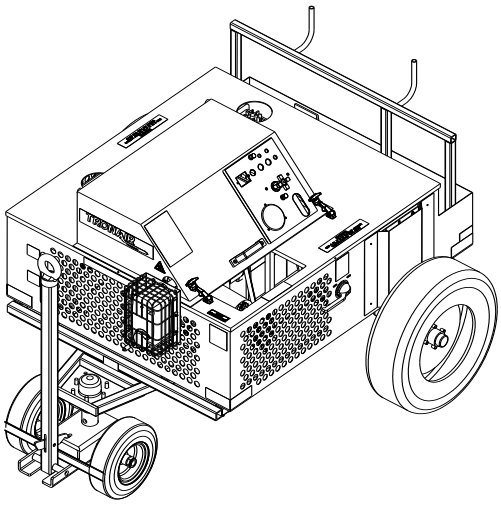
OPERATION & SERVICE MANUAL



Model: 50111ZZG
Gasoline Engine Driven
Hydraulic Power Unit

CE

02/2025 – Rev. 01

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1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Gasoline Engine Driven Hydraulic Power Unit

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit.

1.3 MANUFACTURER

***TRONAIR*, Inc.**
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1.4 FUNCTION

The Hydraulic Power Unit (HPU) provides a source of clean, pressurized hydraulic fluid for performing required aircraft maintenance. A gasoline engine 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. A number 32 lunette eye is provided for connecting to standard towing equipment.

1.5 REQUIREMENTS

Proper octane gasoline must be provided for proper functioning of the HPU. See the unit nameplate for details.

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

The HPU provides pressurized hydraulic fluid for performing aircraft maintenance.

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

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

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

2.2 EXPLANATION OF WARNING & DANGER SIGNS

Hot Parts! Engine components can get extremely hot from operation. To prevent severe burns, do not touch engine components while engine is running or immediately after is shut down. Never operate the engine with heat shields or guards removed.

Explosive Fuel! Gasoline fuel is extremely flammable and its vapor can explode if ignited. Store fuel only in approved containers, in well-ventilated, unoccupied buildings, away from sparks or flames. Do not fill the fuel tank while the engine is hot or running as spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use fuel as a cleaning agent.

Lethal Exhaust Gases! Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled. Avoid inhaling exhaust fumes and never run the engine in a closed building or confined area.

Explosive Gas! Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sparks, open flames and other sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries. Before disconnecting the negative (-) ground cable, ensure all switches are "Off". If "On", a spark will occur at the ground cable terminal which could cause an explosion if hydrogen gas or fuel vapors are present.

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

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

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

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

2.3 COMPONENT SAFETY FEATURES

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

2.4 FUNCTIONAL SAFETY FEATURES

- Emergency shut off switch
- Locking brake system
- Sheet metal panels
- Fluid sample shut off valve

2.5 PERSONAL PROTECTION EQUIPMENT

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

2.6 SAFETY GUIDELINES

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

2.7 GENERAL COMMENTS

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

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

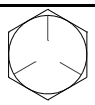
3.0 PREPARATION PRIOR TO FIRST USE

3.1 GENERAL

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

This product should be assembled and/or repaired using good workmanship practices and proper tools. Bolts and elastic stopnuts should be tightened to a torque not to exceed industry standards of Grade '5' bolts.

BOLT TORQUE		
Size	Ft-lbs	N-m
5/16 - 24	20	27
3/8 - 24	35	47
1/2 - 20	85	115



SAE Classification - Grade 5
Markings on top of bolt head indicate grade.

All replacement parts must be the same as or equal to the original parts supplied.

3.2 ASSEMBLY STEPS

1. Generally, check over unit and ensure the tightness of all nuts, bolts and screws
2. Check tire pressure for 25 psi (1.7 bar) maximum
3. Engine System:
   a. Check the engine oil level
   b. Check hydraulic fluid levels
   c. Fill fuel tank with gasoline

WARNING!

Battery posts, terminals and related accessories contain lead and lead compounds; chemicals known to the State of California to cause cancer and reproductive harm.

Wash hands after handling batteries and related accessories.

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

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

4.2 TRAINING PROGRAM

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

4.3 OPERATOR TRAINING

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

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

5.0 OPERATION

5.1 OPERATING PARAMETERS

- The user shall use the HPU in accordance with the aircraft manufacturer's instructions.
- The user shall operate the HPU in accordance with the Operator Manual.
- The employer of the operator shall provide all necessary training.

5.2 NUMERICAL VALUES

5.2.1 Fluid

MIL-PRF-5606

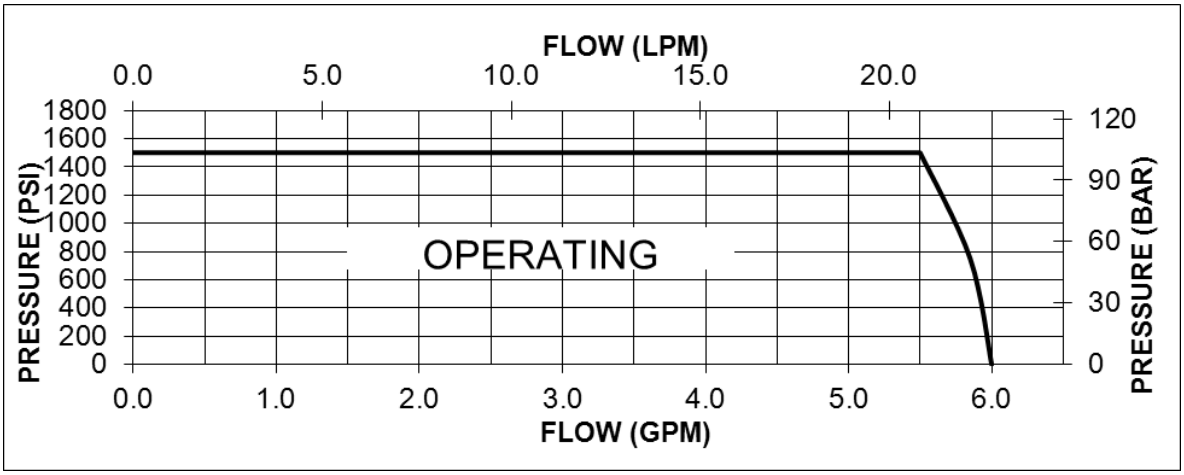
5.2.2 Physical

Gross Vehicle Weight.....1,150 lbs (521.6 kg)
Width.....64-1/8 in (162.9 cm)
Height.....46-1/4 in (117.5 cm)
Depth.....76-7/16 in (194 cm)
Pressure Hoses.....30 ft (9.1 m) Standard Length
-8 (½ in, 12.7 mm) Working Diameter
Return Hoses.....30 ft (9.1 m) Standard Length
-12 (¾ in, 19.1 mm) Working Diameter

5.2.3 Engine Driven Hydraulic Pump

A pressure compensated, adjustable maximum volume piston pump
Maximum flow.....6 gpm (22.7 lpm)
Maximum operating pressure.....1,500 psi (103 bar)
System pressure relief valve setting.....1,750 psi (121 bar)
Return system pressure relief valve setting 75 psi (5.2 bar)
Noise level.....85 dbA @ 3 ft
Performance Curve

Performance Curve



5.2.4 Gasoline Engine

An 18 horsepower, gasoline engine is the prime mover for the HPU. This is attached to the hydraulic pump using a pump/motor adapter and a spider/coupling rotating interface.

- Kohler, 2 cylinder, air-cooled, gasoline engine
- 18 hp (13 kW) @ 3,000 rpm
- High Oil Temperature Switch
- Low oil pressure shut-down
- Capacities:
  - Fuel: 6 U.S. gallons (18.9 lt) gasoline
  - Oil Sump: 2.6 U.S. quarts (2.5 lt)
- Air Cleaner: Replacement Dry Type
- Fuel Specifications:
  - Do not add oil to the gasoline
  - Do not overfill the fuel tank, leave room for the fuel to expand
  - **Fuel Type:** For best results use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 or higher (In countries using the Research method, it should be 90 octane or higher)
  - **Gasoline/Alcohol Blends:** gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends are not approved
  - **Gasoline/Ether Blends**: Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved as a fuel for Kohler engines. Other gasoline/ether blends are not approved
  - **Idle Speed**: 1200 +/- 100 rpm
  - **Run Speed**: 2200 +/- 100 rpm

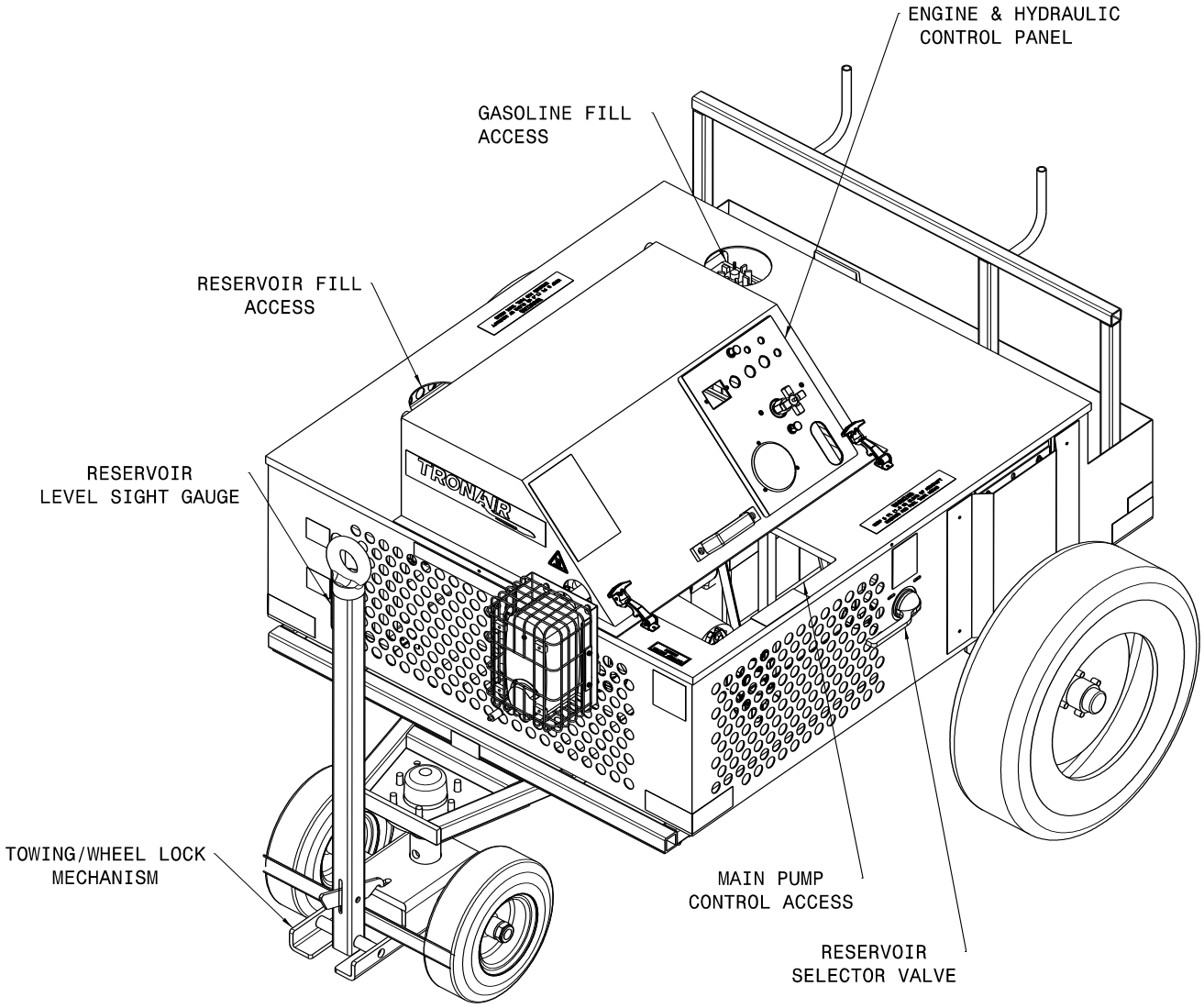
5.2.5 Filters

Pressure..... 2 micron rating, non-bypass high collapse microglass type. Non-cleanable element.
Return ..... 5 micron rating, 25 psi (1.72 bars) bypass microglass type. Non-cleanable element.

5.2.6 Batteries

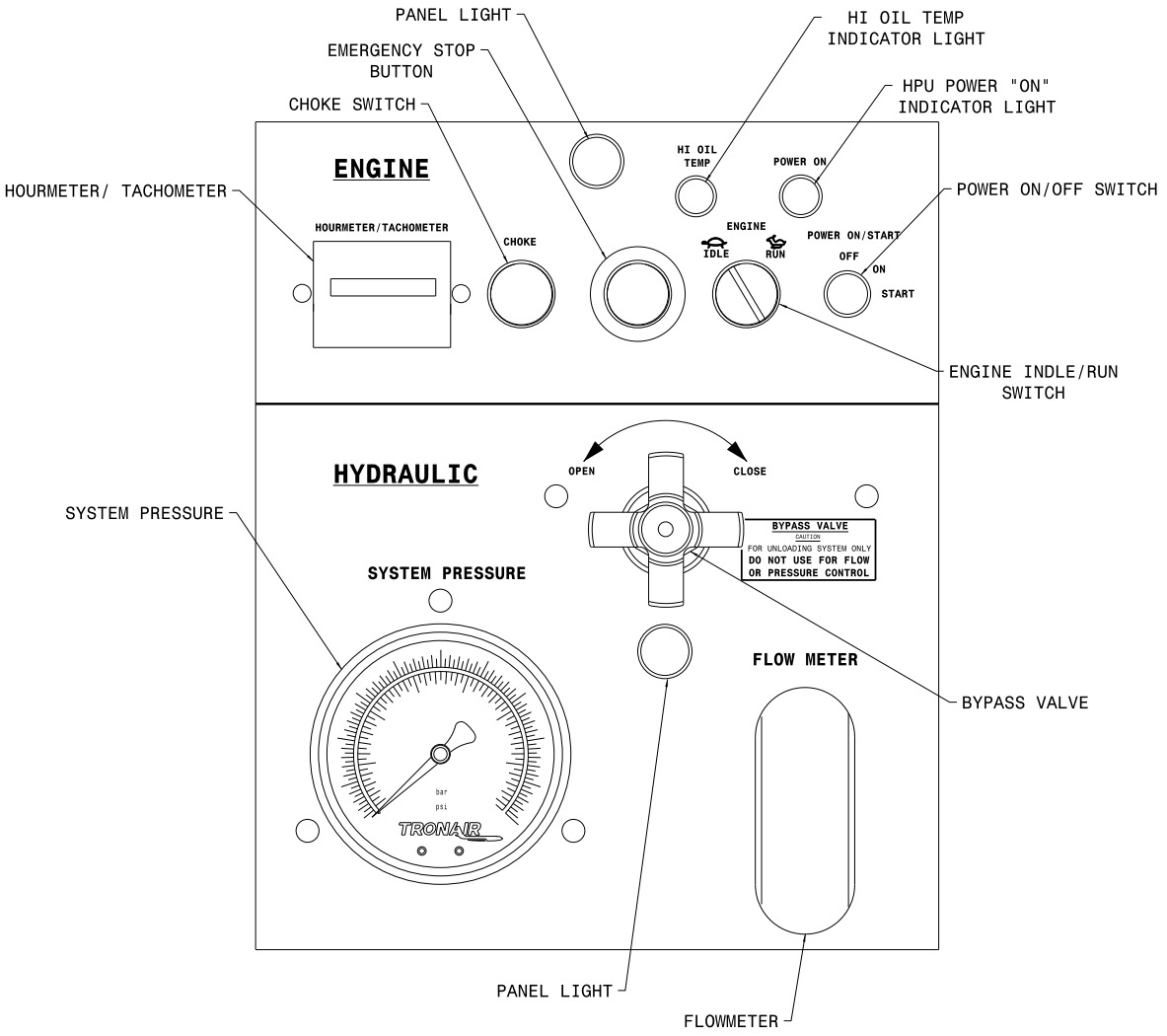
- One (1) 12 volt,
- Group size: U1
- Cold-cranking amps (0º F): 370 Amps
- Terminals: Automotive top post style

5.3 LOCATION & LAYOUT OF CONTROLS



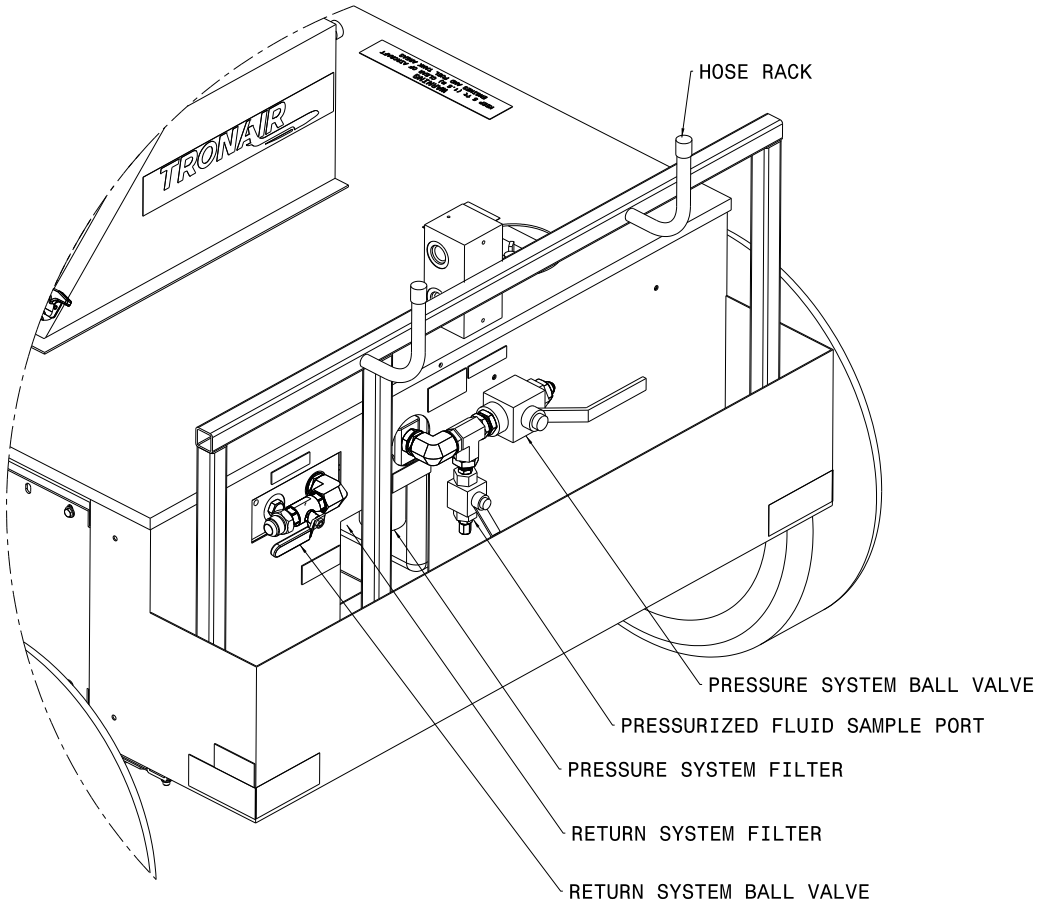
Engine & Hydraulic Control Panel	*See Section 5.3.1*
Towing/Wheel Lock Mechanism	For connecting to a tow vehicle or locking the brakes when the handle is in the upright position
Flow Meter	Displays the flow from the motor driven hydraulic pump
Main Pump Control Access	See ***Figure 5.3.5 - Hydraulic Pump Controls***
Reservoir Selector Valve	For selecting between using the aircraft reservoir or the HPU reservoir
Reservoir Level Sight Gauge	Visual indicator displays the fluid level in the reservoir
Reservoir Fill Access	Cap for servicing the HPU reservoir
Gasoline Fill Access	Cap for servicing the HPU gasoline tank, cap includes a fuel level indicator

5.3.1 Engine and Hydraulic Control Panel



Hourrmeter/Tachometer	Displays engine speed when running (rpm) or operating hours
Choke Switch	Use to start engine in cold weather
Emergency Stop Button	Removes power to all electrical devices, must turn to reset
Panel Light	Illuminates control panel
High Oil Temp Indicator Light	Indicates when oil temperature is too high
HPU Power "On" Indicator Light	Light is illuminated when the electric motor driving the hydraulic pump and cooling fan are powered
Power On/Off Switch	Turns power on to unit, off when running
Engine Idle/Run Switch	Switches between idle and run speed
Bypass Valve	Loads and unloads the hydraulic pump
Flowmeter	Indicates flow from hydraulic pump
System Pressure	Displays the system pressure

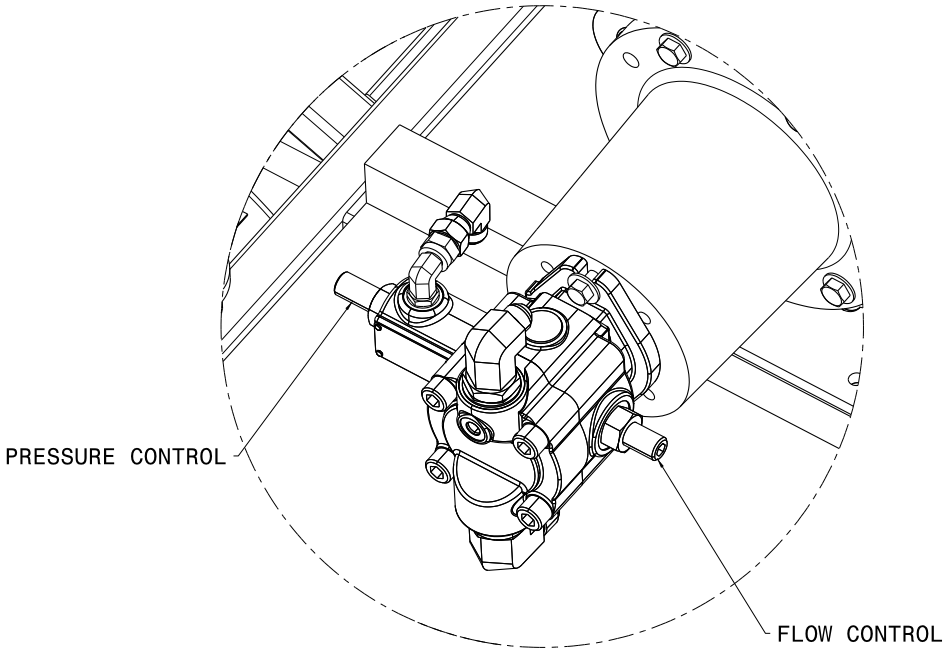
5.3.2 Rear Panel Controls



Hose Racks	Location for storing the pressure and return hoses when not in use
Pressure System Ball Valve	Shut off valve for pressurized fluid from the HPU that flows to the aircraft pressure system through the pressure hose
Pressurized Fluid Sample Port	A sample valve is provided to obtain a fluid sample for analysis. In order to obtain a representative sample
Pressure System Filter	Filters the pressurized fluid before it flows to the aircraft pressure system
Return System Ball Valve	Shut off valve for fluid returning to the HPU from the aircraft that flows through the return hoses
Return System Filter	Filters the returning fluid from the aircraft

5.3.3 Hydraulic Pump Controls

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



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

5.4 START UP PROCEDURES

5.4.1 Oil Recommendations

Using the proper type and weight of oil in the crankcase is extremely important to the life of the engine.

To increase reliability and operational life of this Ground Power Unit:

- Use proper oil type and weight
- Check oil level daily
- Change oil per maintenance schedule

Oil Specifications

To help assist engine running-in, all engines are dispatched with an initial fill lubricating oil which must be changed after 100 hours. All subsequent oil changes must be as specified in the maintenance schedule.

5.4.2 Fuel Recommendations

EXPLOSIVE FUEL!

- **Gasoline is extremely flammable and its vapors can explode if ignited. Store fuel only in approved containers, in well ventilated, unoccupied buildings, and away from sparks or flames.**
- **DO NOT fill the fuel tank while the engine is hot or running. Spilled fuel coming in contact with hot parts or sparks from ignition will ignite.**
- **Do not start the engine near spilled fuel. Never use fuel as a cleaning agent.**

Fuel Specification

The engine must only be used with gasoline which conforms to one of the following:

- **Fuel Type:** For best results use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 or higher (In countries using the Research method, it should be 90 octane or higher)
- **Gasoline/Alcohol Blends:** gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends are not approved
- **Gasoline/Ether Blends**: Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved as a fuel for Kohler engines. Other gasoline/ether blends are not approved

EXPLOSIVE FUEL!

