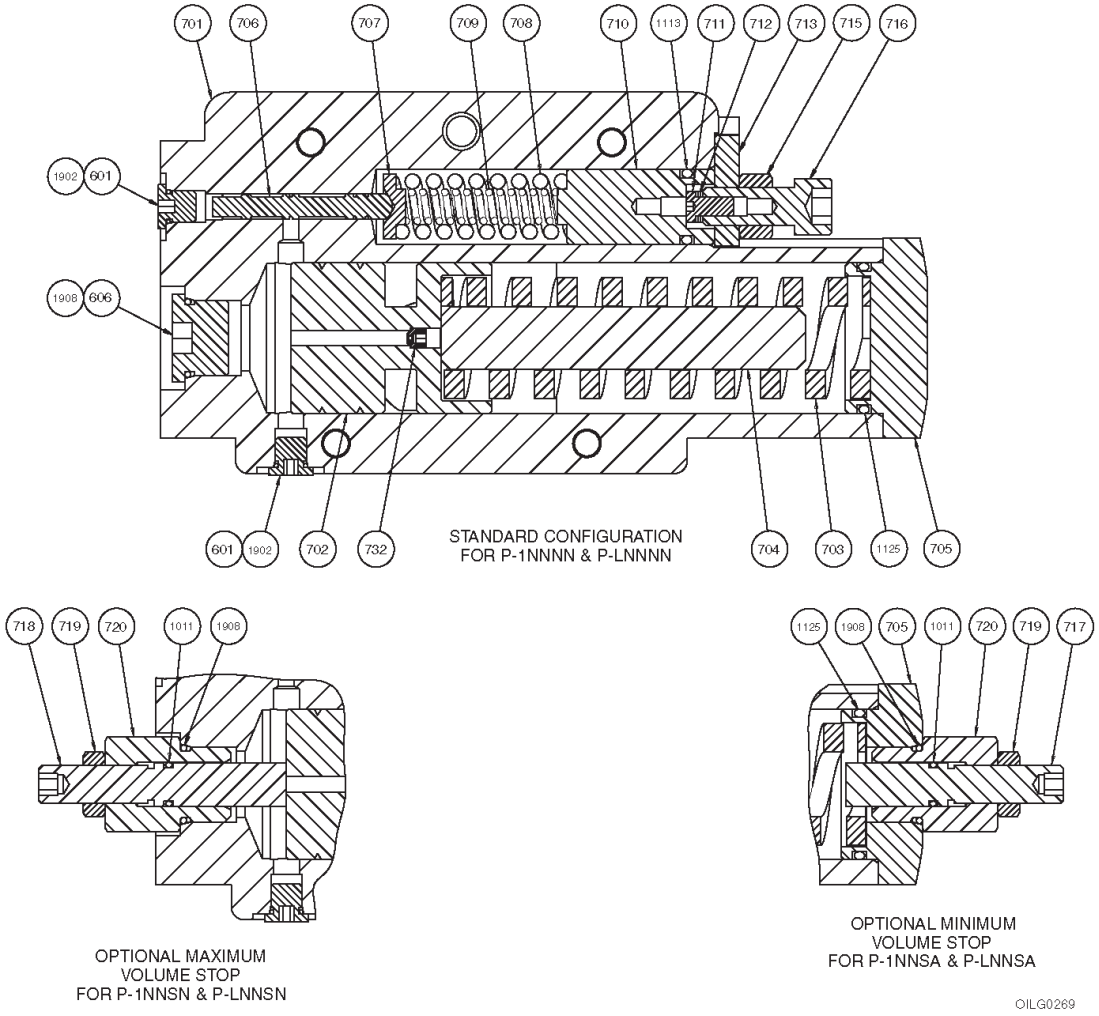

Figure 8. Parts Drawing for “P-1NN” and “P-LNN” Control (519975-201 sheet 1)

MAXIMUM AND MINIMUM VOLUME STOP

The maximum volume stop can be adjusted to attain a maximum volume from full to 25% of full flow. The pump can be de-stroked from full to 25% flow with 11 turns of the volume stop. One turn clockwise will decrease maximum pump outlet flow 7%.

The minimum volume stop can be adjusted to attain a minimum volume from zero to full flow. The adjustment requires 14 turns to go from zero to full flow. One turn clockwise will increase minimum pump outlet flow 9%.