- Do **not add oil to the gasoline**
- **Do not overfill the fuel tank, leave room for the fuel to expand**
- **The user is cautioned that although the engines may operate on fuels outside the above specifications, such operation may well result in excessive wear and damage.**

5.4.3 PERSONAL PROTECTIVE EQUIPMENT

Always wear safety glasses.

5.4.4 CHECKS PRIOR TO START UP

1. Battery switch in “Off” position
2. Engine oil (SAE 10W30) level
3. Hydraulic fluid (MIL-PRF-5606) level
4. Gasoline (90 octane minimum) level
5. Check running hours for scheduled maintenance
6. Battery switch to “On” position

5.4.5 Initial Start Up of the HPU

a. Unit must be prepared per section *3.0 Preparation Prior to First Use*
b. Operator must be familiar with this manual and be properly trained prior to starting the HPU
c. Connect quick disconnects to run around bulkhead fittings or cap the pressure and return hose ends
d. Place the reservoir selector valve in "HPU Reservoir" position
e. Place the bypass valve in the "Open" position

CAUTION!

Ether-based cold start aids must not be used under any circumstances.

Battery Disconnect Switch - Move switch to “ON” position

Throttle Switch - Ensure Idle/Run switch is down in the “Idle” position

Emergency Stop Switch - Pushing this switch in will remove electrical power to the engine control box. Twist switch to right to “pop” out and allow power to engine control box.

Engine Key Switch - Rotate key to the right “ON” position. The following will be observed: Green Power On Lamp

Engine Starter (Start engine)

- Rotating key farther to right to “Start” position will cause engine starter motor to engage
- **DO NOT** crank the engine continuously more than 10 seconds at a time
- ALWAYS allow the starter motor a 60 second cool-down period between cranking attempts if the engine does not start. Failure to follow these guidelines may result in burnout of the starter motor
- NEVER engage starter when engine is running
- Press choke during start if necessary in cold weather

CAUTION!

In the event of “false start”; that is, if the engine attains sufficient speed to disengage the starter but fails to continue running, the engine must be allowed to come to a complete halt before a restart attempt is made.

If the flywheel is still rotating when the starter is engaged, then pinion and ring gears may clash.

Warm Engine at Idle - If the engine is not allowed to sufficiently warm up prior to acceleration, then engine damage may result. Allow engine to run at low idle for a minimum of 60 seconds.

Throttle to “Run” Position

- Moving the throttle to high position provides full operating power.
- In this position, flow will be observed on the flowmeter

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

5.5 SHUT OFF/SHUTDOWN PROCEDURES

1. Open bypass valve
2. Engine speed to “Idle” speed - Reduce engine speed to low position for 30 seconds in order to cool the engine
3. Turn “Power On/Start” to “Off” position

5.6 EMERGENCY SHUTDOWN PROCEDURES

Push emergency stop in

5.7 PRELIMINARY ADJUSTMENTS FOR OPERATION

The following are basic to the operation of the HPU and should be thoroughly understood. The pressure and flow controls have lock nuts to prevent rotation of the control shaft during operation. These nuts should be moved away from the pump during adjustment of flow or pressure in order to eliminate binding of the control shafts.

5.7.1 Flow Control Adjustment

a. Open bypass valve
b. Select "Hydraulic Power Unit" position with reservoir selector valve
c. Start HPU
d. Engine speed to “Run” position
e. Adjust flow control on pump for maximum desired flow. Observing the flowmeter, read flow in gallons (liters) per minute directly from flowmeter. Be sure the control shaft lock nut is loose during adjustment. Tighten after adjustment to maintain setting

5.7.2 Pressure Control Adjustment

a. Open bypass valve
b. Select "Hydraulic Power Unit" position with reservoir selector valve
c. Close the pressure and return ball valves on the rear of the unit
d. Start HPU
e. Engine speed to “Run” position
f. Close bypass valve – Fully close
g. Adjust pressure control for desired pressure; observing the system pressure gauge, read in psi (bars). Be sure the control shaft lock nut is loose during adjustment. Tighten after adjustment to maintain setting

NOTE: Once the flow and pressure controls have been adjusted, it is not necessary to change these settings after each operation unless desired. Flow control may need to be set higher than required to achieve same flow while pressurized.

5.7.3 Reservoir Selector Valve Operation

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

CAUTION!

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

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

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

Since the HPU reservoir is vented to atmosphere and the aircraft is at a higher level, it is normal for the aircraft reservoir to drain into the HPU reservoir. It is, therefore, necessary to be sure that sufficient room is available in the HPU reservoir to accommodate the additional fluid.

CAUTION!

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

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

5.7.4 Bypass Valve Operation

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

a. Start Up Operation:
The bypass valve must be opened prior to starting the HPU in order to allow the motor to start under a no load condition and not pressurize the aircraft hydraulic system.
b. Shut **Down** Operation:
Prior to shutdown, the bypass valve must be opened to bleed off any residual system pressure.

CAUTION!

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

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

5.8 BLEEDING AIR FROM SYSTEM

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

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

5.8.1 To Easily Purge the Unit of Air

a. Fill reservoir to recommended level
b. Open bypass valve
c. Place reservoir selector valve in “Hydraulic Power Unit” position
d. Connect the pressure and return couplings to the run around system bulkhead fittings
e. Start unit and adjust flow control to maximum position (do not exceed 8 gpm flow)

NOTE: If fluid is not flowing, shut off HPU and reference 8.2 No Flow

f. Run unit for five (5) minutes and shut off
g. If additional bleeding is required, start the HPU and slowly close the bypass valve (system pressure should remain under 200 psi (approximately 14 bar). Allow fluid to flow at full flow (do not exceed 8 gpm flow) for five (5) minutes, then shut the HPU off

WARNING!

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

5.9 BATTERY

WARNING!

Battery posts, terminals and related accessories contain lead and lead compounds; chemicals known to the State of California to cause cancer and reproductive harm.

Wash hands after handling batteries and related accessories.

Refer to the battery MSDS, Appendix VII, for specific maintenance regarding the batteries.

It is suggested that each year the battery be tested. Replace worn battery. Acceptable battery should be fully charged.

5.10 SAMPLE VALVE

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

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

5.11 EMERGENCY SHUT DOWN PROCEDURE

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

5.12 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.

1. Assure that the HPU reservoir is filled between the minimum and maximum level
2. Verify the unit has sufficient fuel to operate for one hour
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
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. Place the selector valve in the Aircraft Reservoir position
16. Close the pressure and return ball valves on the back of the unit

6.0 PACKAGING AND STORAGE

6.1 PACKAGING REQUIREMENTS

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

NOTE: Use at least four (4) straps with a minimum 1,200 lb (544.3 kg) capacity each.

6.2 HANDLING

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

NOTE: Be sure the forks are long enough to reach the frame cross members for stability during lifting. Spread the forks to their maximum width for stability. Reference 7.0 Transportation.

6.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required.

6.4 LABELING OF PACKAGING

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

6.5 STORAGE COMPATIBILITY

Drain all fuel from the unit.

6.6 STORAGE ENVIRONMENT

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

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

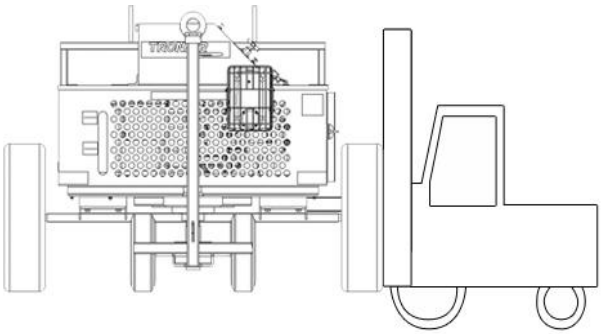
6.7 STORAGE SPACE AND HANDLING FACILITIES

Weight..... 1,150 lbs (521.6 kg)
Width..... 64 ⅛ in (162.9 cm)
Height..... 46 ¼ in (117.5 cm)
Depth..... 76 7/16 in (194 cm)

7.0 TRANSPORTATION

1 Do not stack Hydraulic Power Units.
2 The unit can be lifted by means of a fork truck from the engine side center of the HPU.
3 Gross Vehicle Weight: 1,150 lbs (521.6 kg)

NOTE: Be sure the forks are long enough to reach frame cross members for stability during lifting.



8.0 TROUBLE SHOOTING

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

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

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

Problem	Possible Solution
No indicator lights when key is turned	Switch battery to “ON” Ensure emergency stop is in out position Check wiring from battery to starter
Indicator light is on, engine starter will not energize	Check for 12 VDC to starter solenoid
Engine starter energized, engine will not run	Prime fuel system ***Note: Reference Kohler Maintenance Manual for engine trouble shooting***
Engine runs, no high throttle	Check circuit breaker two Ensure throttle solenoid linkage is not binding

8.1 HPU WILL NOT START

Possible Cause	Solution
High engine temperature	High engine temperature indicator light will be illuminated. Allow the hydraulic unit to cool until the light goes out. Refer to Section 8.5 for over-heated causes.

NOTE: Using the bypass valve to meter flow or pressure will increase the engine load. Refer to section 5.5.4 Bypass Valve Operation for proper use of the bypass valve.

8.2 NO FLOW

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

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

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

8.3 REDUCED FLOW

Possible Cause	Solution
Flow control set too low	Increase flow setting.
Pressure adjustment is set too low	Slightly increase pressure setting.
Pressure compensator control is reducing pump output	When system pressure exceeds the compensator control setting, or when the system no longer requires flow, the control de-strokes the pump while maintaining the preset pressure.
Pump inlet is not receiving enough fluid (cavitation)	Follow the procedure for “Air in pump inlet lines” in Section 8.2.

8.4 NO PRESSURE or REDUCED PRESSURE

Possible Cause	Solution
Pressure adjustment is set too low	Increase pressure adjustment.
Pump inlet is not receiving enough fluid (cavitation)	Follow the procedure for “Air in pump inlet lines” in Section 8.2.
Flow path is open	Pressure is resistance to flow. The HPU will reach full pressure as flow paths (such as moving actuators and open valves) are closed.

8.5 FLUID OVERHEATS

Possible Cause	Solution
Fan is not functioning properly	Check the cooler fan output. Forced air should be easily detected at the right hand side of the HPU. Check the fuses for the fan motor (See Appendices – Electrical Schematic INS-2016).
Bypass valve or rear ball valve is being used in a partially closed position	The bypass valve and all ball valves must be used in a fully open or fully closed position. These valves are not intended for metering flow. All flow adjustments must be made using the pump flow control.

9.0 MAINTENANCE

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

9.1 GENERAL

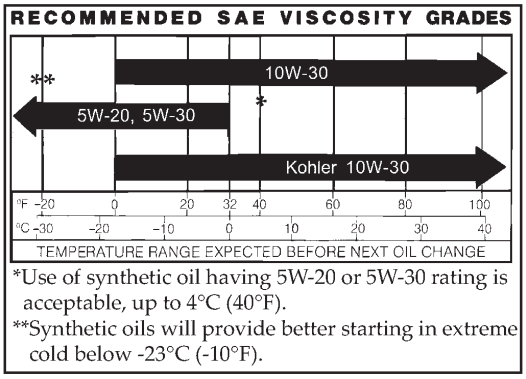
Periodically inspect the HPU for loose fasteners, hose fittings and damaged hoses. Make repairs as needed for safe operation.

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

9.2 ENGINE MAINTENANCE

9.2.1 Engine Oil

Using the proper type and weight of oil in the crankcase is extremely important. So is checking oil daily and changing oil regularly. Failure to use the correct oil, or using dirty oil, causes premature engine wear and failure.



*Use of synthetic oil having 5W-20 or 5W-30 rating is acceptable, up to 4°C (40°F).
**Synthetic oils will provide better starting in extreme cold below -23°C (-10°F).

Use high quality detergent oil of API (American Petroleum Institute) service class SG, SH, SJ or higher. Select viscosity based on air temperature at time of operation as shown.

NOTE: Using other than service class SG, SH, SJ or higher oil or extending oil change intervals longer than recommended can cause engine damage.

NOTE: Synthetic oils meeting the listed classifications may be used with oil changes performed at the recommended intervals. However t to allow piston rings to properly seat, a new or rebuilt engine should be operated for at least 50 hours using standard petroleum based oil before switching to synthetic oil.

A logo or symbol on oil containers identifies the API service class and SAE viscosity grade.

9.2.2 Fuel

Explosive Fuel! Gasoline fuel is extremely flammable and its vapors can explode if ignited. Store fuel only in approved containers, in well-ventilated, unoccupied buildings, away from sparks or flames. Do not fill the fuel tank while the engine is hot or running as spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use fuel as a cleaning agent.

- Do not add oil to the gasoline
- Do not overfill the fuel tank. Leave room for the fuel to expand

Fuel Type : For best results use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 or higher. In countries using the Research method, it should be 90 octane minimum.

Unleaded gasoline is recommended as it leaves less combustion chamber deposits and reduces harmful exhaust emissions. Leaded gasoline is not recommended and **must not** be used.

Gasoline/Alcohol blends: Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved a fuel. Other gasoline/alcohol blends including E20 and E85 are not to be used. Any failures resulting from the use of these fuels will not be warranted.

Gasoline/Ether blends: Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved. Other gasoline/ether blends are not approved.

9.2.3 Engine Maintenance Schedule

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

Frequency	Maintenance Required
Daily or Before Starting Engine	• Fill fuel tank • Check oil level • Check air cleaner for dirty*, loose or damaged parts • Check air intake and cooling areas, clean as necessary *
Every 25 Hours	• Service pre-cleaner element *
Every 100 Hours	• Replace air cleaner element * • Change oil (more frequently under sever conditions • Remove cooling shrouds and clean cooling areas * • Check oil cooler fins, clean as necessary (if equipped)
Every 200 Hours	• Check spark plug condition and gap • Change oil filter • Replace fuel filter (carbureted engines)

* Perform these procedures more frequently under extremely dusty or dirty conditions

Change Oil: Change oil after every 100 hours of operation (more frequently under sever conditions). Refill with service class SG, SH, SJ or higher oil as specified in the Viscosity Grades table.

Change oil while the engine is still warm. The oil will flow more freely and carry away more impurities. Make sure the engine is level when filling, checking and changing the oil.

9.2.4 Engine Trouble Shooting

Possible Cause/Problem	No fuel	Improper fuel	Dirt in fuel line/ system	Dirty grass screen	Incorrect oil level	Engine overloaded	Dirty air cleaner	Faulty spark plug
Will not start	**X**	**X**	**X**		**X**	**X**	**X**	**X**
Hard starting		**X**	**X**		**X**	**X**	**X**	**X**
Stops suddenly	**X**		**X**	**X**	**X**	**X**	**X**	
Lacks power		**X**	**X**	**X**	**X**	**X**	**X**	**X**
Operates Erratically		**X**	**X**	**X**		**X**	**X**	**X**
Knocks or pings		**X**		**X**		**X**		**X**
Skips or misfires		**X**	**X**	**X**			**X**	**X**
Backfires			**X**			**X**	**X**	**X**
Over heats			**X**	**X**	**X**	**X**	**X**	
High fuel consumption						**X**	**X**	**X**

9.3 HYDRAULIC POWER UNIT MAINTENANCE

9.3.1 Motor Driven Hydraulic Pump

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

9.3.2 Hydraulic Fluid

Any time an unusual color; smell or visual indicator is noticed with the hydraulic fluid, a sample analysis should be performed to determine the condition of the fluid. Refer to the manufacturer of the specific fluid for your unit to obtain additional information.

9.3.3 Filters

Pressure Filter: Replace the filter element annually to ensure proper cleanliness of the hydraulic system. This is a minimum requirement. Standard filter changes depend on how frequently the HPU is used and the cleanliness of the fluid, along with the environment to which the HPU is exposed. Periodic fluid analysis is recommended to properly determine the optimum frequency of filter element changes.

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

9.3.4 Hydraulic Hoses

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

9.3.5 Instrument Panel

Refer to Section ***Hydraulic Hoses*** concerning hose inspection for general maintenance on Hose Assembly

Electric Panel: The Electric Panel does not require regular general maintenance.

Hydraulic Panel: Annual calibration of instrumentation is recommended. See Calibration of Instrumentation for details of calibration.

Control Block/Flowmeter: The Control Block components do not require regular general maintenance.

System Pressure Relief Valve: The System Pressure Relief Valve does not require regular general maintenance. It is possible however, for a contaminant to hold the relief valve in a partially open condition. If service is required, the new or repaired relief valve must be reset 250 psig above maximum system operating pressure.

Check Valve: The Check Valve does not require regular general maintenance.

Bypass Valve: The Bypass Valve does not require regular general maintenance.

9.3.6 Reservoir Assembly

The Reservoir Assembly does not require regular general maintenance. If periodic inspections for silt are desired, be certain to thoroughly clean the cover and surrounding area before removing the cover. The Selector Valve is not field serviceable.

9.3.7 Return Manifold Assembly

Return Filter: See information on changing filter element.

Return System Pressure Relief Valve

NOTE: DO NOT attempt to adjust the Return System Pressure Relief Valve

The Return System Pressure Relief Valve can be purchased as a preset assembly. If the end user services the relief valve, the valve must be set to crack at 75+/-5 psig before being re-installed on the HPU.

9.3.8 Heat Exchanger Assembly

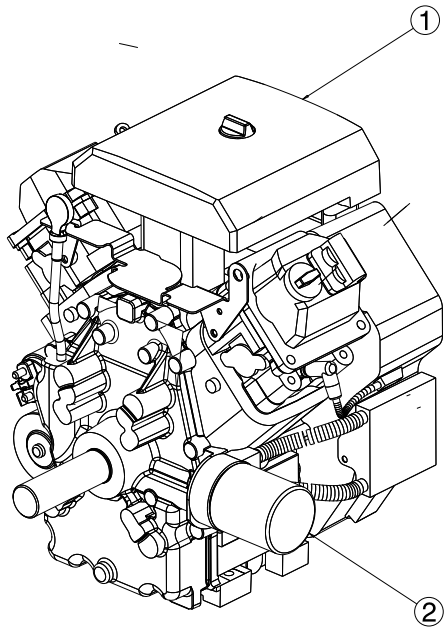
The Heat Exchanger Assembly does not require regular general maintenance.

9.3.9 External Components

Keep HPU clean. Do not allow labels to become damaged; thusly illegible.

Hour Meter: The Hour Meter does not require regular general maintenance.

9.4 ENGINE

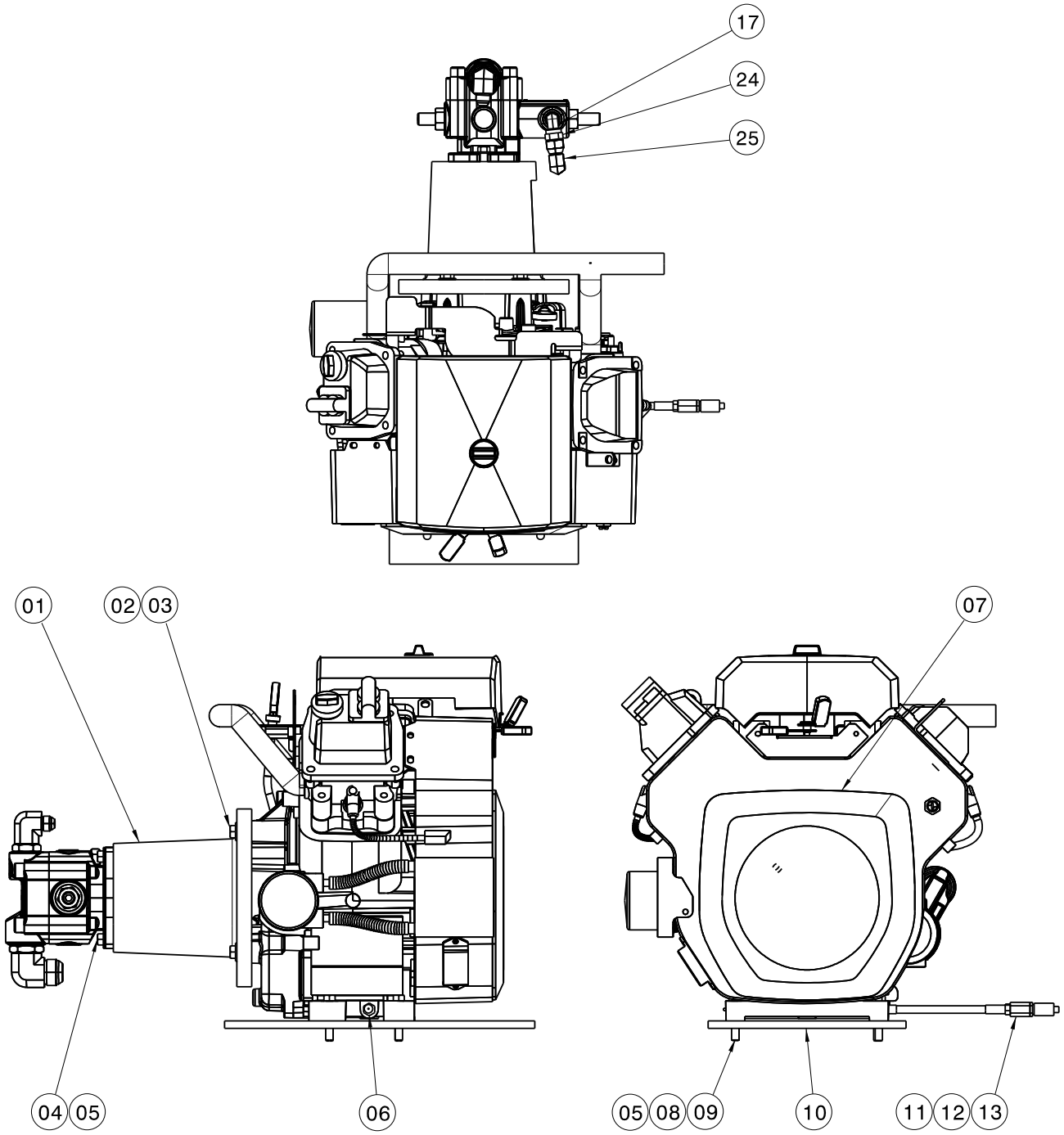


Parts List

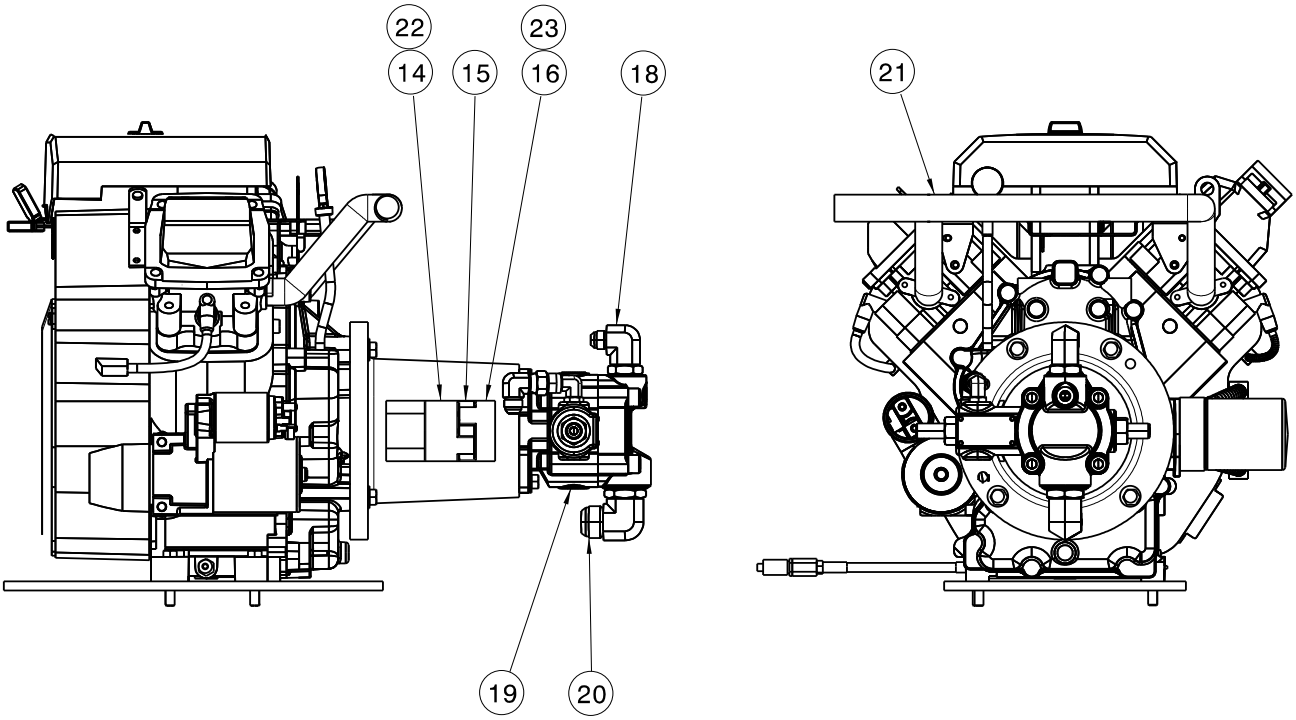
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	H-4257	ENGINE	1
2	H-3501	OIL FILTER	1
N/S	H-3502	FUEL FILTER	1
	H-3503	BREATHER FILTER	1
	H-3504	AIR FILTER	1
	H-2232	SPARK PLUG	1

9.5 ENGINE/PUMP ASSEMBLY



9.5 ENGINE/PUMP ASSEMBLY *(continued)*



Parts List

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

Item	Part Number	Description	Qty
1	Z-7692	MACHINING, ADAPTER	1
2	G-1100-108014	BOLT, HH 7/16 – 14 X 1 ½ LONG	4
3	G-1250-1080N	FLATWASHER, 7/16	4
4	G-1100-107010	BOLT, HH ⅜ – 16 X 1 LONG	2
5	G-1250-1070N	FLATWASHER, ⅜ NARROW	10
6	190270S	SENSOR, OIL TEMPERATURE	REF
7	H-4257	ENGINE, KOHLER CH-18 COMPLETE	1
8	G-1420-107020	BOLT, HH ⅜ – 24 X 2 LONG	4
9	G-1202-1070	ESN, 3/8 – 24	4
10	J-5010-01	PLATE, ENGINE MOUNT	1
11	24-326-56-S	HOSE, OIL DRAIN	REF
12	25-249-01-S	COUPLING, ⅜ FEMALE	REF
13	25-755-14-S	VALVE, OIL DRAIN	REF
14	H-2224-03	COUPLING, HALF	1
15	H-2227	SPIDER, HYTREL	1
16	2224-01	COUPLING, HALF	1
17	N-2001-08-S-B	ELBOW, STRAIGHT THREAD (06)	1
18	N-2001-14-S-B	ELBOW, STRAIGHT THREAD (8-12)	1
19	HC-1070-01	PUMP, VANE	1
20	N-2001-24-S-B	ELBOW, STRAIGHT THREAD (16)	1
21	24-164-03-S	MANIFOLD, EXHAUST	REF
22	J211-01*001.25	KEYSTOCK, ¼ SQ X 1 ¼ LONG	1
23	J209-01*001.00	KEYSTOCK, 3/16 SQ X 1 LONG	1
24	N-2052-07	EXPANDER, TUBE (6-8)	1
25	N-20002-06-S	ELBOW, SWIVEL NUT (8-8)	1

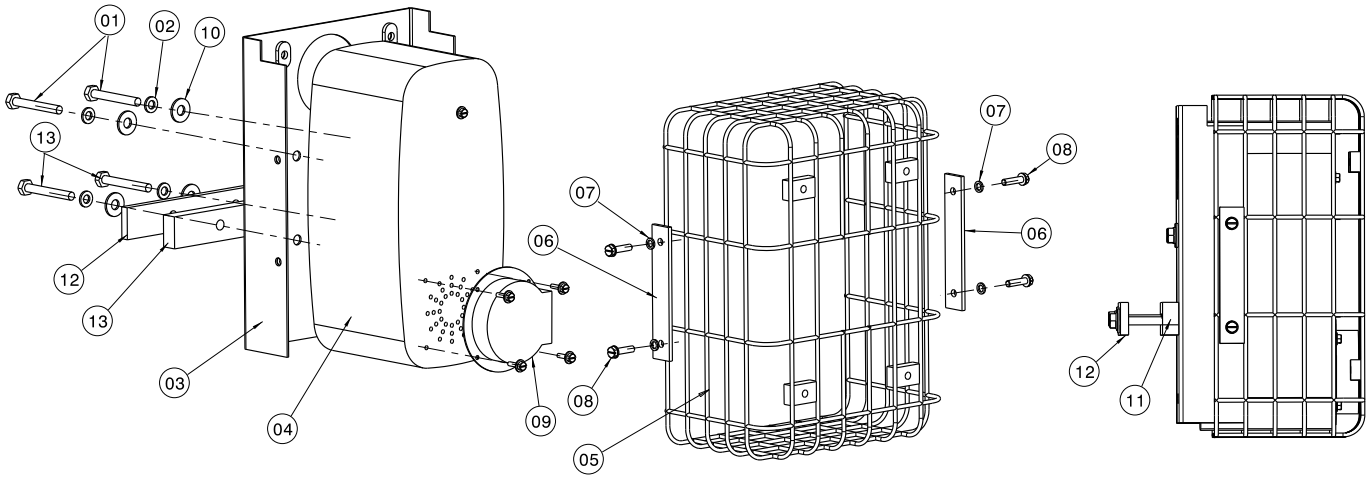
9.6 ENGINE DRIVEN HYDRAULIC PUMP

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

9.6.1 Motor Driven Hydraulic Pump Replacement Kits List

Part Number	Description
HC-1070-01	PUMP, VANE
HC-1816	SHAFT SEAL
K-1078	KIT, SEAL (INCLUDES SHAFT SEAL)

9.7 ENGINE MUFFLER



Parts List

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

Item	Part Number	Description	Qty
1	G-1100-105010	BOLT, ¼ -20 X 1	2
2	G-1502-1050R	LOCKWASHER, ¼ REGULAR	4
3	Z-3862	WELDMENT, HEAT SHIELD	1
4	H-2183	MUFFLER	1
5	H-2184	GUARD, MUFFLER	1
6	S-1583	PLATE, MUFFLER GUARD MOUNTING	2
7	G-1251-1030R	LOCKWASHER, #10 REGULAR	4
8	G-1150-103506	SCREW, HH, #10-32 X ¾ LONG	4
9	24-755-50-S	DEFLECTOR, MUFFLER	1
10	G-1503-1050N	FLATWASHER, ¼ NARROW	4
11	J-3861-01	PLATE, MOUNTING EXTERIOR	1
12	J-3862-01	PLATE, MOUNTING INTERIOR	1
13	G-1100-105020	BOLT, ¼ -20 X 2	2

9.8 HYDRAULIC FLUID

Any time an unusual color, smell or visual indicator is noticed with the hydraulic fluid, a sample analysis should be performed to determine the condition of the fluid. (See Section ***5.11 – Sample Valve Operation***)

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

Fluid Type: MIL-PRF-5606

9.9 HYDRAULIC HOSES

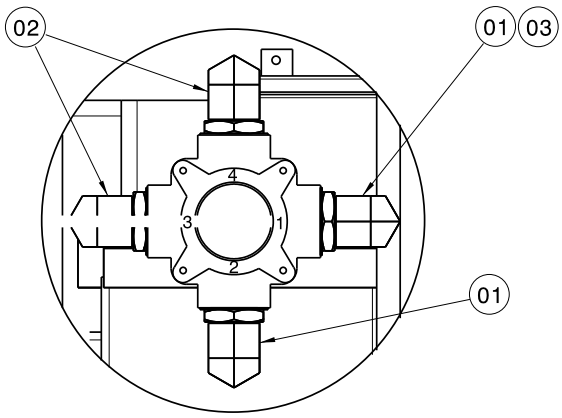
Hoses used on the HPU must be periodically inspected for damage, blisters, leaks, or hose end problems. Any damaged or defective hose should be replaced as soon as possible.

Parts List

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

Item	Part Number	Description	From	To	Qty
29	TF-1039-02-32.5	ASSEMBLY HOSE	RESERVOIR	SELECTOR VALVE (RS)	1
30	TF-1039-07-15.0	ASSEMBLY HOSE	SELECTOR VALVE (BOTTOM)	PUMP INLET	1
31	TF-1039-15-45.5	ASSEMBLY HOSE	SELECTOR VALVE (TOP)	RESERVOIR	1
32	TF-1039-01-32.5	ASSEMBLY HOSE	SELECTOR VALVE (LS)	RETURN MANIFOLD	1
33	TF-1037-12*24.0	ASSEMBLY HOSE	PUMP OUTLET	FLOWMETER	1
34	TF-1037-13-29.0	ASSEMBLY HOSE	CONTROL BLOCK OUTPUT	PRESSURE FILTER	1
35	TF-1037-13-32.0	ASSEMBLY HOSE	PUMP CASE DRAIN	COOLER BOTTOM	1
36	TF-1037-13*22.0	ASSEMBLY HOSE	COOLER TOP	RETURN MANIFOLD	1
37	TF-1037-12-22.0	ASSEMBLY HOSE	CONTROL BLOCK RELIEF	RETURN MANIFOLD	1
38	TF-1037-01-41.0	ASSEMBLY HOSE	RETURN MANIFOLD RELIEF	RESERVOIR	1
39	TF-1047-01*12.0	HOSE, ¼ GREY	FUEL TANK	ENGINE FUEL FILTER	1
42	TF-1037-03*13.0	ASSEMBLY HOSE	PRESSURE GAUGE	CONTROL BLOCK	1
NA	TF-1037-01*360	HOSE	PRESSURE	EXTERNAL	1
NA	TF-1039-01*360	HOSE	RETURN	EXTERNAL	1

9.10 SELECTOR VALVE

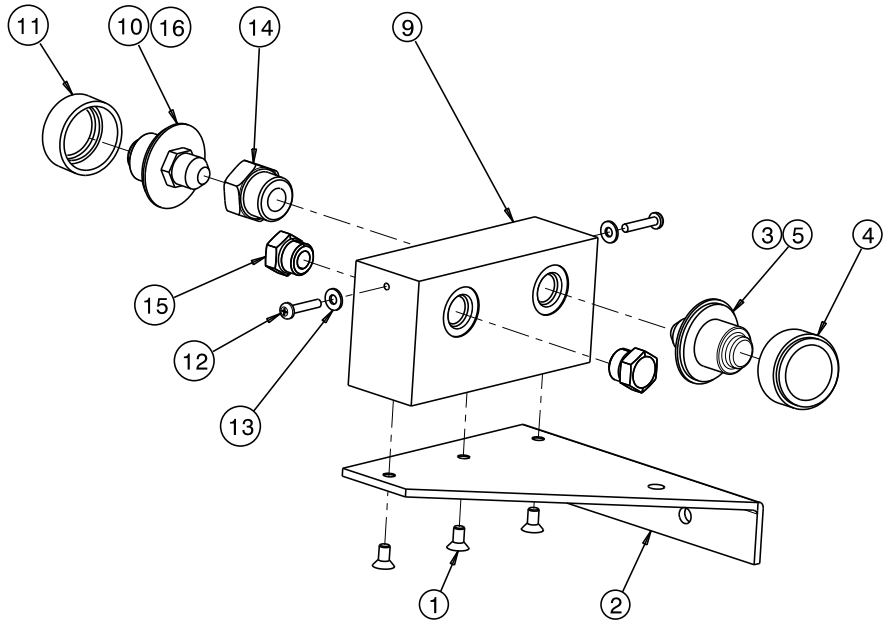


Parts List

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

Item	Part Number	Description	Qty
1	N-2001-27-S-B	ELBOW, STRAIGHT THREAD (16-20)	2
2	N-2001-37-S-B	ELBOW, STRAIGHT THREAD (12-20)	2
3	N-2081-08	ELBOW, 45º (16)	1

9.11 COUPLING KITS

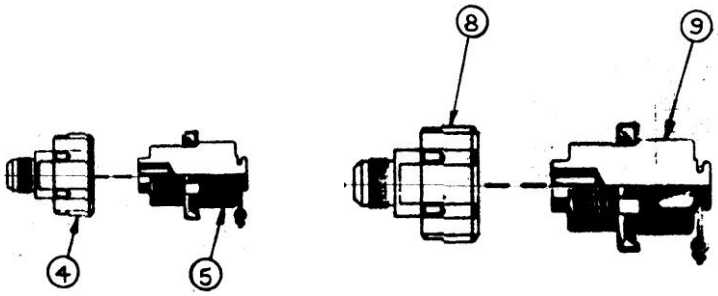


Parts List

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

Item	Part Number	Description	Qty
1	G-1152-105206	SCREW, SOC FLAT HEAD CAP ¼ - 20 X ¾ LONG	3
2	S-2070	BRACKET, MANIFOLD	1
3	N-2699	COUPLING, HALF BULKHEAD	1
4	N-2701	CAP, DUST	1
9	J-4243	MANIFOLD (-12 SAE PORTS)	1
10	N-2698	COUPLING, HALF BULKHEAD	1
11	N-2698	CAP, DUST	1
12	G-1157-103006	SCREW, PAN HD CRS REC 10-24 X ¾ LONG	2
13	G-1250-1030N	FLATWASHER, #10	2
14	N-2463-10-S-B	FITTING, REDUCER/EXPANDER (12-8)	1
15	N-2053-08-S-B	PLUG, O-RING (12)	2
N/S	HC-2010-912	O-RING, SERIES 3	1
	HC-2010-908	O-RING, SERIES 3	1

9.11 COUPLING KITS *(continued)*

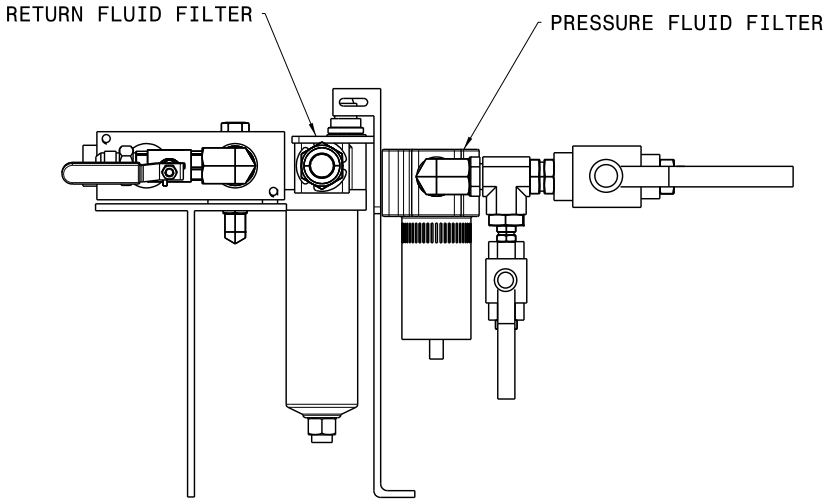


Parts List

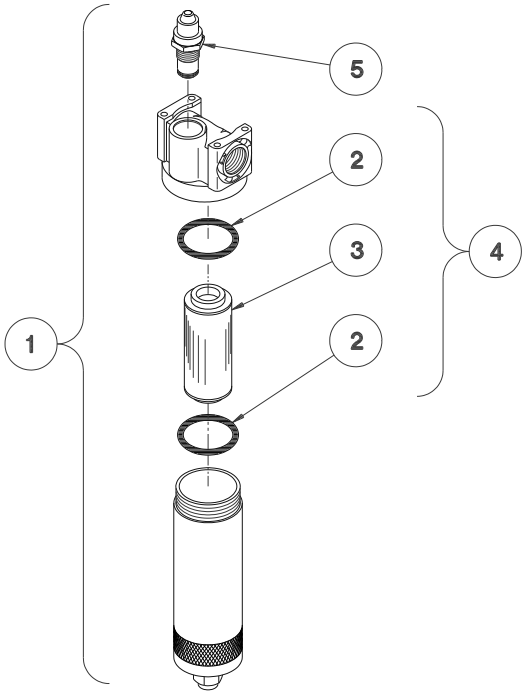
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
4	N-2417-4	QUICK DISCONNECT	1
5	N-2418-4	PLUG	1
8	N-2417-6	QUICK DISCONNECT	1
9	N-2418-6	PLUG	1

9.12 FILTERS



9.12.1 Return Filter Assembly



Parts List

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

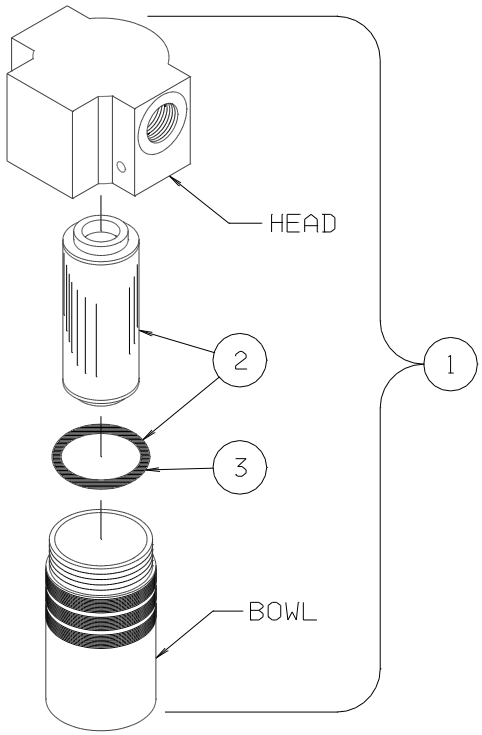
Item	Part Number	Description	Qty
1	HC-1453	ASSEMBLY, FILTER	1
3	HC-1454	ELEMENT, FILTER	1
	FILTER REPLACEMENT PARTS		
2	HC-2000-142	O-ring	2
♦ 4	K-3096	Kit, filter element	1
5	HC-1849	Indicator, clogging	1

♦ ***Item 4 includes corresponding Item 2—O-ring.***

9.12.2 Pressure Filter

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

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



FILTER ASSEMBLY

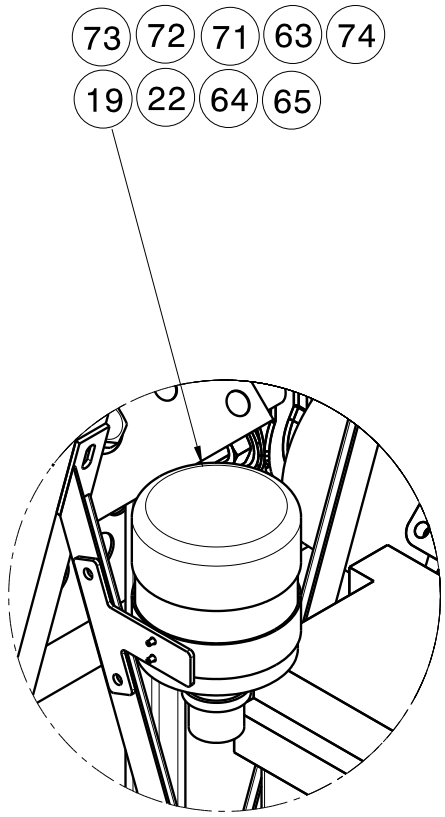
Parts List

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
	FILTER REPLACEMENT PARTS		
2	K-1414	KIT, FILTER ELEMENT	1
3	HC-2000-138	O-RING, BOWL	1

NOTE: Item 3 is included in Item 2.

9.12.3 Desiccant Filter

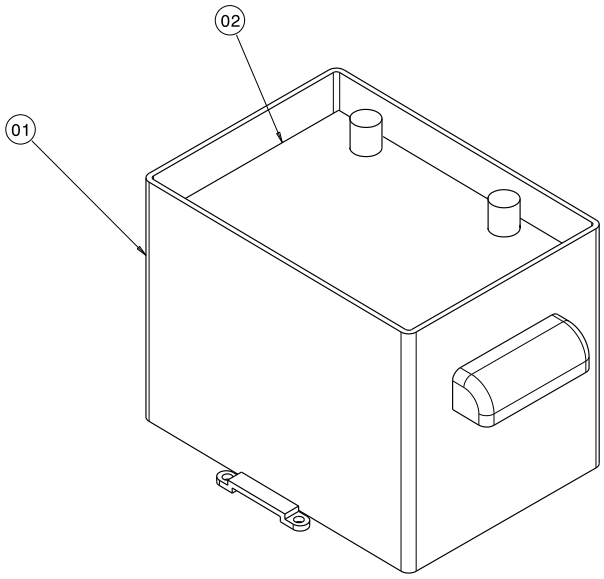


Parts List

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

Item	Part Number	Description	Qty
19	G-1250-1050W	WASHER, FLAT ¼ WIDE	2
22	G-1202-1050	ESN, ¼ - 20	2
63	HC-1763	FILTER, DESICCANT	1
64	Z-7945	BRACKET, DESICCANT	1
65	TF-1047-01*6.00	HOSE, ¼ GRAY	1
71	N-2918	CAP, MODIFIED	1
72	N-2410-03	ELBOW, 1/4	1
73	N-2008-05-S	CAP, END 3/8	2
74	G-1476-105-006	SCREW, BUTTON HD CAP	2

9.13 BATTERY BOX

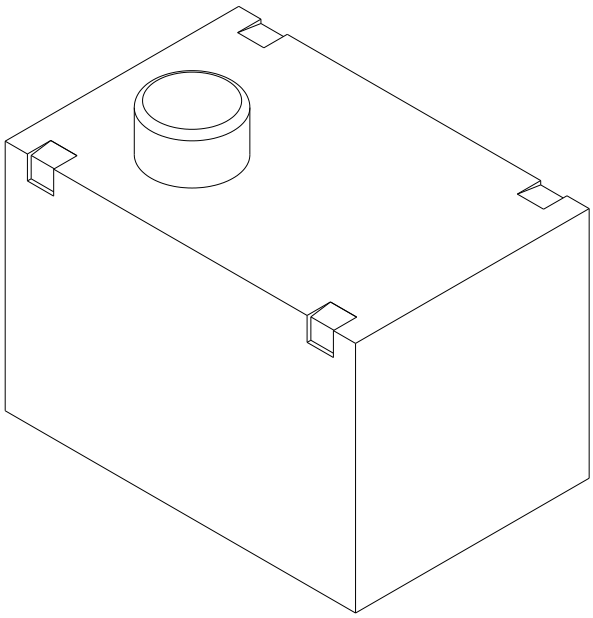


Parts List

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

Item	Part Number	Description	Qty
1	H-3488	BOX, BATTERY	1
2	EC-2405	BATTERY	1

9.14 FUEL TANK/CAP



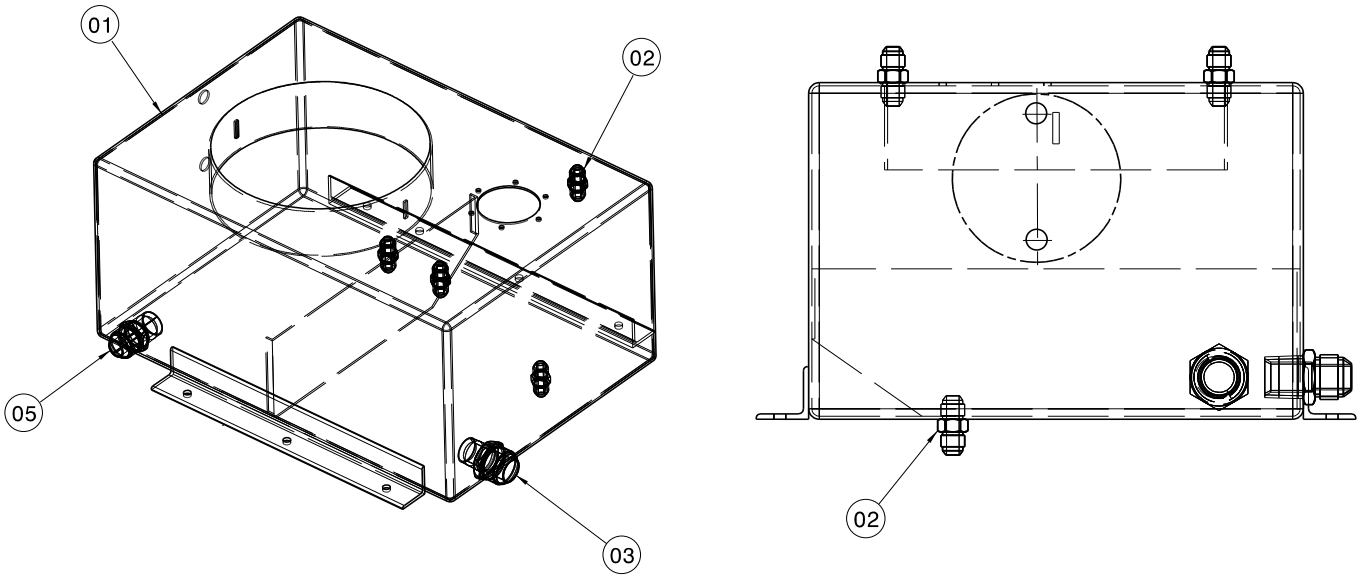
Parts List

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

Item	Part Number	Description	Qty
1	H-3515	TANK, FUEL	1
2	H-3539	CAP, FUEL GAUGE	1

9.15 RESERVOIR ASSEMBLY

Replace the desiccant air filter whenever the material inside the element is pink or reddish in color (See Element label for details). The Reservoir Assembly does not require regular general maintenance. If periodic inspections for silt are desired, be certain to thoroughly clean the dome cover and surrounding area before removing the dome cover. The Selector Valve (Item 9) is not field serviceable.