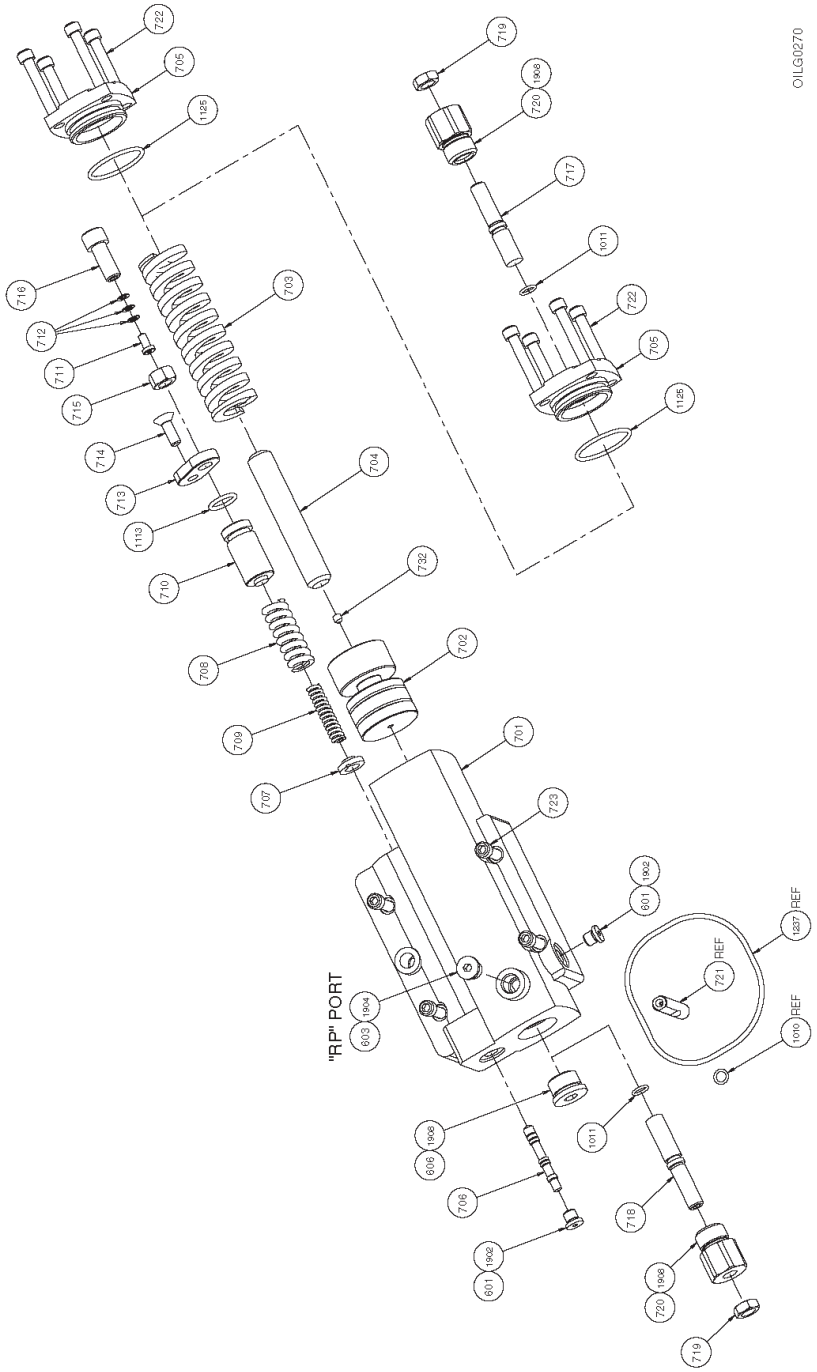

Figure 9. Exploded Parts Drawing for “P-1NN” and “P-LNN” Control (519975-201 sheet 2)

NOTES

NOTES

AFTER SALES SERVICES

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

STAY-ON-STREAM SERVICE

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

SERVICE SCHOOLS

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

SPARE PARTS AVAILABILITY

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

THE OILGEAR COMPANY
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Bulletin 947634

TRONAIR®

APPENDIX IV

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

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/m³ - ACGIH TLV (inhalable fraction), 5 mg/m³ - 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, corrosivity 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.

Internal Use Only

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

DGN: 2005454XUS (552975)