Parts List

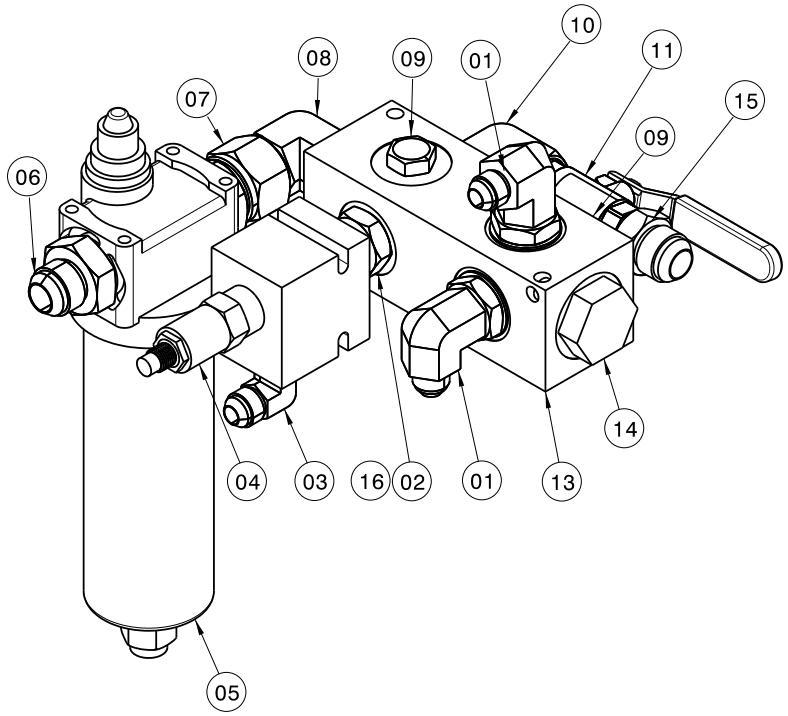
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-7912	RESERVOIR, BASE	1
2	N-2011-06-SS	UNION, #8	4
3	N-2011-10-SS	UNION, #16	1
5	N-2011-08-SS	UNION, #12	1

9.16 RETURN MANIFOLD ASSEMBLY

The Return Manifold does not require regular general maintenance.

NOTE: DO NOT attempt to adjust the Return System Pressure Relief Valve. See Section 9.16.1 – Return System Pressure Relief Valve for details.



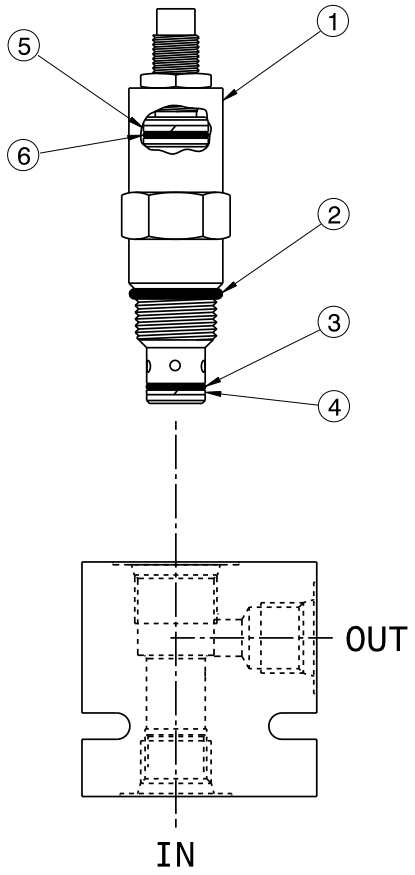
Parts List

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

Item	Part Number	Description	Qty
1	N-2001-14-S-B	ELBOW, STRAIGHT THREAD (8-12)	2
2	N-2463-10-S-B	FITTING, REDUCER/EXPANDER	1
3	N-2001-11-S-B	ELBOW, STRAIGHT THREAD	1
4	HC-2199	VALVE, PRESSURE RELIEF (PRE-SET, 75 PSI)	1
5	HC-1453	ASSEMBLY, FILTER	1
6	N-2007-21-S-B	CONNECTOR, STRAIGHT THREAD (12-16)	1
7	N-2036-10-S-B	SWIVEL, FEMALE	1
8	N-2001-24-S-B	ELBOW, STRAIGHT THREAD	1
9	N-2053-08-S-B	PLUG, HED HD W/O-RING	2
10	N-2661-05-S-B	ELBOW, STRAIGHT THREAD	1
11	HC-1766-04	VALVE, BALL	1
13	HC-2556	MANIFOLD, HEADER	1
14	N-2053-10-S-B	PLUG, HED HD W/O-RING	1
15	N-2007-18-S-B	CONNECTOR, STRAIGHT THREAD	1
16	N-2464-06-S-B	UNION, STRAIGHT THREAD (-08)	1

9.16.1 Return System Pressure Relief Valve

The Return System Pressure Relief Valve can be purchased as a preset assembly. If the relief valve is serviced by the end user, the valve must be set to crack at 75+/-5 psig **before** being re-installed on the HPU.



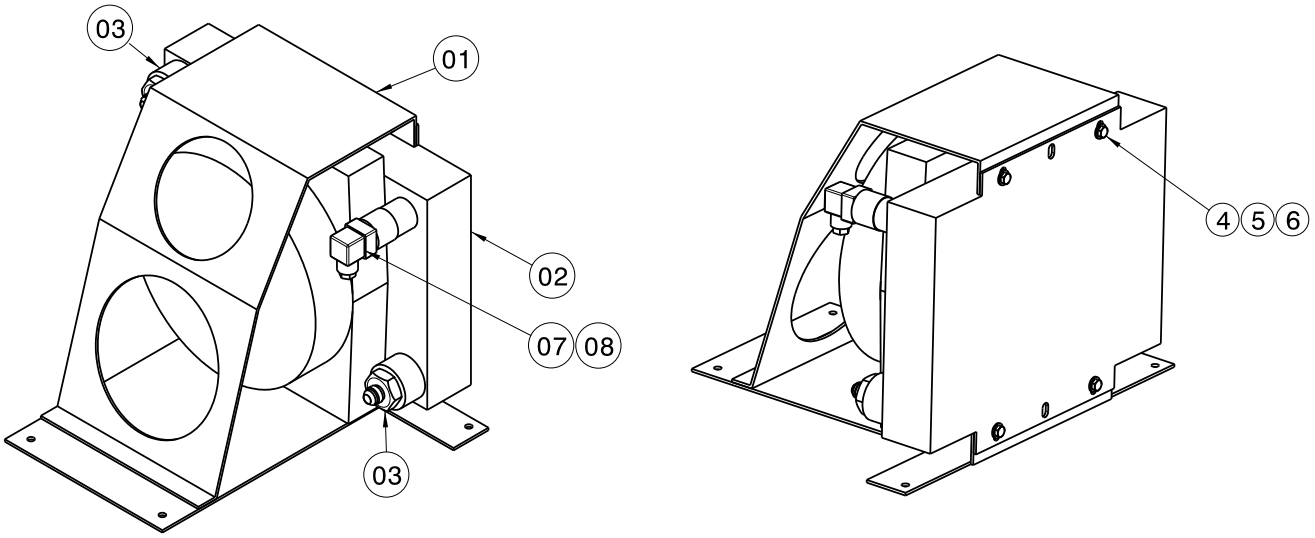
Parts List

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

Item	Part Number	Description	Qty
1	HC-2199	PRESSURE RELIEF VALVE *(INCLUDES VALVE BLOCK)*	1
2	HC-2010-910	O-RING, SERIES 3	1
3	HC-2000-014	O-RING, SERIES 2	1
4	HC-2020-014	BACKUP RING (TEFLON)	1
5	HC-2020-015	BACKUP RING (TEFLON)	1
6	HC-2000-015	O-RING, SERIES 2	1

9.17 HEAT EXCHANGER ASSEMBLY

The Heat Exchanger Assembly does not require regular general maintenance.



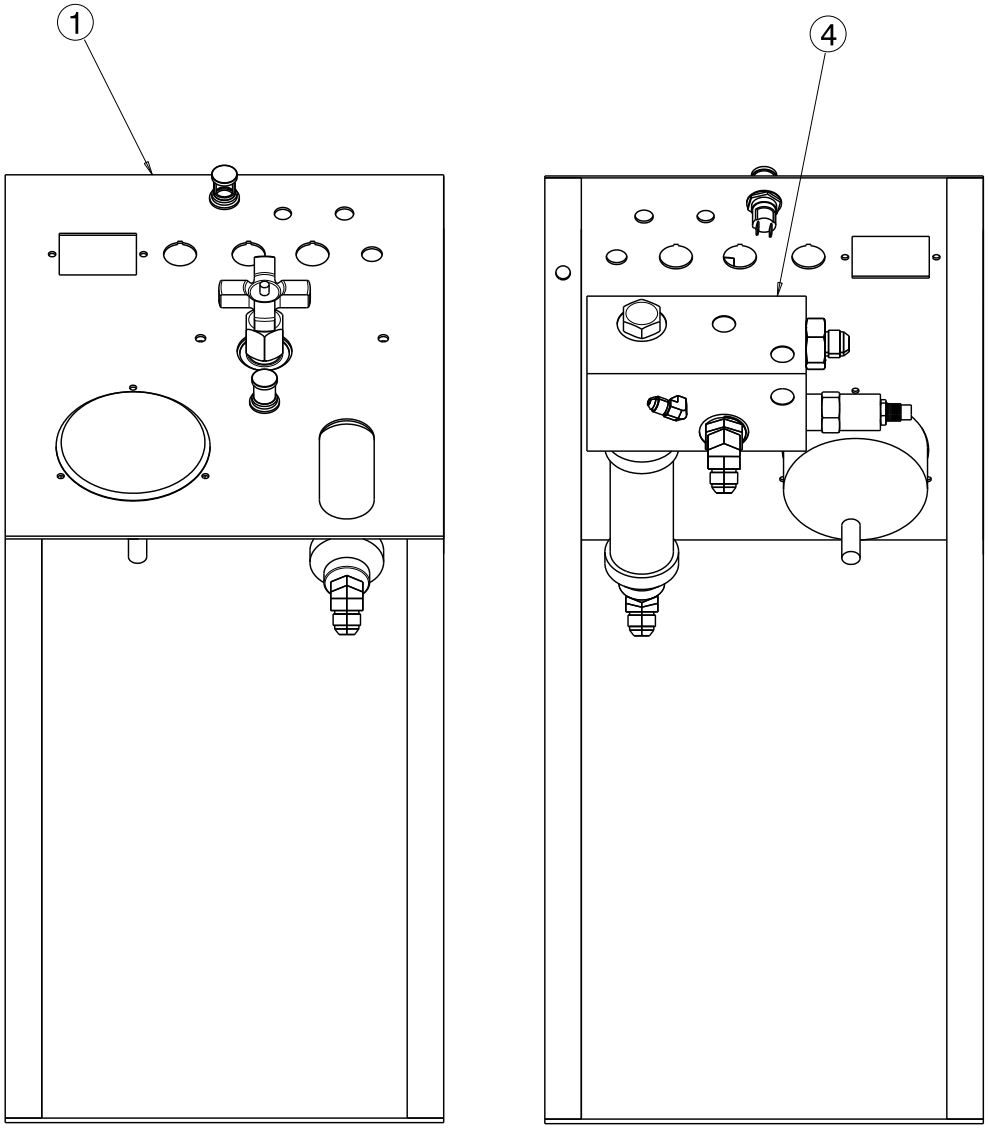
Parts List

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

Item	Part Number	Description	Qty
1	Z-7718-01	BRACKET, COOLER	1
2	HC-2551	COOLER, OIL	1
3	N-2007-35-S-B	CONNECTOR, STRAIGHT THREAD (8-16)	2
4	G-1503-1060N	FLATWASHER, 5/16 SS	8
5	G-1202-1060	ESN, 5/16 – 18	4
6	G-1112-106010	BOLT, HH SS 5/16 – 18 X 1 LONG	4
7	EC-2400	SWITCH, TEMPERATURE (100º F, RISING)	1
8	EC-1778	CABLE, DIN	1

9.18 INSTRUMENT PANEL

Refer to Section ***9.106 Hydraulic Hoses*** concerning hose inspection for general maintenance on Item 3 Hose Assembly.



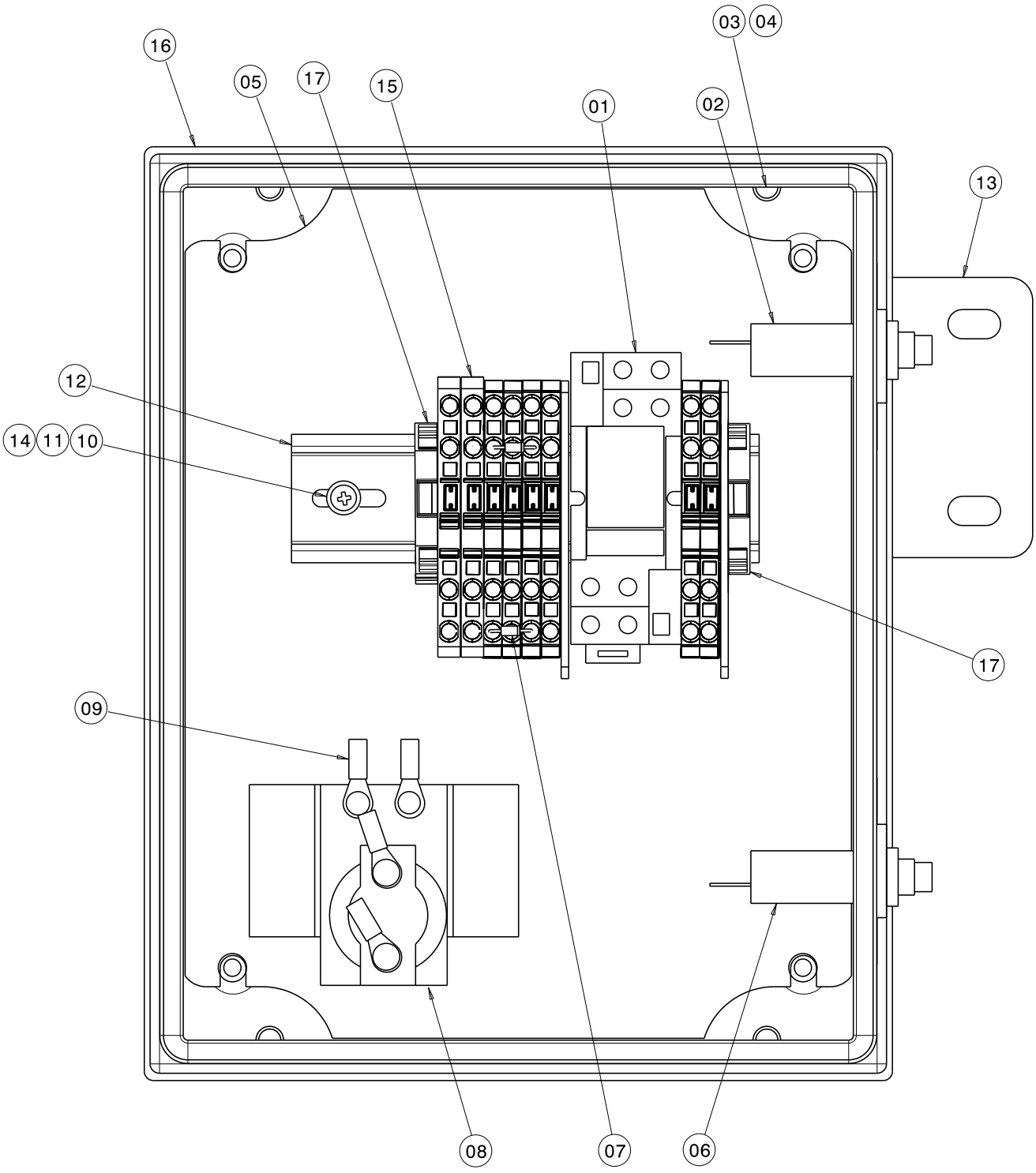
Front View **Rear View**

Parts List

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

Item	Part Number	Description	Qty
1	*See 9.18.2 Electric Panel*	CONTROL PANEL	1
4	*See 9.18.3 Control Block/Flowmeter*	CONTROL BLOCK/FLOWMETER	1

9.18.1 Electric Box



9.18.1 Electric Box *(continued)*

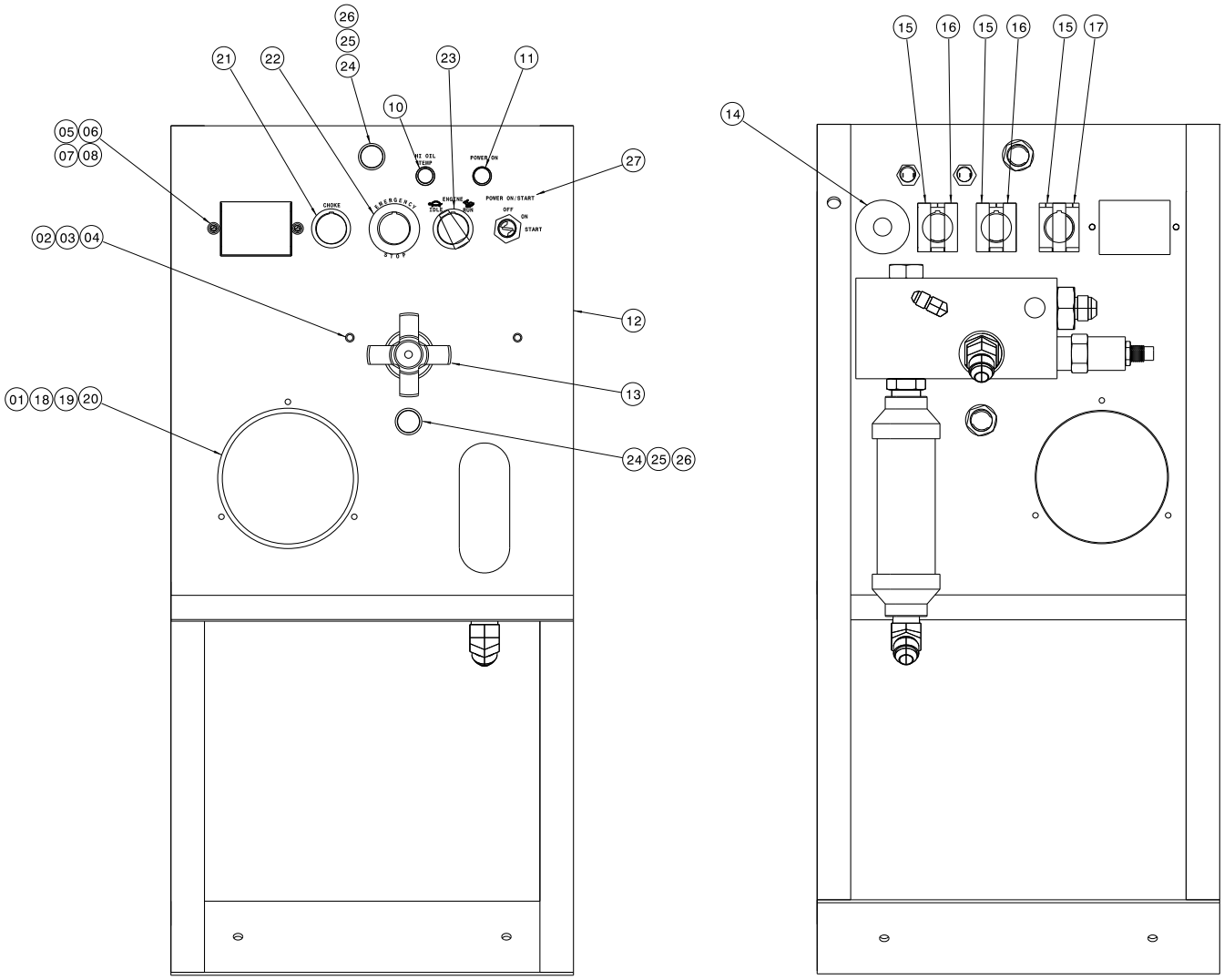
Parts List

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

Item	Part Number	Description	Qty
1	EC-2409	ASSEMBLY, ELECTRICAL	1
2	EC-2159	CIRCUIT BREAKER, (25 AMPS)	1
3	G-1439-1035-S	NUTSERT, #10-32 OPEN END	4
4	G-1476-103106	SCREW, #10-32 SOCKET HEAD CAP	4
5	J-2090	PLATE, ELECTRICAL BOX	1
6	12001	BREAKER, CIRCUIT (10A)	1
7	4002-6	DIODE, POWER	2
8	EC-2406	CONTRACTOR	1
9	17111	RED RING, #10	4
10	G-1497-103104	SCREW, #10-32 X .5 LONG	2
11	G-1503-1030N	FLATWASHER, #10 NARROW SS	2
12	13072	RAIL, DIN 6 ⅞	1
13	Z-7793-01	WELDMENT, ELECTRICAL SUPPORT	1
14	G-1501-1031	NUT, #10-32	2
15	EC-2065	BLOCK, TERMINAL POLE	2
16	EC-2407	BOX, ELECTRICAL	1
17	13070	ANCHOR, DIN RAIL END	2

9.18.2 Electric Panel

The Electric Panel does not require regular general maintenance.



Parts List

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

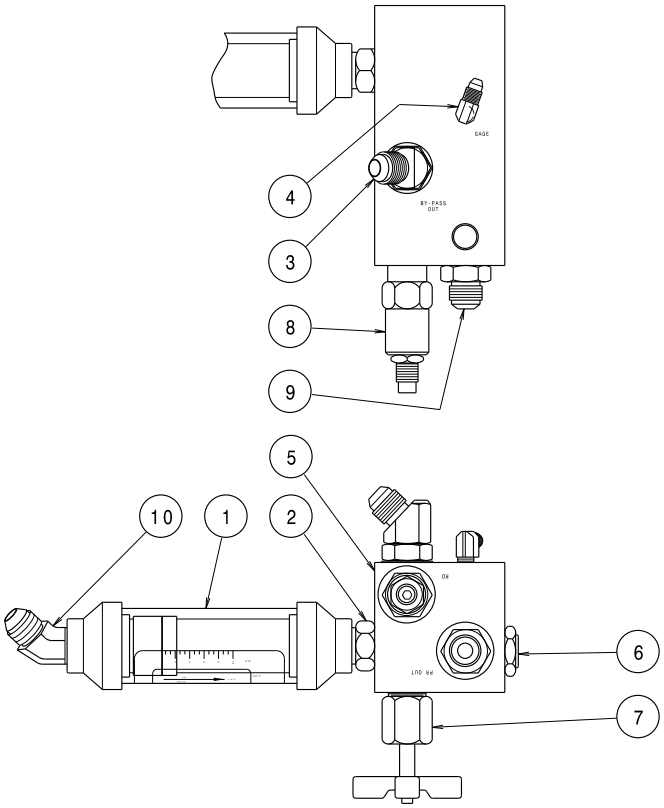
Item	Part Number	Description	Qty
1	HC-2259	GAUGE, PRESSURE (4”, 3000 PSI/BAR)	1
2	G-1100-105006	BOLT, ¼ - 20 X ¾ LONG	2
3	G-1251-1050R	LOCKWASHER, ¼	2
4	G-1250-1050N	FLATWASHER, ¼	2
5	19027TT	HOURMETER/TACHOMETER	REF
6	G-1159-102010	SCR, #8-32	2
7	G-1202-1020	ESN, #8-32	2
8	G-1250-1020N	FLATWASHER, #8	4
10	EC-2008-03	LAMP, ASSEMBLY RED (LED)	1
11	EC-2008-02	LAMP, ASSEMBLY GREEN (LED)	1
12	Z-7729-01	WELDMENT, INSTRUMENT PANEL	1
13	Z-2666-01	ASSEMBLY, CONTROL BLOCK	1

9.18.2 Electric Panel *(continued)*

Item	Part Number	Description	Qty
14	EC-1970	SWITCH, KEY STARTER	1
15	14143	BLOCK, CONTACT GREEN	4
16	14144	BLOCK, CONTACT RED	3
17	14142	FLANGE, LATCH	4
18	G-1497-103110	SCR, SS RD HD CRS #10-32	3
19	G-1501-1031	ESN, SS 10-32	3
20	G-1250-1030N	FLATWASHER, #10 NARROW	3
21	14141	SWITCH, PUSH	1
22	14132	SWITCH, E-STOP	1
23	14133	SWITCH, 2 POSITION	1
24	EC-1767	BASE, INDICATOR	2
25	EC-1776	SHIELD, INDICATOR	2
26	EC-1993	BULB, 12 V	2
27	V-2410	LABEL, CONTROL PANEL	1

9.18.3 Control Block/Flowmeter

The Control Block components do not require regular general maintenance.



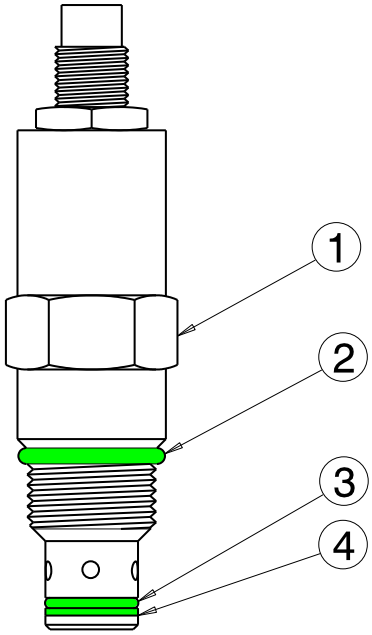
Parts List

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

Item	Part Number	Description	Qty
1	HC-2150	FLOWMETER	1
2	N-2214-05-S-B	CONNECTOR, STRAIGHT THREAD	1
3	N-2042-07-S-B	ELBOW, 45º STRAIGHT THREAD	1
4	N-2005-03-S	ELBOW, MALE	1
5	Z-2472-00	ASSEMBLY, CONTROL BLOCK	1
6	HC-1673	VALVE, CHECK	1
7	HC-1254	VALVE, BY-PASS	1
8	HC-1451	VALVE, PRESSURE RELIEF	1
9	N-2007-13-S-B	CONNECTOR, STRAIGHT THREAD	1
10	N-2021-14-S	ELBOW, 45º MALE	1

9.18.3.a System Pressure Relief Valve

The System Pressure Relief Valve does not require regular general maintenance. It is possible however, for a contaminant to hold the relief valve in a partially open condition. If service is required, the new or repaired relief valve must be reset to 3,250 psig.



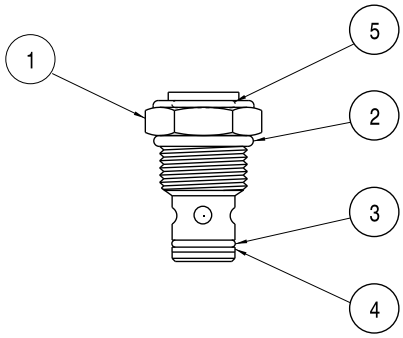
Parts List

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

Item	Part Number	Description	Qty
1	HC-1451	PRESSURE RELIEF VALVE *(NOT SET)*	1
2	HC-2010-910	O-RING	1
3	HC-2000-014	O-RING	1
4	HC-2020-014	BACKUP RING *(TEFLON)*	1

9.18.3.b Check Valve

The Check Valve does not require regular general maintenance.



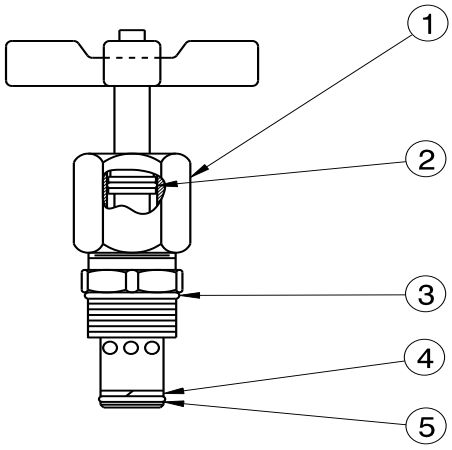
Parts List

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

Item	Part Number	Description	Qty
1	HC-1673	CHECK VALVE	1
2	HC-2013-910	O-RING, SERIES 3	1
3	HC-2000-14	O-RING, SERIES 2	1
4	HC-2020-14	BACKUP RING	1
5	HC-2013-905	O-RING, SERIES 3	1

9.18.3.c Bypass Valve

The Bypass Valve does not require regular general maintenance.



Parts List

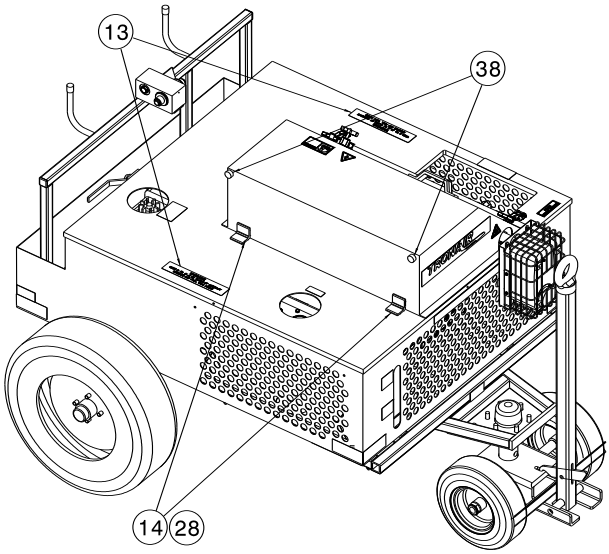
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

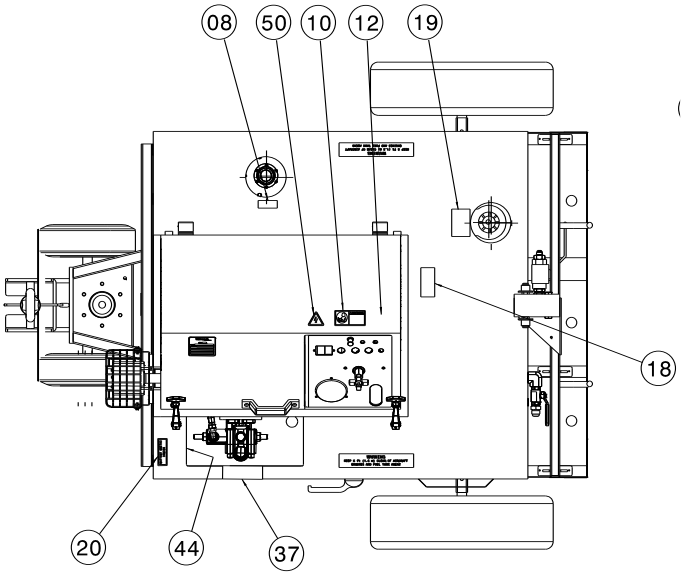
Item	Part Number	Description	Qty
1	HC-1254	NEEDLE VALVE	1
2	HC-2006-111	O-RING	1
3	HC-2013-912	O-RING	1
4	HC-2020-114	BACKUP RING	1
5	HC-2006-114	O-RING	1

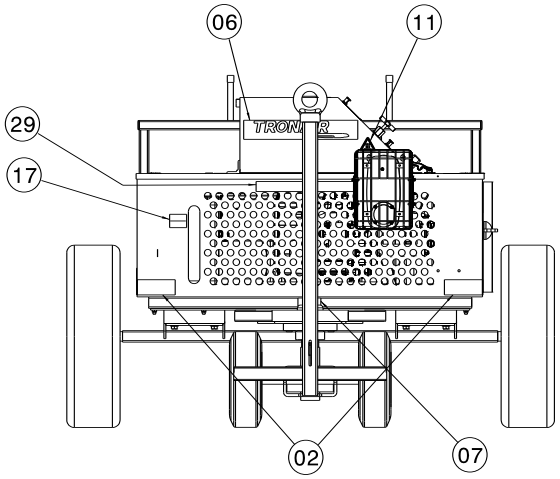
9.19 EXTERNAL COMPONENTS

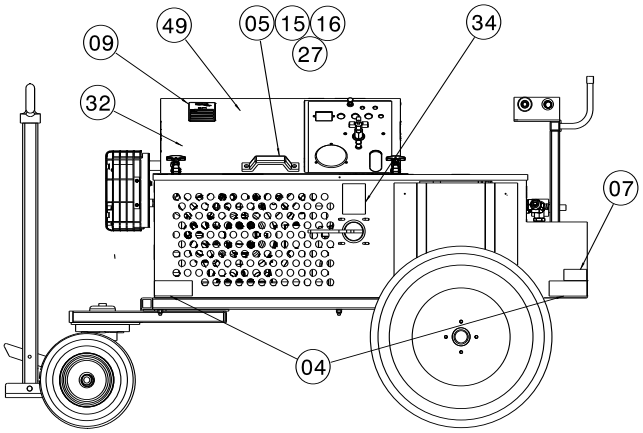
Keep HPU clean. Do not allow labels to become damaged; thusly illegible. Regularly inspect casters and floor locks to ensure safe working condition.

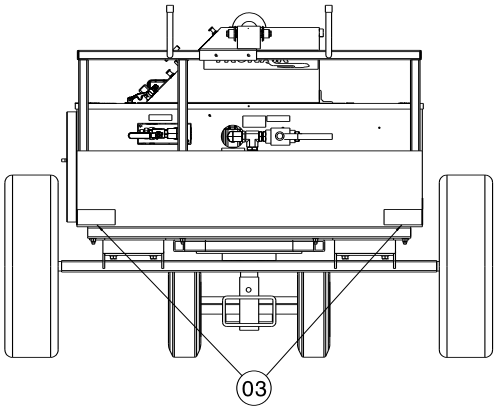
Parts List



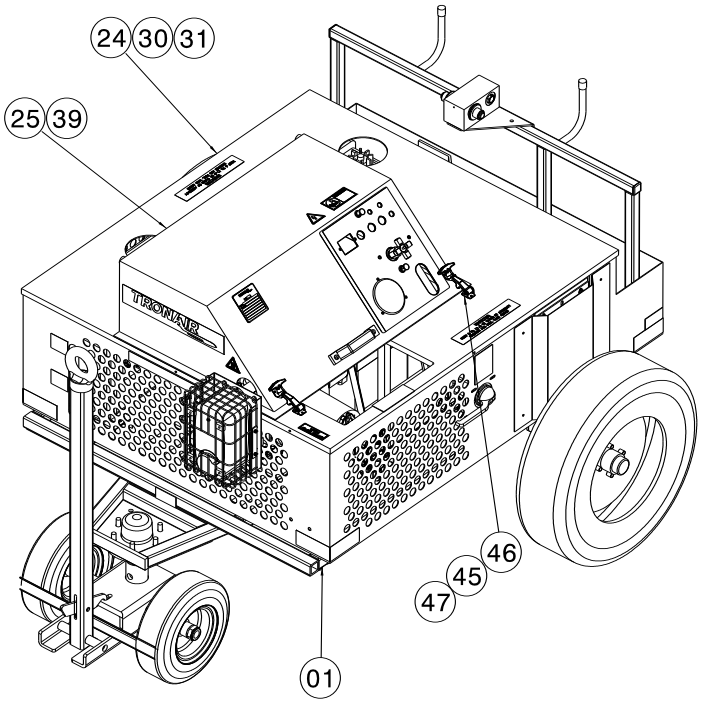


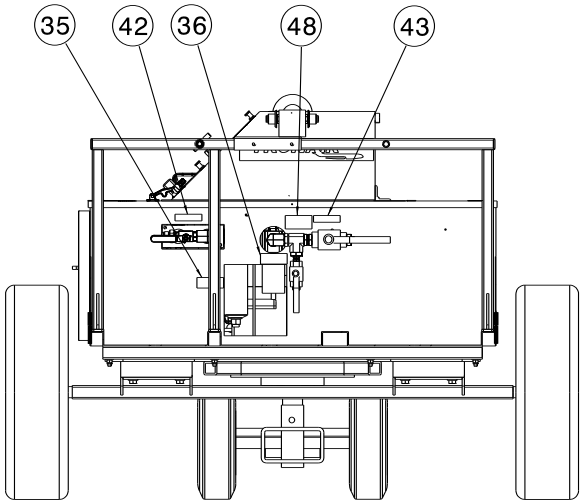






9.19 EXTERNAL COMPONENTS *(continue)*





Parts List

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

Item	Part Number	Description	Qty
1	Z-7742-01	ASSEMBLY, SUB	1
2	H-2899*005.00	TAPE, REFLECTIVE WHITE	2
3	H-2807*005.13	TAPE, REFLECTIVE RED	2
4	H-2806*004.50	TAPE, REFLECTIVE YELLOW	4
5	H-1780	HANDLE, GRAB	1
6	V-1033	LABEL, TRONAIR	2
7	V-2367	LABEL, MAX TIRE PRESSURE	3
8	V-1975	LABEL, MIL-H-5606	1
9	V-2118	LABEL, SERIAL NUMBER CE	1
10	V-1985	LABEL, READ MANUAL	1
11	V-1721	LABEL, ISO BURN HOT SURFACE	1
12	V-1836	LABEL, ISO EXPLOSION	1
13	V-1900	LABEL, WARNING KEEP 5 FT CLEAR	2
14	H-2827	HINGE	2
15	G-1202-1055	ESN, ¼ - 28	2
16	G-1476-105106	SCR, BHCS ¼ - 28 X ¾ LONG	2
17	V-2419	LABEL, MAXIMUM/MINIMUM OIL LEVEL	1
18	V-1916	LABEL, DESICCANT FILTER REPLACEMENT HC-1763	1
19	V-1851	LABEL, GASOLINE	1
20	V-2108	LABEL, BATTERY SWITCH	1
24	S-2518-01	COVER, LID	1
25	S-2519-01	COWEL, TOP	1

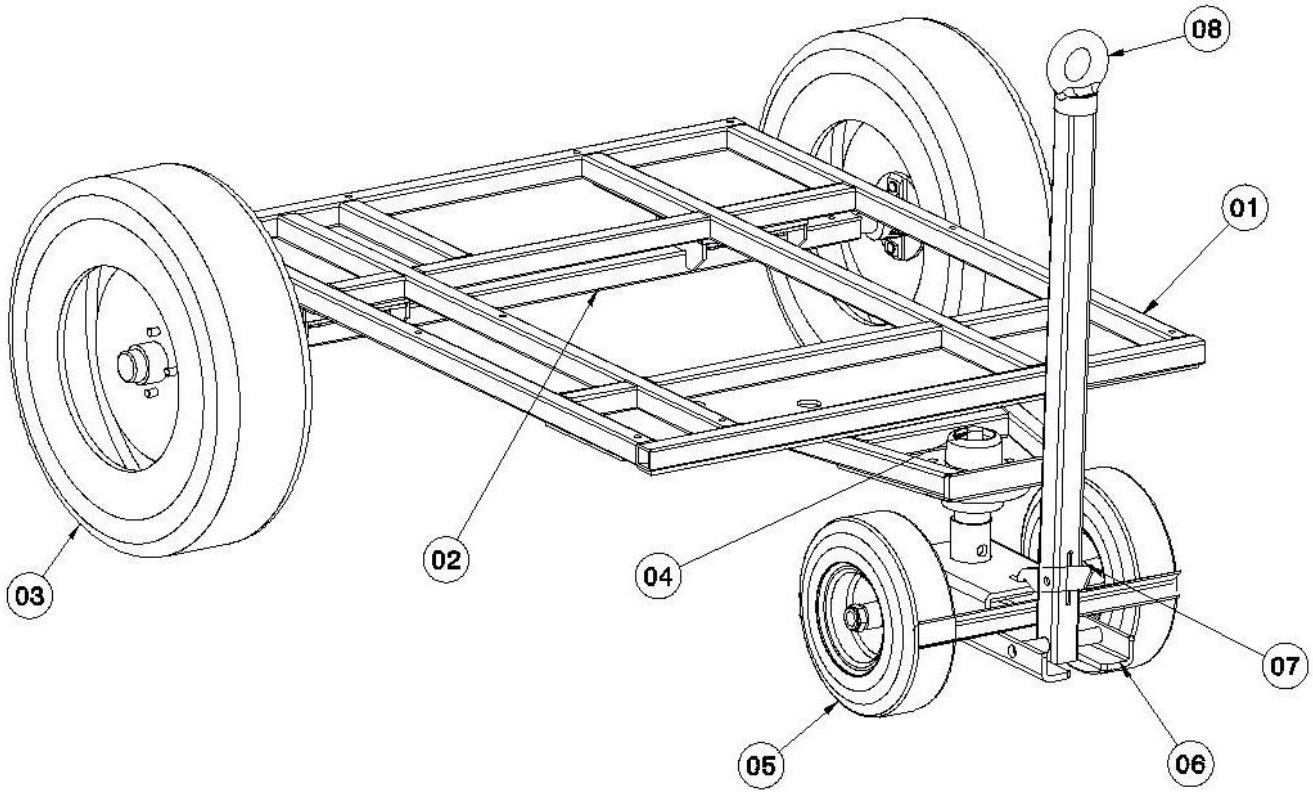
9.19 EXTERNAL COMPONENTS *(continue)*

Parts List

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

Item	Part Number	Description	Qty
27	G-1250-1050W	FLATWASHER, ¼ WIDE	2
28	G-1470-M6-1.	ESN, M6-1.0	8
29	V-2366	LABEL, MAX TOWING	1
30	G-1439-1035-S	NUTSERT, 10-32 OPEN END	4
31	G-1497-103106	SCR, 10-32 X ¾ LONG	4
32	V-2409	LABEL, HYDRAULIC SCHEMATIC	1
34	V-1144	LABEL, RESERVOIR SELECT	1
35	V-1759	LABEL, FILTER ELEMENT K-3096 (RETURN)	1
36	V-1335	LABEL, FILTER ELEMENT K-1414 (PRESSURE)	1
37	V-1126	LABEL, PRESSURE/FLOW	1
38	12029	BUMPONS	2
39	H-1203	TAPE, SILICONE	84”
42	V-1059	LABEL, PRESSURE	1
43	V-1060	LABEL, RETURN	1
44	V-2129	LABEL, BATTERY ON/OFF	1
45	JP-256	DIAMOND PLATE DRAW LATCH	2
46	G-1497-103104	SCR, RD HD PH SS 10-32 X ½	8
47	G-1501-1031	ESN, SS 10-32	8
48	V-1058	LABEL, SAMPLE VALVE	1
49	V-2411	LABEL, OPERATING INSTRUCTIONS	1
50	V-1050	LABEL, ISO ELECTRICAL	1

9.20 TOWING TRAILER



Parts List

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

Item	Part Number	Description	Qty
1	Z-7561-01	WELDMENT, TRAILER FRAME	1
2	Z-7561-01	WELDMENT, AXLE	1
3	U-1148	WHEEL, REAR	2
4	H-3200	HUB	1
5	U-1144	ASSEMBLY, TIRE/RIM	2
6	Z-7567-01	WELDMENT, STEER AXLE	1
7	J-3427	LEVER	1
8	Z-6003-01	WELDMENT, TOWBAR	1

9.21 REPLACEMENT LABELS PARTS LISTS

9.21.1 Base Unit

Part Number	Description	Qty
V-1001	"Made in USA"	1
V-1033	"TRONAIR"	1
V-1050	ISO Electrical Shock Symbol	2
V-1033	"TRONAIR"	1
V-1058	"SAMPLE VALVE"	1
V-1059	"PRESSURE"	1
V-1060	"RETURN"	1
V-1126	LABEL, PRESSURE/FLOW	1
V-1144	RESERVOIR SELECTOR VALVE	1
V-1721	ISO BURN HOT SURFACE	1
V-1851	LABEL, GASOLINE	1
V-1900	"WARNING KEEP 5 FT CLEAR…"	2
V-1916	LABEL, DESICCANT FILTER REPLACEMENT	1
V-1919	"OPERATING INSTRUCTIONS…"	1
V-2419	"MIN/MAX OIL LEVEL"	1
V-2409	HYDRAULIC SCHEMATIC	1
V-2411	"OPERATING INSTRUCTIONS . . ."	1
V-2410	LABEL, CONTROL	1
V-2367	LABEL, MAX TIRE PRESSURE	3
V-2118	LABEL, SERIAL NUMBER CE	1
V-2108	LABEL, BATTERY SWITCH	1
V-2366	LABEL, MAX TOWING	1
V-2129	LABEL, BATTERY ON/OFF	1

9.21.2 Fluid Labels

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

9.21.3 Filter Element Kit Labels

Part Number	Description	Qty
V-1759	Label, Filter Element K-3096 (Return)	1
V-1335	Label, Filter Element K-1414 (Pressure)	1
V-1916	Label, Desiccant Filter Replacement	1

10.0 PROVISION OF SPARES

10.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

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

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

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

10.2 RECOMMENDED SPARE PARTS LISTS

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

Part Number	Description	Qty
K-3428	KIT, PRESSURE FILTER ELEMENT	1
K-3494	KIT, RETURN FILTER ELEMENT	1
K-1078	KIT, SHAFT SEAL AND SEAL FOR MAIN PUMP	1
TF-1037-01*360	HOSE, PRESSURE (EXTERNAL)	1
TF-1039-01*360	HOSE, RETURN (EXTERNAL)	1
HC-1070-01	PUMP, VANE	1
K-4623	KIT, OIL FILTER	1
K-4624	KIT, FUEL FILTER	1
K-4625	KIT BREATHER FILTER	1
K-4626	KIT AIR FILTER	1
K-4627	KIT, SPARK PLUG	1
EC-2405	BATTERY	1

11.0 CALIBRATION OF INSTRUMENTATION

All gauges on the Hydraulic Power Unit can be either returned to Tronair for calibration or certified by the end user if proper calibration equipment is available. Gauges returned to Tronair for calibration will be tested with standards traceable to N.I.S.T. (National Institute of Standards and Technology). Tronair recommends calibration of instrumentation at yearly intervals, but actual calibration dates may be based upon frequency of use and the end users quality system. For information on returning gauges for calibration, Reference ***11.1 – Source of Calibration***.

11.1 SOURCE OF CALIBRATION

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

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

11.2 Self Calibration

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

SYSTEM PRESSURE GAUGE (HC-2559)

Applied Pressure (System Pressure Gauge) (psig)	Minimum Acceptable (psig)	Maximum Acceptable (psig)	Gauge Movement (Direction)	Indicated Pressure (Calibration Gauge) (psig)
1000	970	1030	Increasing	
1000	970	1030	Increasing	
1500	1470	1530	Increasing	
2000	1970	2030	Increasing	
2500	2470	2530	Increasing	
3000	2970	3030	Increasing	
2500	2470	2530	Decreasing	
2000	1970	2030	Decreasing	
1500	1470	1530	Decreasing	
1000	970	1030	Decreasing	
1000	970	1030	Decreasing	
Allowable operating tolerance: +/- 1.0% of full scale (30 psig) at room temperature (70° F).				

12.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information.

13.0 GUARANTEES/LIMITATION OF LIABILITY

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

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

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

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

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

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

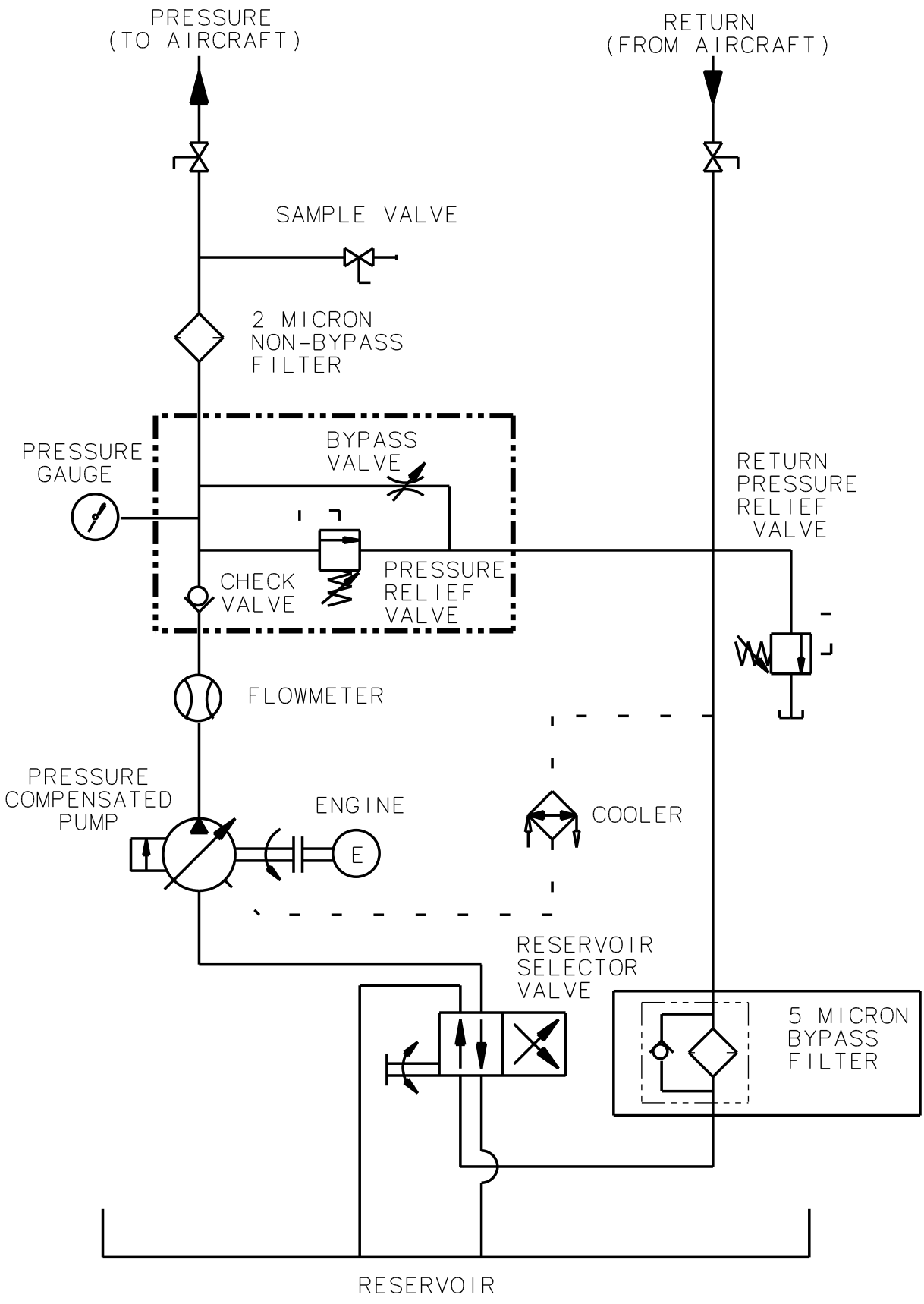
14.0 APPENDICES

APPENDIX I	Hydraulic Schematic
APPENDIX II	Electrical Schematic (INS-2135)
APPENDIX III	Wiring Diagram (INS-2140)
APPENDIX IV	Kohler Engine Manual
APPENDIX V	Continental Pump Manual
APPENDIX VI	Material Safety Data Sheet (MSDS) pertaining to Hydraulic Fluid
APPENDIX VII	Material Safety Data Sheet (MSDS) pertaining to battery
APPENDIX VIII	Instrument Certification Notice
APPENDIX IX	Declaration of Conformity

APPENDIX I

Hydraulic Schematic

Hydraulic Schematic



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APPENDIX II

Electrical Schematic
(INS-2135)

LET	REVISION	ECN	DWN	CHK	DATE
A	ORIGINAL RELEASE	18376	REW	PEH	03-01-12

KEY

1 =TERMINAL NUMBERS
= PLUG JUNCTION
[A] =WIRE NAME
= N/O RELAY CONTACT
= N/C RELAY CONTACT
=TERMINAL BLOCK
=CHASSIS GROUND
=CIRCUIT GROUND
=N/O TEMP SWITCH
=N/O PUSHSWITCH
=N/C PUSHSWITCH
=SELECTOR SWITCH
=DIODE

M =METER
SW =SWITCH
TSW = THERMO SWITCH
SOL = SOLENOID
L =LAMP
D =DIODE
K =RELAY
CB =CIRCUIT BREAKER

WIRE COLORS

BLK =BLACK, 12VDC POWER ON
BRN =BROWN, 12VDC FAN SWITCH
RED =RED, 12VDC KEY SWITCH
YEL =YELLOW, 12VDC BATTERY VOLTS
GRN =GREEN, GROUNDS
BLU =BLUE, 12VDC IDLE/RUN SYSTEM
VIO =VIOLET, KEY SWITCH
WHT =WHITE, ENGINE KILL SYSTEM

LAMP L1 · LAMP L2 · POWER ON · L3 · HI OIL TEMP · L4 · TB5 · TB1 · TB2 · TB3 · TB4
DIN CONNECTOR · BROWN · BLACK · FAN TEMP SWITCH TSW1 · COM · NO · 100°F
SOL-1 · SOL-1 12VDC · D1 · 2 WIRE CONNECTOR · COOLER FAN · Motor · 12VDC · CHASSIS GROUND
CB1 · 25A · CB2 · 10A
E-STOP · SW5 · JUMPER
IDLE \ RUN SWITCH · RUN · IDLE · SW4
K1 12VDC · D4 · OIL PRESS BYPASS
D3 1N5404 · D2 1N5404
TACHOMETER · 2200
ENGINE · J1 J2 J3 J4 · J5 J6 J7 J8
TACHOMETER WHITE WIRE · TACHOMETER RED WIRE · SPARK PLUG
MODULE CONTROL SPARK · 20 AWG · 12 AWG
ENGINE OIL PRESS · 5 PSI · ENGINE OIL TEMP · 350°F
ENGINE THROTTLE · ENGINE CHOKE · CHOKE SWITCH · SW3
RECTIFIER-REGULATOR · AC · AC · R+ · ENG ALT
ENGINE SOLENOID · STARTER · M
ENGINE CONNECTOR · BLUE · RED 12 AWG · RED 20 AWG · YELLOW · WHITE · ENGINE CONNECTOR FRONT VIEW
KEY SWITCH · STOP · ON · START · R · B · BAT · G · SW2
SW1 BATTERY SWITCH · BATTERY · 12VDC · GROUND STUD · CHASSIS GROUND

{BROWN} {BLACK} {BLUE START} {START} {BLACK} {VIOLET} {WHITE} {YELLOW} {RED} {BLUE} {GREEN} {BATTERY}

[M] [P] [Y] [Z] [N] [Q] [V] [AA] [DD] [L] [R] [K] [EE] [J] [G] [C] [B] [A] [H] [I] [F] [S] [T] [D] [BB] [U] [FF] [II] [HH] [X] [E] [GG]

INS-2135
Title: 50111ABG
Drawn By: R. Wallace
Page: Power On/Off Engine Control
Page Number: 1 of 1
Original Date: 03/01/12
Revision: A
Revision Date:
ECN: 18376

TRONAIR

APPENDIX III

Wiring Diagram
(INS-2140)

LET	REVISION	EC	DWN	CHK	DATE
A	ORIGINAL RELEASE	18376	-	-	04-17-12

TEMP SWITCH/DIN CONNECTOR

FAN MOTOR

HEAT EXCHANGER

BRN

BLK

BLK

RED

GRN

YEL

AA

Q

TO SPARK PLUG 2

RED WHT

Y P Y Z M P

A

DD

CB1 25A

CB2 10A

BLK

B

Q

ELECTRICAL BOX

SOL-1

L3 POWER ON

HI OIL TEMP

PANEL LIGHT L1

BLK BLU START F BLU START I A X

SW2 POWER ON/START

IDLE/ RUN SW4

E STOP SW5

CHOKE SW3

J G J H B E

VIOLET WHITE BLUE START RED

HOURMETER/ TACHOMETER

1

PANEL LIGHT LT

M P

INSTRUMENT PANEL (BACK VIEW)

II F

HH E

2 WHT

RED 2

B

ENGINE CONNECTOR

GRN

S

OIL PRESSURE SWITCH

L

MAIN INPUT BATTERY POWER

CHOKE

THROTTLE

OIL TEMP SWITCH

GROUND

ENGINE

GG U

C

C Y Z H BRN FF S II I BB V

G D T BB D HH M U T P EE

D3 D2 K1 D4

1 1 2 3 4 4 5 5

8 5 4 1 14 13 12 9

VIEW A

DIODE 2 CATHODE

DOIDE 3 CATHODE

D3 2 3 4 D2

VIEW C

DD L X R

BATTERY SWITCH SW1

R K

BATTERY 12VDC

AA GG EE

TB5 CHASSIS GROUND

NOTE:

1 NEED TO BREAK INTO THE BLUE WIRE TO WIRE THROUGH SW5 SWITCH.

2 WRAP RED WIRE AROUND SPARK PLUG WIRE. CONNECT WHITE WIRE TO GROUND.

ENGINE CONNECTOR HARNESS

RED WHT YEL RED BLU START — VIO WHT YEL RED BLU START

BLK YEL WHT GRN — J2 J4 J8 J5 — BLK BLU GRN GRN

ENGINE CONNECTOR

VIEW B

MAKE FROM: N/A	BREAK ALL SHARP EDGES AND CORNERS	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT	
MATERIAL: N/A TYPE: N/A	( ) INDICATED REFERENCE DIMENSIONS ITEM NUMBER ABOVE, QUANTITY BELOW	DWN BY JMB CKD BY PEH 04-17-12	
FINISH: MILL	TOLERANCES UNLESS OTHERWISE SPECIFIED: DECIMAL INCH[mm]: .X[X] ± .100[3] .XX[.XX] ± .030[0.8] .XXX[.XX] ± .010[0.25] .XXXX[.XXX] ± .003[0.076] FRACTION INCH[mm]: 1/XX[1/X] ± 1/16[1.6] ANGLES DEGREE[RADIANS] X[XXX] ± .5[0.001]	DIAGRAM, WIRING	
THIRD ANGLE PROJECTION SCALE: 1:1	DO NOT SCALE DRAWING SIZE E	05 INS-2140	REV A

TRONAIR®

APPENDIX IV

Kohler
Command Engine Owner's Manual

OWNER'S MANUAL

KOHLER COMMAND

CH18-CH26, CH620-CH750

HORIZONTAL CRANKSHAFT

KOHLER ENGINES

Safety Precautions

To ensure safe operations please read the following statements and understand their meaning. Also refer to your equipment owner'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 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 is ignored.

NOTE
Note is used to notify people of installation, operation, or maintenance information that is important but not hazard-related.

For Your Safety!
These precautions should be followed at all times. Failure to follow these precautions could result in injury to yourself and others.

WARNING

Explosive Fuel can cause fires and severe burns.

Do not fill the fuel tank while the engine is hot or running.

Explosive Fuel!
Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, unoccupied buildings, away from sparks or flames. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use gasoline as a cleaning agent.

WARNING

Rotating Parts can cause severe injury.

Stay away while engine is in operation.

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

CAUTION

Electrical Shock can cause injury.

Do not touch wires while engine is running.

Electrical Shock!
Never touch electrical wires or components while the engine is running. They can be sources of electrical shock.

WARNING

Hot Parts can cause severe burns.

Do not touch engine while operating or just after stopping.

Hot Parts!
Engine components can get extremely hot from operation. To prevent severe burns, do not touch these areas while the engine is running, or immediately after it is turned off. Never operate the engine with heat shields or guards removed.

California Proposition 65 Warning

Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

⚠ WARNING

Accidental Starts can cause severe injury or death.

Disconnect and ground spark plug leads before servicing.

Accidental Starts!

Disabling engine. Accidental starting can cause severe injury or death. *Before working on the engine or equipment, disable the engine as follows: 1) Disconnect the spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.*

⚠ WARNING

Carbon Monoxide can cause severe nausea, fainting or death.

Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.

Lethal Exhaust Gases!

Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled. Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.

⚠ WARNING

Explosive Gas can cause fires and severe acid burns.

Charge battery only in a well ventilated area. Keep sources of ignition away.

Explosive Gas!

Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sparks, open flames, and other sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries.

Before disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal which could cause an explosion if hydrogen gas or gasoline vapors are present.

Congratulations – You have selected a fine four-cycle, twin cylinder, air-cooled engine. Kohler designs long life strength and on-the-job durability into each engine...making a Kohler engine dependable...dependability you can count on. Here are some reasons why:

- Efficient overhead valve design and full pressure lubrication provide maximum power, torque, and reliability under all operating conditions.
- Dependable, maintenance-free electronic ignition ensures fast, easy starts time after time.
- Kohler engines are easy to service. All routine service areas like the dipstick, oil fill, air cleaner, and spark plugs are easily and quickly accessible.
- Parts subject to the most wear and tear (like the cylinder liner* and camshaft) are made from precision formulated cast iron. Because the cylinder liner* can be rebored, these engines can last even longer.

  *Some CH25/26 engines have POWER-BORE™ Cylinders. These cylinders are plated with nickel-silicon to give increased power, virtually permanent cylinder life, superior oil control, and reduced exhaust emissions. These cylinders cannot be rebored.

- Every Kohler engine is backed by a worldwide network of over 10,000 distributors and dealers. Service support is just a phone call away. Call 1-800-544-2444 (U.S. & Canada) for Sales & Service assistance.

To keep your engine in top operating condition, follow the maintenance procedures in this manual.

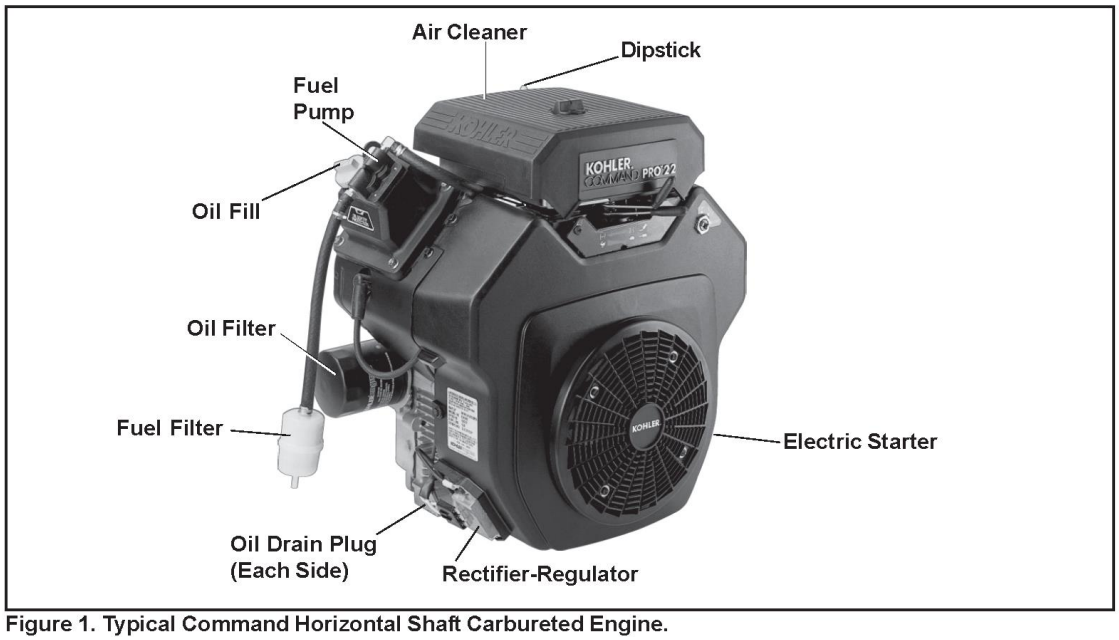


Figure 1. Typical Command Horizontal Shaft Carbureted Engine.

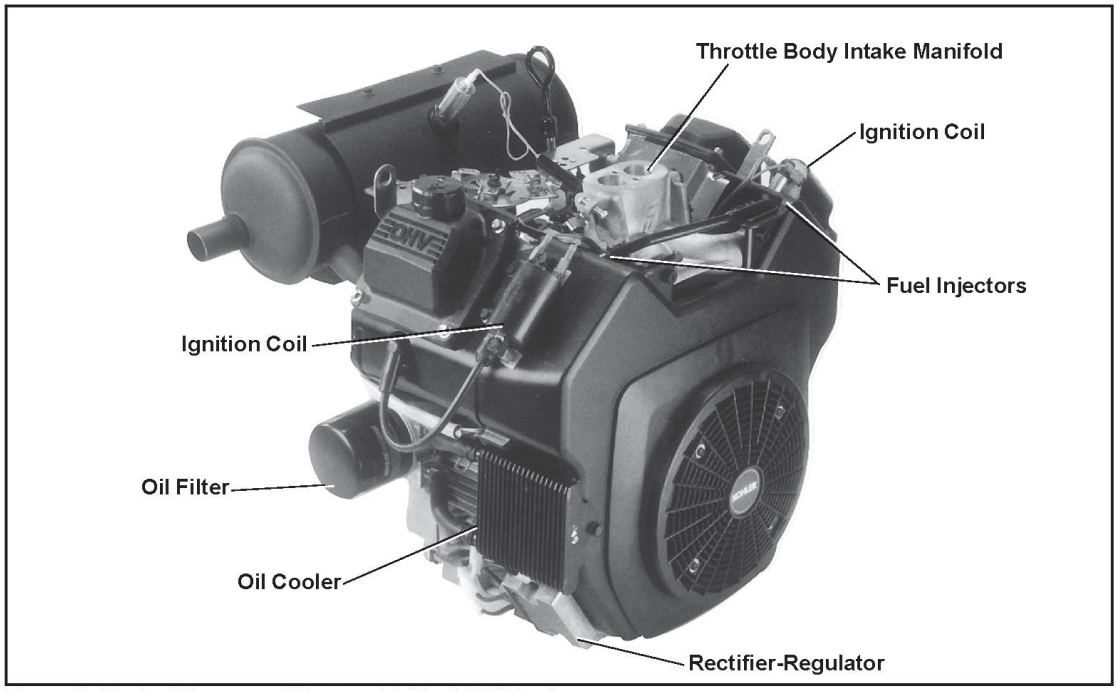


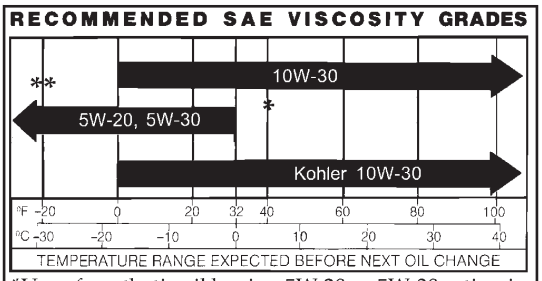
Figure 2. Typical Command Horizontal Shaft EFI Engine.

Oil Recommendations

Using the proper type and weight of oil in the crankcase is extremely important. So is checking oil daily and changing oil regularly. Failure to use the correct oil, or using dirty oil, causes premature engine wear and failure.

Oil Type

Use high quality detergent oil of **API (American Petroleum Institute) service class SG, SH, SJ, or higher**. Select the viscosity based on the air temperature at the time of operation as shown in the following table.



*Use of synthetic oil having 5W-20 or 5W-30 rating is acceptable, up to 4°C (40°F).

**Synthetic oils will provide better starting in extreme cold below -23°C (-10°F).

Figure 3. Viscosity Grades Table.

NOTE: Using other than service class SG, SH, SJ or higher oil or extending oil change intervals longer than recommended can cause engine damage.

NOTE: Synthetic oils meeting the listed classifications may be used with oil changes performed at the recommended intervals. However to allow piston rings to properly seat, a new or rebuilt engine should be operated for at least 50 hours using standard petroleum based oil before switching to synthetic oil.

A logo or symbol on oil containers identifies the API service class and SAE viscosity grade. See Figure 4.

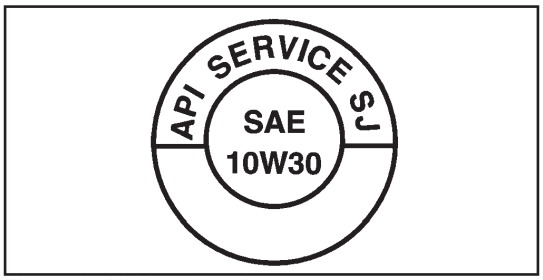


Figure 4. Oil Container Logo.

Refer to Maintenance Instructions beginning on page 8 for detailed oil check, oil change, and oil filter change procedures.

Fuel Recommendations

WARNING: Explosive Fuel!

Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, unoccupied buildings, away from sparks or flames. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use gasoline as a cleaning agent.

General Recommendations

Purchase gasoline in small quantities and store in clean, approved containers. A container with a capacity of 2 gallons or less with a pouring spout is recommended. Such a container is easier to handle and helps eliminate spillage during refueling.

Do not use gasoline left over from the previous season, to minimize gum deposits in fuel system and to ensure easy starting.

Do not add oil to the gasoline.

Do not overfill the fuel tank. Leave room for the fuel to expand.

Fuel Type

For best results use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 or higher. In countries using the Research method, it should be 90 octane minimum.

Unleaded gasoline is recommended as it leaves less combustion chamber deposits and reduces harmful exhaust emissions. Leaded gasoline is not recommended and **must not** be used on EFI engines, or on other models where exhaust emissions are regulated.

Gasoline/Alcohol blends

Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends including E20 and E85 are not to be used and not approved. Any failures resulting from use of these fuels will not be warranted.

Gasoline/Ether blends

Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved as a fuel for Kohler engines. Other gasoline/ether blends are not approved.

Engine Identification Numbers

When ordering parts, or in any communication involving an engine, always give the **Model, Specification, and Serial Numbers** of the engine.

The engine identification numbers appear on a decal affixed to the engine shrouding. Include letter suffixes, if there are any. Record your engine identification numbers on an identification label below (Figure 5) for future reference.

For Models CH18-CH745

KOHLER

IMPORTANT ENGINE INFORMATION
THIS ENGINE MEETS U.S. EPA PH2 AND EC STAGE II (SN:4) EMISSION REGS FOR SI SORE NOT FOR SALE IN CALIFORNIA UNLESS PREEMPT PER SEC. 209(e)(1) of CAA
FAMILY
TYPE APP
DISPL (CC)
MODEL NO. N11236
SPEC. NO.
SERIAL NO.
BUILD DATE
OEM PROD. NO.
EMISSION COMPLIANCE PERIOD:
EPA:
CERTIFIED ON:
REFER TO OWNER'S MANUAL FOR HP RATING, SAFETY, MAINTENANCE AND ADJUSTMENTS
1-800-544-2444 KohlerEngines.com
KOHLER CO. KOHLER, WISCONSIN USA

KOHLER

IMPORTANT ENGINE INFORMATION
THIS ENGINE MEETS U.S. EPA PH2, EC STAGE II (SN:4) AND CA 2008 AND LATER EXH EMISSION REGS FOR SI SORE
FAMILY
TYPE APP
DISPL (CC)
MODEL NO.
SPEC. NO. N11236
SERIAL NO.
BUILD DATE
OEM PROD. NO.
EMISSION COMPLIANCE PERIOD:
EPA: CARB:
CERTIFIED ON:
REFER TO OWNER'S MANUAL FOR HP RATING, SAFETY, MAINTENANCE AND ADJUSTMENTS
1-800-544-2444 KohlerEngines.com
KOHLER CO. KOHLER, WISCONSIN USA

For Model CH750

KOHLER

IMPORTANT ENGINE INFORMATION
THIS ENGINE MEETS EMISSION REGS FOR U.S. EPA 2005 AND LATER AND EC STAGE II (SN:4) SI SMALL OFF-ROAD ENGINES AND CA 2005 AND LATER LSI ENGINES
FAMILY
TYPE APP
DISPL (CC)
MODEL NO.
SPEC. NO. N11236
SERIAL NO.
BUILD DATE
OEM PROD. NO.
EMISSION COMPLIANCE PERIOD:
EPA:
CERTIFIED ON:
REFER TO OWNER'S MANUAL FOR HP RATING, SAFETY, MAINTENANCE AND ADJUSTMENTS
1-800-544-2444 KohlerEngines.com
KOHLER CO. KOHLER, WISCONSIN USA

Figure 5. Engine Identification Label.

The Emission Compliance Period referred to on the Emission Control or Air Index label indicates the number of operating hours for which the engine has been shown to meet Federal and CARB emission requirements. The following table provides the Engine Compliance Period (in hours) associated with the category descriptor found on the certification label.

Emission Compliance Period (Hours)

EPA	Category C 250 hours	Category B 500 hours	Category A 1000 hours
CARB	Moderate 125 hours	Intermediate 250 hours	Extended 500* hours

*Extended hours for Model CH750 is 1000.

Refer to certification label for engine displacement.

Exhaust Emission Control System for models CH18/CH620, CH20/CH640, CH23/CH680, CH730, CH740, CH750 is EM. Exhaust Emission Control System for models CH26/CH735 and CH745 are EM, O2S, ECM, MFI.

Model Designation

Model CH20S for example: C designates Command engine, H designates horizontal crankshaft, and 20 designates horsepower. Some model numbers (CH730) use a numerical designation rather than horsepower. A letter suffix designates a specific version as follows:

Suffix	Designates
S	Electric Start
ST	Electric Start/Retractable Start
QS	Quiet Model/Electric Start
EP	Electric Plant
CS	Clutch Model/Electric Start

Operating Instructions

Also read the operating instructions of the equipment this engine powers.

Pre-Start Checklist

- Check oil level. Add oil if low. Do not overfill.
- Check fuel level. Add fuel if low.
- Check cooling air intake areas and external surfaces of engine. Make sure they are clean and unobstructed.
- Check that the air cleaner components and all shrouds, equipment covers, and guards are in place and securely fastened.

- Check that any clutches or transmissions are disengaged or placed in neutral. This is especially important on equipment with hydrostatic drive. The shift lever must be exactly in neutral to prevent resistance which could keep the engine from starting.

WARNING: Lethal Exhaust Gases!

Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled. Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.

Cold Weather Starting Hints

1. Be sure to use the proper oil for the temperature expected. See Figure 3 on page 5.

2. Disengage all possible external loads.

3. Be sure the battery is in good condition. A warm battery has much more starting capacity than a cold battery.

4. Use fresh winter grade fuel. NOTE: Winter grade gasoline has higher volatility to improve starting. Do not use gasoline left over from summer.

Starting

1. Place the throttle control **midway** between the **slow** and **fast** positions. Place the choke control (non-EFI engines only) into the **on** position. See Figure 6.

Figure 6. Optional Engine Mounted Throttle and Choke Controls (Carbureted Engines).

2. Start the engine by activating the key switch. Release the switch as soon as the engine starts.

   EFI Engines Only – Initial Starting or After Running out of Fuel (Dry System)

   a. Turn the key switch to the **on** position for one minute. Allow the fuel pump to cycle and prime the system. Turn the key switch **off**.

   b. Turn the key switch to the **start** position, crank and start engine.

   c. If the engine fails to start, repeat steps **a** and **b**. If the engine does not start after two priming intervals, contact your Kohler Engine Service Dealer for further assistance.

   NOTE: Do not crank the engine continuously for more than 10 seconds at a time. If the engine does not start, allow a 60 second cool down period between starting attempts. Failure to follow these guidelines can burn out, or permanently damage, the starter motor.

   NOTE: Upon start-up, a metallic ticking may occur. This is caused by hydraulic lifter leakdown during storage. Run the engine for 5 minutes. The noise will normally cease in the first minute. If noise continues, run the engine at mid-throttle for 20 minutes. If noise persists, take the engine to your local authorized Kohler Engine Service Dealer.

   NOTE: If the engine develops sufficient speed to disengage the starter but does not keep running (a false start), engine rotation must be allowed to come to a complete stop before attempting to restart the engine. If the starter is engaged while the flywheel is rotating, the starter pinion and flywheel ring gear may clash resulting in damage to the starter.

   If the starter does not turn the engine over, shut off starter immediately. Do not make further attempts to start the engine until the condition is corrected. Do not jump start using another battery (refer to **Battery** on page 8). See your Kohler Engine Service Dealer for service assistance.

Carbureted Engines Only:

3. **For a Cold Engine –** Gradually return the choke control to the **off** position after the engine starts and warms up.

   The engine/equipment may be operated during the warm-up period, but it may be necessary to leave the choke partially on until the engine warms up.

4. **For a Warm Engine –** Return choke to **off** position as soon as engine starts.

Stopping

1. Remove the load by disengaging all PTO driven attachments.

2. **For Carbureted Engines Without A Shutdown Solenoid:** Move the throttle to the **slow** or **low** idle position. Allow the engine to run at idle for 30-60 seconds; then stop the engine.

   For Carbureted Engines Equipped With A Shutdown Solenoid: Position the throttle control somewhere between half and full throttle; then stop the engine.

   For EFI Engines: Move the throttle to the **slow** or **idle** position; turn key **off** to stop engine.

Battery

A 12 volt battery is normally used. Refer to the operating instructions of the equipment this engine powers for specific battery requirements.

If the battery charge is not sufficient to crank the engine, recharge the battery (see page 13).

Operating

Angle of Operation

This engine will operate continuously at angles up to 25°. Check oil level to assure crankcase oil level is at the "F" mark on the dipstick.

Refer to the operating instructions of the equipment this engine powers. Because of equipment design or application, there may be more stringent restrictions regarding the angle of operation.

NOTE: Do not operate this engine continuously at angles exceeding 25° in any direction. Engine damage could result from insufficient lubrication.

Cooling

NOTE: If debris builds up on the grass screen or other cooling air intake areas, stop the engine immediately and clean. Operating the engine with blocked or dirty air intake and cooling areas can cause extensive damage due to overheating.

WARNING: Hot Parts!

Engine components can get extremely hot from operation. To prevent severe burns, do not touch these areas while the engine is running, or immediately after it is turned off. Never operate the engine with heat shields or guards removed.

Engine Speed

NOTE: Do not tamper with the governor setting to increase the maximum engine speed. Overspeed is hazardous and will void the engine warranty. The maximum allowable high idle speed for these engines is 3750 RPM, no load.

Maintenance Instructions

Maintenance, repair, or replacement of the emission control devices and systems, which are being done at the customers expense, may be performed by any non-road engine repair establishment or individual. Warranty repairs must be performed by an authorized Kohler service outlet.

WARNING: Accidental Starts!

Disabling engine. Accidental starting can cause severe injury or death. *Before working on the engine or equipment, disable the engine as follows: 1) Disconnect the spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.*

Maintenance Schedule

These required maintenance procedures should be performed at the frequency stated in the table. They should also be included as part of any seasonal tune-up.

Frequency	Maintenance Required
Daily or Before Starting Engine	• Fill fuel tank. • Check oil level. • Check air cleaner for dirty[1], loose, or damaged parts. • Check air intake and cooling areas, clean as necessary[1].
Every 25 Hours	• Service precleaner element[1].
Every 100 Hours	• Replace air cleaner element[1]. • Change oil. (More frequently under severe conditions.) • Remove cooling shrouds and clean cooling areas[1,3]. • Check oil cooler fins, clean as necessary (if equipped).
Every 200 Hours	• Check spark plug condition and gap. • Change oil filter. • Replace fuel filter (carbureted engines).
Every 250 Hours	• Replace heavy-duty air cleaner element and check inner element[1].
Annually or Every 500 Hours	• Have bendix starter drive serviced[2,4]. • Have solenoid shift starter disassembled and cleaned[2,4].
Every 500 Hours	• Have crankshaft spline lubricated[2].
Every 1500 Hours	• Replace fuel filter[1] (EFI engines).

[1]*Perform these maintenance procedures more frequently under extremely dusty, dirty conditions.*
[2]*Have a Kohler Engine Service Dealer perform this service.*
[3]*Cleanout Kits 25 755 20-S (black) or 25 755 21-S (gold) allow cooling areas to be cleaned without removing shrouds.*
[4]*Only required for Denso starters. Not necessary on Delco starters.*

Check Oil Level

The importance of checking and maintaining the proper oil level in the crankcase cannot be overemphasized. Check oil **BEFORE EACH USE** as follows:

1. Make sure the engine is stopped, level, and is cool so the oil has had time to drain into the sump.

2. To keep dirt, debris, etc., out of the engine, clean the area around the dipstick before removing it.

3. Remove the dipstick; wipe oil off. Reinsert the dipstick into the tube and press all the way down.

4. Remove the dipstick and check the oil level. The oil level should be up to, but not over, the "F" mark on the dipstick. See Figure 7.

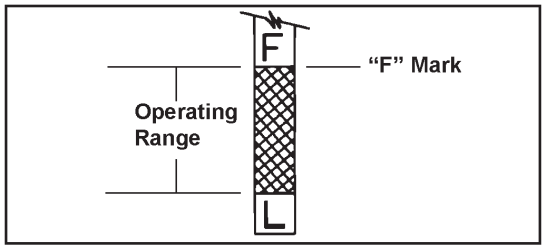


Figure 7. Oil Level Dipstick.

5. If the level is low, add oil of the proper type, up to the "F" mark on the dipstick. (Refer to Oil Type on page 5.) Always check the level with the dipstick before adding more oil.

   NOTE: To prevent extensive engine wear or damage, always maintain the proper oil level in the crankcase. Never operate the engine with the oil level below the "L" mark or over the "F" mark on the dipstick.

Oil Sentry™

Some engines are equipped with an optional Oil Sentry™ oil pressure switch. If the oil pressure decreases below an acceptable level, the Oil Sentry™ will either shut off the engine or activate a warning signal, depending on the application.

NOTE: Make sure the oil level is checked **BEFORE EACH USE** and is maintained up to the "F" mark on the dipstick. This includes engines equipped with Oil Sentry™.

Change Oil and Filter, Service Oil Cooler

Change Oil

Change oil after every **100 hours** of operation (more frequently under severe conditions). Refill with service class SG, SH, SJ or higher oil as specified in the Viscosity Grades table (Figure 3) on page 5.

Change the oil while the engine is still warm. The oil will flow more freely and carry away more impurities. Make sure the engine is level when filling, checking, and changing the oil.

Change the oil as follows (see Figures 8 and 9):

1. To keep dirt, debris, etc., out of the engine, clean the area around the oil fill cap/dipstick before removing it.
2. Remove one of the oil drain plugs, oil fill cap, and dipstick. Be sure to allow ample time for complete drainage.
3. Reinstall the drain plug. Make sure it is tightened to **13.6 N·m (10 ft. lb.)** torque.
4. Fill the crankcase, with new oil of the proper type, to the "F" mark on the dipstick. Refer to Oil Type on page 5. Always check the level with the dipstick before adding more oil.
5. Reinstall the oil fill cap and tighten securely. Reinstall dipstick.

   NOTE: To prevent extensive engine wear or damage, always maintain the proper oil level in the crankcase. Never operate the engine with the oil level below the "L" mark or over the "F" mark on the dipstick.

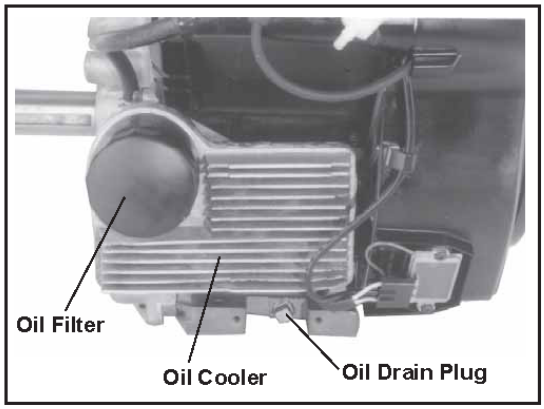


Figure 8. Oil Drain Plugs, Oil Filter, and Oil Cooler (Crankcase Mounted).

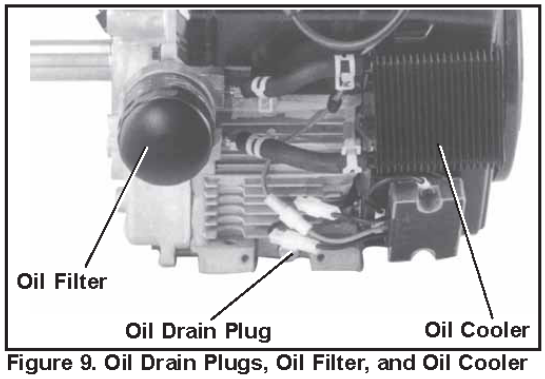


Figure 9. Oil Drain Plugs, Oil Filter, and Oil Cooler (Blower Housing Mounted).

Change Oil Filter

Replace the oil filter **at least every other oil change (every 200 hours of operation)**. Always use a genuine Kohler oil filter. Use chart below to determine part number to order.

Oil Filter Part No.	Length
12 050 01-S	2-1/2"
52 050 02-S	3-3/8"

Replace the oil filter as follows:

1. Drain the oil from the engine crankcase.
2. Allow the oil filter to drain.
3. Before removing the oil filter, clean the area around the oil filter to keep dirt and debris out of the engine. Remove the old filter. Wipe off the surface where the oil filter mounts.
4. Place a new replacement filter in a shallow pan with the open end up. Pour new oil, of the proper type, in through the threaded center hole. Stop pouring when the oil reaches the bottom of the threads. Allow a minute or two for the oil to be absorbed by the filter material.
5. Apply a thin film of clean oil to the rubber gasket on the new filter.
6. Install the replacement oil filter to the filter adapter or oil cooler. Turn the oil filter clockwise until the rubber gasket contacts the filter adapter or oil cooler, then tighten the filter an additional **3/4 to 1 turn**.
7. Reinstall the drain plug. Make sure it is tightened to **13.6 N·m (10 ft. lb.)** torque.
8. Fill the crankcase with new oil of the proper type to the "F" mark on the dipstick.

9. Start the engine and check for oil leaks. Correct any leaks before placing the engine into service. Check oil level to be sure it is up to but not over the "F" mark.

Service Oil Cooler

Some engines are equipped with an oil cooler. One style of oil cooler mounts on the engine crankcase and has the oil filter on it (See Figure 8). The other style of oil cooler is mounted on the blower housing (see Figure 9), separate from the oil filter.

Inspect and clean the oil cooler **every 100 hours of operation** (more frequently under severe conditions). Oil cooler must be kept free of debris.

To service the crankcase mounted oil cooler clean off the outside fins with a brush or with compressed air.

To service the blower housing mounted oil cooler, clean the outside of fins with a brush. Remove the two screws holding the cooler unit to the blower housing. Tilt the cooler downward as shown in Figure 10. Clean the inside of cooler with a brush as shown in Figure 10 or with compressed air. After cleaning, reinstall oil cooler to blower housing with two mounting screws.

Figure 10. Cleaning Oil Cooler.

Service Precleaner and Air Cleaner Element

This engine is equipped with a replaceable, high density paper air cleaner element. Most engines are also equipped with an oiled, foam precleaner which surrounds the paper element. See Figure 11. Some engines use the heavy-duty air cleaner system. See Figure 13.

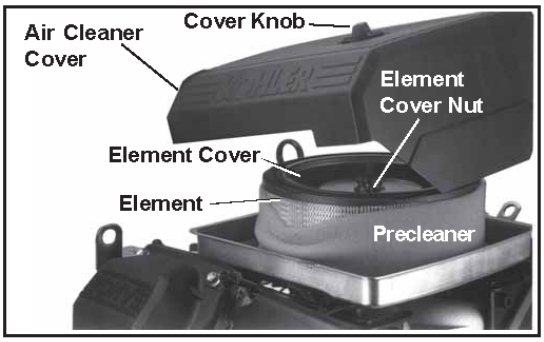


Figure 11. Air Cleaner System Components.

Check the air cleaner **daily or before starting the engine**. Check for a buildup of dirt and debris around the air cleaner system. Keep this area clean. Also check for loose or damaged components. Replace all bent or damaged air cleaner components.

NOTE: Operating the engine with loose or damaged air cleaner components could allow unfiltered air into the engine causing premature wear and failure.

Service Precleaner

If so equipped, wash and reoil the precleaner every **25 hours** of operation (more often under extremely dusty or dirty conditions).

1. Loosen the cover retaining knob and remove the cover.
2. Remove the precleaner from the paper element.
3. Wash the precleaner in warm water with detergent. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Allow the precleaner to air dry.
4. Saturate the precleaner with new engine oil. Squeeze out all excess oil.
5. Reinstall the precleaner over the paper element.
6. Reinstall the air cleaner cover. Secure cover with the cover retaining knob.
7. When precleaner replacement is necessary, order genuine Kohler parts.

24 083 02-S	61 mm (2.40 in.) high x 173 mm (6.81 in.) O.D.
24 083 05-S	71 mm (2.79 in.) high x 173 mm (6.81 in.) O.D.

Service Paper Element

Every **100 hours** of operation (more often under extremely dusty or dirty conditions) replace the paper element.

1. Loosen the cover retaining knob and remove the cover.

2. Remove the element cover nut, element cover, and paper element with precleaner.

3. Remove the precleaner (if so equipped) from the paper element. Service the precleaner as described above.

4. **Do not wash the paper element or use pressurized air**, as this will damage the element. Replace a dirty, bent, or damaged element with a genuine Kohler element. Handle new elements carefully; do not use if the sealing surfaces are bent or damaged.

5. When servicing the air cleaner, check the air cleaner base. Make sure it is secured and not bent or damaged. Also, check the element cover for damage or improper fit. Replace all damaged air cleaner components.

   NOTE: If any loose dirt or debris fell on the air cleaner base when the element was removed, carefully remove it and wipe the base clean. Be careful that none of it drops into the intake throat. Check the condition of the rubber seal on the air cleaner stud. If the condition is questionable in any way, replace it with the new seal packaged with the replacement element.

6. Reinstall the paper element, precleaner, element cover, element cover nut, and air cleaner cover. Secure cover with the cover retaining knob.

7. When element replacement is necessary, order genuine Kohler parts.

47 083 03-S	65 mm (2.55 in.) high x 178 mm (7.00 in.) O.D.
24 083 03-S	74 mm (2.91 in.) high x 178 mm (7.00 in.) O.D.

Heavy-Duty Air Cleaner

To Service

Every **250 hours** of operation (more often under extremely dusty or dirty conditions), replace the paper element and check inner element. Follow these steps.

1. Unhook the two retaining clips and remove the end cap from the air cleaner housing.

2. Pull the air cleaner element out of the housing. See Figure 12.

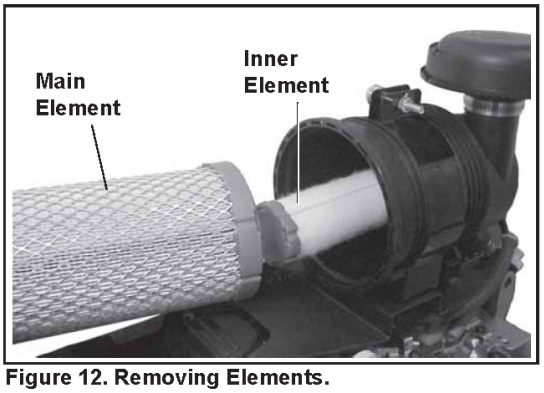


Figure 12. Removing Elements.

3. After the main element is removed, check the condition of the inner element. It should be replaced whenever it appears dirty, typically every other time the main element is replaced. Clean the area around the base of the inner element before removing it, so dirt does not get into the engine.

4. **Do not** wash the paper element and inner element or use pressurized air, this will damage the elements. Replace dirty, bent or damaged elements with new genuine Kohler elements as required. Handle new elements carefully; do not use if the sealing surfaces are bent or damaged.

5. Check all parts for wear, cracks, or damage. Replace any damaged components.

6. Install the new inner element, Kohler Part No. **25 083 04-S** followed by the outer element, Kohler Part No. **25 083 01-S**. Slide each fully into place in the air cleaner housing.

7. Reinstall the end cap so the dust ejector valve is down and secure with the two retaining clips. See Figure 13.

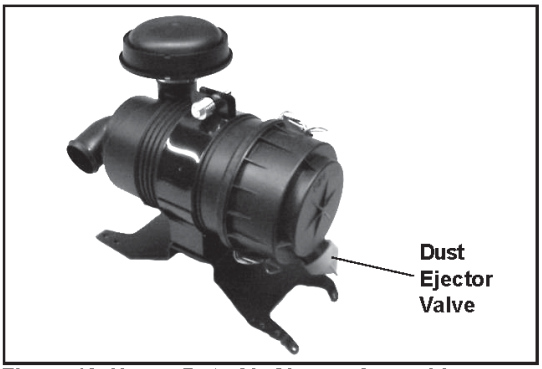


Figure 13. Heavy-Duty Air Cleaner Assembly.

Clean Air Intake/Cooling Areas

To ensure proper cooling, make sure the grass screen, cooling fins, and other external surfaces of the engine are kept clean **at all times**.

Every **100 hours** of operation (more often under extremely dusty, dirty conditions), remove the blower housing* and other cooling shrouds. Clean the cooling fins and external surfaces as necessary. Make sure the cooling shrouds are reinstalled.

NOTE: Operating the engine with a blocked grass screen, dirty or plugged cooling fins, and/or cooling shrouds removed, will cause engine damage due to overheating.

*Cleanout kits 25 755 20-S (black) or 25 755 21-S (gold) allow inspection and cleanout of the cooling fins, without removing the blower housing.

Ignition System

Carbureted Engines - Use an electronic Capacitive Discharge (CD) ignition system. Other than periodically checking/replacing the spark plugs, no maintenance, timing, or adjustments are necessary or possible with this system.

EFI Engines - Incorporate a computer-controlled battery ignition system with individual coils. Other than periodically checking/replacing the spark plugs, no maintenance, timing, or adjustments are necessary or possible with this system.

Check Spark Plugs

Every **200 hours** of operation, remove the spark plugs, check condition, and reset the gap or replace with new plugs as necessary. The standard spark plug is a Champion® RC12YC (Kohler Part No. 12 132 02-S). RFI complaint engines use a Champion® XC12YC (Kohler Part No. 25 132 14-S) spark plug. A high-performance spark plug, Champion® Platinum 3071 (used on Pro Series engines, Kohler Part No. 25 132 12-S) is also available. Equivalent alternate brand plugs can also be used.

1. Before removing the spark plug, clean the area around the base of the plug to keep dirt and debris out of the engine.

2. Remove the plug and check its condition. Replace the plug if worn or reuse is questionable.

   NOTE: Do not clean the spark plug in a machine using abrasive grit. Some grit could remain in the spark plug and enter the engine causing extensive wear and damage.

3. Check the gap using a wire feeler gauge. Adjust the gap to **0.76 mm (0.030 in.)** by carefully bending the ground electrode. See Figure 14.

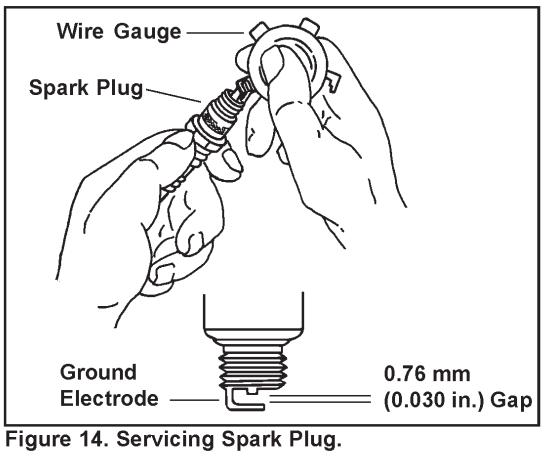


Figure 14. Servicing Spark Plug.

4. Reinstall the spark plug into the cylinder head. Torque the spark plug to **24.4-29.8 N·m (18-22 ft. lb.)**.

Battery Charging

WARNING: Explosive Gas!

Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sparks, open flames, and other sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries.

Before disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal which could cause an explosion if hydrogen gas or gasoline vapors are present.

NOTE: Do not apply 12 volt DC to kill terminal of ignition module.

Fuel System

WARNING: Fuel System Under Pressure!

The EFI fuel system operates under high pressure, and the fuel filter and fuel line used must be approved system components only. Use of substitute parts can result in system failure, gasoline leakage and possible explosion.

Fuel Filter

Carbureted Engines: Most engines are equipped with an in-line fuel filter. Periodically inspect the filter and replace with a genuine Kohler filter every **200 operating hours**.

EFI Engines: A special, high volume, high pressure filter with greater filtration capabilities and internal surface area is used. See Figure 15.

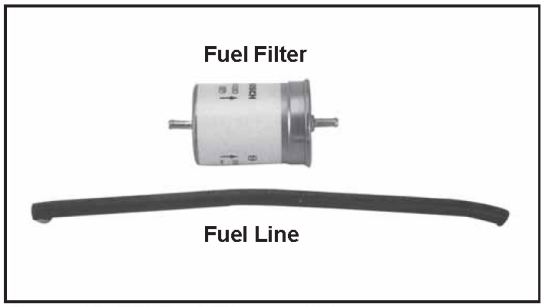


Figure 15. EFI Fuel Filter and Line.

Replacement is recommended every **1500 hours**, or more frequently under extremely dusty or dirty conditions. When replacement is necessary, always use genuine Kohler parts.

Fuel Line

Carbureted Engines: In compliance with CARB Tier III Emission Regulations, carbureted engines with a **Family** identification number beginning with "6" or greater (see Figure 16), must use Low Permeation SAE 30 R7 rated fuel line; certified to meet CARB requirements. Standard fuel line may not be used. Order replacement hose by part number through a Kohler Engine Service Dealer.

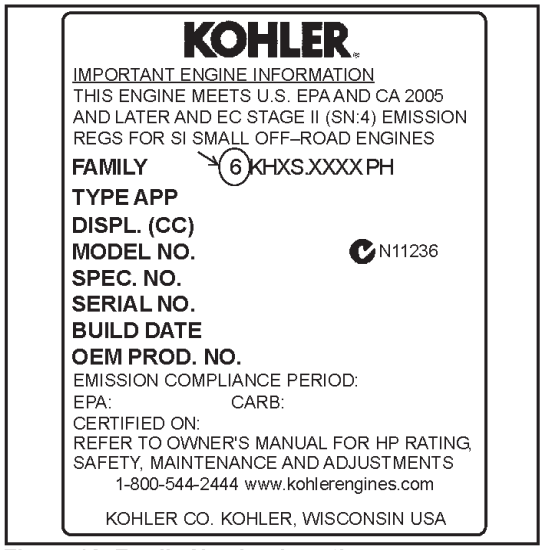


Figure 16. Family Number Location.

EFI Engines: A special fuel line, capable of withstanding the high pressure of the EFI fuel system, is used (must meet SAE R9 specifications). See Figure 15. If fuel line must be replaced, see your Kohler Engine Service Dealer.

Carburetor Troubleshooting and Adjustments

Engines in this series use either a one- or two-barrel carburetor depending on model, and may also be equipped with a Governed Idle System. Specific adjustment procedures are provided based on the model and carburetor involved. If the engine is equipped with a Governed Idle System, refer to **Models with Governed Idle System** on page 15 when performing any carburetor adjustment, as an additional step to the listed adjustment procedure(s) is required.

NOTE: Carburetor adjustments should be made only after the engine has warmed up.

The carburetor is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. To comply with current emission regulations, the fuel mixture settings are made at the factory and cannot be adjusted.

NOTE: To ensure correct engine operation at altitudes above 1525 meters (5000 ft.), it may be necessary to have an authorized Kohler dealer install a special high-altitude jet kit in the carburetor. If a high-altitude kit has been installed, the engine must be reconverted to the original jet size, before it is operated at lower altitudes, or overheating and engine damage can result.

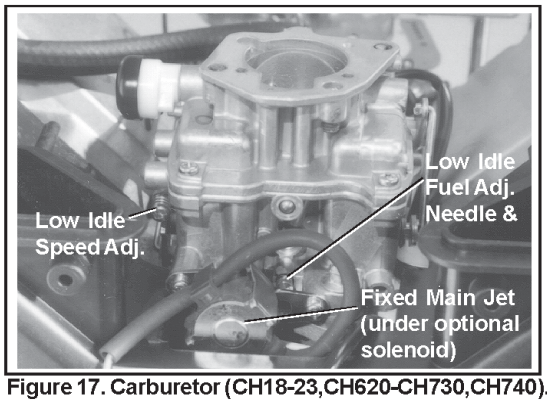


Figure 17. Carburetor (CH18-23,CH620-CH730,CH740).

Troubleshooting

If engine troubles are experienced that appear to be fuel system related, check the following areas before adjusting the carburetor.

- Make sure the fuel tank is filled with clean, fresh gasoline.
- Make sure the fuel tank cap vent is not blocked and that it is operating properly.

- If the fuel tank is equipped with a shut-off valve, make sure it is open.
- If the engine is equipped with an in-line fuel filter, make sure it is clean and unobstructed. Replace the filter if necessary.
- Make sure fuel is reaching the carburetor. This includes checking the fuel lines and fuel pump for restrictions or faulty components, replace as necessary.
- Make sure the air cleaner element is clean and all air cleaner element components are fastened securely.

If, after checking the items listed above, the engine is hard to start, runs roughly, or stalls at low idle speed, it may be necessary to adjust or service the carburetor.

Adjust Carburetor

Models CH18-740

There are no accessible mixture adjustment screws on the carburetor. The only setting which can be changed is the low idle speed.

1. Start the engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before making final settings (steps 2 and 3).
2. **Low Idle Speed Setting:** Place the throttle control into the **idle** or **slow** position. Set the low idle speed to **1200 RPM*** (± 75 RPM) by turning the low idle speed adjusting screw **in** or **out**. Check the speed using a tachometer.

   *NOTE: The actual low idle speed depends on the application – refer to equipment manufacturers recommendations. The standard low idle speed is 1200 RPM.

3. If proper operation is not restored after adjusting the low idle speed, carburetor servicing by an authorized Kohler Engine Service Dealer may be required.

Models with Governed Idle System

An optional governed idle control system is supplied on some CH18-740 engines. The purpose of this system is to maintain a desired idle speed regardless of ambient conditions (temperature, parasitic load, etc.) that may change. Engines with this feature contain a small secondary spring connected between the governor lever and the lower adjustment tab of the main bracket. See Figure 18.

The system requires an additional procedure for setting the idle speed. If speed adjustments are required proceed as follows.

1. Make any necessary speed or control adjustments following the appropriate instructions covered in this section.
2. Move the throttle control to the idle position. Hold the governor lever away from the carburetor, or hold the throttle lever so it is tight against the idle speed adjusting screw, to negate the governor activation. See Figure 19. Check the speed with a tachometer and adjust it to 1500 RPM.
3. Release the governor lever and allow the engine to return to the governed idle speed. Check it with a tachometer against the equipment manufacturers recommended idle speed. Governed Idle Speed (RPM) is typically 300 RPM (approximate) higher than the low idle speed. If adjustment is necessary, bend the adjusting tab on the speed control assembly to set. See Figure 18.

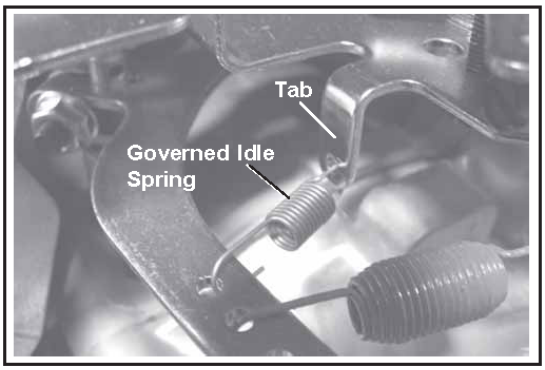


Figure 18. Governed Idle Spring Location.

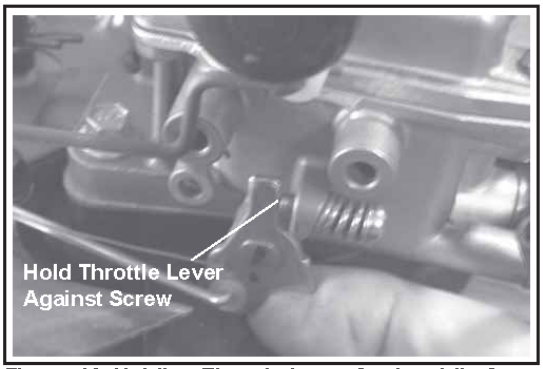


Figure 19. Holding Throttle Lever Against Idle Stop Screw.

Model CH750

CH750 engines use a Keihin BK two-barrel carburetor with fixed main jets and fixed or limiter-equipped low idle fuel adjusting needles. See Figure 20. Adjustments are made as follows.

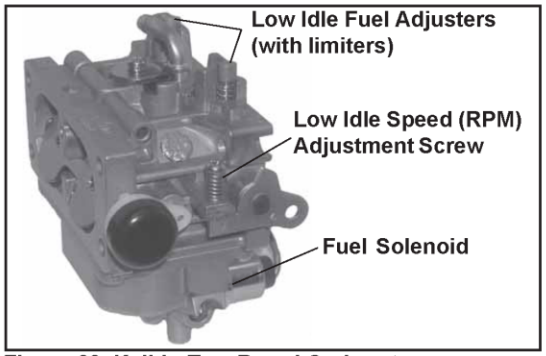


Figure 20. Keihin Two-Barrel Carburetor.

Low Idle Speed (RPM) Adjustment

1. **Low Idle Speed (RPM) Setting**: Place the throttle control into the **idle** or **slow** position. Set the low idle speed to **1200 RPM*** (± 75 RPM) by turning the low idle speed adjusting screw **in or out**. Check the speed using a tachometer.

*NOTE: The actual low idle speed depends on the application. Refer to the equipment manufacturer's recommendations. The low idle speed for basic engines is 1200 RPM. To ensure best results when setting the low idle fuel needle, the low idle speed should be 1200 RPM (± 75 RPM).

Low Idle Fuel Adjustment

NOTE: Engines will have fixed low idle or limiter caps on the two idle fuel adjusting needles. Step 3 can only be performed within the limits allowed by the cap. Do not attempt to remove the limiter caps.

1. Start the engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before doing steps 2, 3, and 4.

2. Place the throttle control into the **idle** or **slow** position. Adjust the low idle speed to **1200 RPM*** Follow the **Adjusting the Low Idle Speed (RPM)** procedure.

3. **Low Idle Fuel Needle(s) Setting**: Place the throttle into the **idle** or **slow** position.

   a. Turn one of the low idle fuel adjusting needles out (counterclockwise) from the preliminary setting until the engine speed decreases (rich). Note the position of the needle. Now turn the adjusting needle in (clockwise). The engine speed may increase, then it will decrease as the needle is turned **in** (lean). Note the position of the needle. Set the adjusting needle midway between the rich and lean settings. See Figure 21.

   b. Repeat the procedure on the other low idle adjustment needle.

4. Recheck/adjust the **Low Idle Speed (RPM)**, to the specified setting.

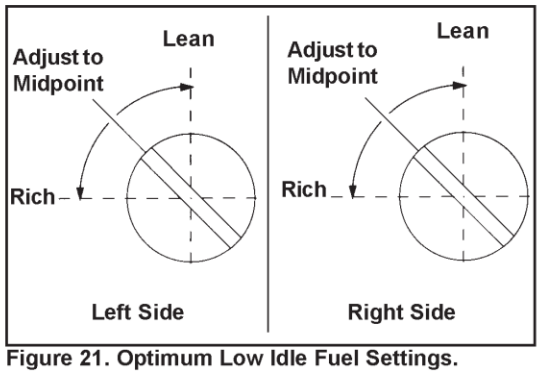


Figure 21. Optimum Low Idle Fuel Settings.

Models with Governed Idle System

An optional governed idle control system is supplied on some CH750 engines. The purpose of this system is to maintain a desired idle speed regardless of ambient conditions (temperature, parasitic load, etc.) that may change. Engines with this feature contain a small secondary spring connected between the governor lever and the lower adjustment tab of the main bracket. See Figure 18. Refer to the same adjustment procedure covered in **Models with Governed Idle System** for the CH18-740 models on page 15, when adjustments are required.

Electronic Fuel Injection (EFI) System

The EFI system is a complete, electronically-controlled fuel management system, designed to deliver a precisely controlled fuel flow under all operating conditions. The electronic control unit (ECU), the **brain** of the system, automatically adjusts fuel delivery and ignition timing based upon load, speed, operating temperature, and exhaust emission levels. The low idle speed is the only manual adjustment possible.

The ECU continuously monitors operation of the EFI system. If it detects a problem or fault within the system, it will illuminate the malfunction indicator light (MIL), which is mounted in view of the operator. This is a signal that normal, programmed operation has been affected, and service by an authorized Kohler Engine Dealer is required.

NOTE: The EFI system requires a rather complex wiring harness to carry the electrical signals between the sensors and the ECU. **Do not** spray water at the wiring harness or any of the electrical components, especially the ECU, as it could cause malfunction, damage, or failure.

Troubleshooting

If the MIL comes on, or the engine becomes hard to start, runs roughly, or stalls at low idle speed, initial checks should be made in the following areas:

- Make sure the fuel tank is filled with clean, fresh gasoline, and shut-off valve (if so equipped) is opened completely.
- Make sure fuel tank vent cap is not blocked and it is operating properly.
- Make sure the air cleaner element and precleaner are clean and all components are properly secured. Clean or replace as necessary.
- Make sure the proper fuel filter is being used, and it is clean and unobstructed. Replace filter **only** with genuine Kohler parts.
- Make sure all connections to sensors, ECU, and fuel injectors are properly secured.
- Make sure a good 12 volt battery is being used and is fully charged.

If these checks do not correct the problem, or the MIL remains on, further diagnosis and servicing by an authorized Kohler Engine Dealer is necessary.

Adjustment – EFI Throttle Body

Low Idle Speed (RPM) is the only adjustment that can be made. All other fuel calibrations are permanently preset and controlled by the ECU. The standard low idle speed is **1500 RPM*** (+ 75 RPM).

*NOTE: The actual low idle speed depends on the application -- refer to equipment manufacturer's recommendations.

When an EFI engine is started cold, the ECU will be using internal programming for cold running, and the idle speed may vary from the manual setting. Do not attempt to perform any readjustment during this warm-up period.

If adjustment is to be made, the engine must be at operating temperature, air cleaner in place, and check engine light must be off (no fault codes present).

1. Start the engine and run at half throttle for 5 to 10 minutes to warm up.
2. Place the throttle control into the **idle** or **slow** position.
3. Turn the low idle speed adjusting screw in or out and check RPM with a tachometer. See Figure 22.

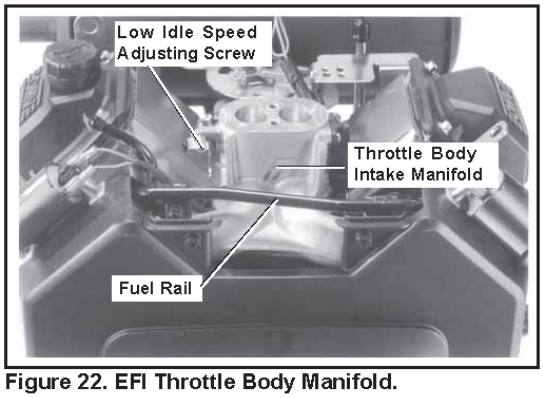


Figure 22. EFI Throttle Body Manifold.

Troubleshooting

When troubles occur, be sure to check the simple causes which, at first, may seem too obvious to be considered. For example, a starting problem could be caused by an empty fuel tank. Some common causes of engine troubles are listed in the following table.

Do not attempt to service or replace major engine components, or any items that require special timing or adjustment procedures. Have your Kohler Engine Service Dealer do this work.

Possible Cause / Problem	No Fuel	Improper Fuel	Dirt In Fuel Line/System	Dirty Grass Screen	Incorrect Oil Level	Engine Overloaded	Dirty Air Cleaner	Faulty Spark Plug
Will Not Start	•	•	•		•	•	•	•
Hard Starting		•	•		•	•	•	•
Stops Suddenly	•		•	•	•	•	•	
Lacks Power		•	•	•	•	•	•	•
Operates Erratically		•	•	•		•	•	•
Knocks or Pings		•		•		•		•
Skips or Misfires		•	•	•			•	•
Backfires			•			•	•	•
Overheats			•	•	•	•	•	
High Fuel Consumption						•	•	•

Storage

If the engine will be out of service for two months or more, use the following storage procedure:

1. Clean the exterior surfaces of the engine. On EFI engines, avoid spraying water at the wiring harness or any of the electrical components.

2. Change the oil and filter while the engine is still warm from operation. See Change Oil and Filter on page 10.

3. The fuel system must be completely emptied, or the gasoline must be treated with a stabilizer to prevent deterioration. If you choose to use a stabilizer, follow the manufacturers recommendations, and add the correct amount for the capacity of the fuel system. Fill the fuel tank with clean, fresh gasoline. Run the engine for 2-3 minutes to get stabilized fuel into the rest of the system. Close fuel shut-off valve when unit is being stored or transported.

   To empty the system, run the engine until the tank and fuel system are empty.

4. Remove the spark plugs. Add one tablespoon of engine oil into each spark plug hole. Install the plugs, but do not connect the plug leads. Crank the engine two or three revolutions.

5. On units with EFI engines, disconnect the negative (-) battery cable or use a battery minder trickle charger while the unit is in storage.

6. Store the engine in a clean, dry place.

Parts Ordering

The engine Specification, Model, and Serial Numbers are required when ordering replacement parts from your Kohler Engine Service Dealer. These numbers are found on the identification plate which is affixed to the engine shrouding. Include letter suffixes if there are any. See Engine Identification Numbers on page 6.

Always insist on genuine Kohler parts. All genuine Kohler parts meet strict standards for fit, reliability, and performance.

Major Repair

Major repair information is available in Kohler Engine Service Manuals. This type of repair generally requires the services of a trained mechanic and the use of special tools and equipment. Kohler Engine Service Dealers have the facilities, training, and genuine Kohler replacement parts necessary to perform this service.

For the nearest Sales & Service location:

- visit our website www.kohlerengines.com
- call 1-800-544-2444 (U.S. & Canada)
- look in the yellow pages under Engines-Gasoline

Specifications

Model:	CH18/CH620	CH20/CH640	CH23/CH680
Bore: mm (in.)	77 (3.03)	77 (3.03)	80 (3.2)
Stroke: mm (in.)	67 (2.64)	67 (2.64)	67 (2.64)
Displacement: cm^3 (in^3)	624 (38.1)	624 (38.1)	674 (41)
Power (@ 3600 RPM): kW (HP)	13.4 (18*)	14.9 (20*)	17.2 (23*)
Compression Ratio:	8.5:1	8.5:1	8.5:1
Weight: kg (lb.)	41 (90)	41 (90)	41 (90)
Oil Capacity (w/filter) - approximate, determined by oil filter and oil cooler used:	1.6-1.8 L (1.7-1.9 U.S. qt.)		
Lubrication:	Full Pressure w/full Flow Filter		

Model:	CH730	CH26/CH735	CH740	CH745	CH750
Bore: mm (in.)	83 (3.27)	83 (3.27)	83 (3.27)	83 (3.27)	83 (3.27)
Stroke: mm (in.)	67 (2.64)	67 (2.64)	67 (2.64)	67 (2.64)	69 (2.72)
Displacement: cm^3 (in^3)	725 (44)	725 (44)	725 (44)	725 (44)	747 (45.6)
Power (@ 3600 RPM): kW (HP)	18.6 (25*)	19.4 (26*)	20.1 (27*)	20.9 (28*)	22.4 (30*)
Compression Ratio:	9:1	9:1	9:1	9:1	9.4:1
Weight: kg (lb.)	43 (94)	43 (94)	43 (94)	43 (94)	47 (105)
Oil Capacity (w/filter) - approximate, determined by oil filter and oil cooler used:	1.6-1.8 L (1.7-1.9 U.S. qt.)				
Lubrication:	Full Pressure w/full Flow Filter				

Exhaust Emission Control System for models CH18/CH620, CH20/CH640, CH23/CH680, CH730, CH740, CH750 is EM.
Exhaust Emission Control System for models CH26/CH735 and CH745 are EM, O2S, ECM, MFI.

*Horsepower ratings exceed Society of Automotive Engineers Small Engine Test Code J1940. Actual engine horsepower is lower and affected by, but not limited to, accessories (air cleaner, exhaust, charging, cooling, fuel pump, etc.), application, engine speed and ambient operating conditions (temperature, humidity, and altitude). Kohler reserves the right to change product specifications, designs and equipment without notice and without incurring obligation.

LIMITED 2 YEAR COMMAND ENGINE WARRANTY

Kohler Co. warrants to the original consumer that each new COMMAND engine sold by Kohler Co. will be free from manufacturing defects in materials or workmanship in normal service for a period of two (2) years from date of purchase, provided it is operated and maintained in accordance with Kohler Co.'s instructions and manuals.

Our obligation under this warranty is expressly limited, at our option, to the replacement or repair at Kohler Co., Kohler, Wisconsin 53044, or at a service facility designated by us of such parts as inspection shall disclose to have been defective.

EXCLUSIONS:
Mufflers on engines used commercially (non-residential) are warranted for one (1) year from date of purchase, except catalytic mufflers, which are warranted for two (2) years.

This warranty does not apply to defects caused by casualty or unreasonable use, including faulty repairs by others and failure to provide reasonable and necessary maintenance.

The following items are not covered by this warranty:

Engine accessories such as fuel tanks, clutches, transmissions, power-drive assemblies, and batteries, unless supplied or installed by Kohler Co. These are subject to the warranties, if any, of their manufacturers.

KOHLER CO. AND/OR THE SELLER SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY KIND, including but not limited to labor costs or transportation charges in connection with the repair or replacement of defective parts.

IMPLIED OR STATUTORY WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY LIMITED TO THE DURATION OF THIS WRITTEN WARRANTY. We make no other express warranty, nor is any one authorized to make any on our behalf.

Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

TO OBTAIN WARRANTY SERVICE:
Purchaser must bring the engine to an authorized Kohler service facility. To locate the nearest facility, visit our website, www.kohlerengines.com, and click on DEALER LOCATOR to use the locator function, consult your Yellow Pages or telephone 1-800-544-2444.

ENGINE DIVISION, KOHLER CO., KOHLER, WISCONSIN 53044

KOHLER CO.
FEDERAL AND CALIFORNIA EMISSION CONTROL SYSTEMS
LIMITED WARRANTY
SMALL OFF-ROAD AND CLASS 1 LSI ENGINES

The U.S. Environmental Protection Agency (EPA), the California Air Resources Board (CARB), and Kohler Co. are pleased to explain the Federal and California Emission Control Systems Warranty on your off-road equipment engine. In California beginning in 2006, "emissions" means both exhaust and evaporative emissions. For California, small off-road engines produced in 2006 and later, and Class 1 LSI (Large Spark Ignited engines at or below 1.0 liter) produced in 2002 and later, must be designed, built and equipped to meet the state's stringent anti-smog standards. In other states, 1997 and later model year engines must be designed, built and equipped, to meet the U.S. EPA regulations for non-road engines. The engine must be free from defects in materials and workmanship, which cause it to fail to conform with U.S. EPA standards for the first two years of engine use from the date of sale to the ultimate purchaser. Kohler Co. must warrant the emission control system on the engine for the period of time listed above, provided there has been no abuse, neglect or improper maintenance.

The emission control system may include parts such as the carburetor or fuel injection system, the ignition system, and catalytic converter. Also included are the hoses, belts and connectors and other emission-related assemblies.

Where a warrantable condition exists, Kohler Co. will repair the engine at no cost, including diagnosis (if the diagnostic work is performed at an authorized dealer), parts and labor.

MANUFACTURER'S WARRANTY COVERAGE
Small off-road engines produced in 2006 or later, and Class 1 LSI engines produced in 2002 and later, are warranted for two years in California. In other states, 1997 and later model year engines are warranted for two years. If any emission related part on the engine is defective, the part will be repaired or replaced by Kohler Co. free of charge.

OWNER'S WARRANTY RESPONSIBILITIES
(a) The engine owner is responsible for the performance of the required maintenance listed in the owner's manual. Kohler Co. recommends that you retain all receipts covering maintenance on the engine, but Kohler Co. cannot deny warranty solely for the lack of receipts or for your failure to assure that all scheduled maintenance was performed.

(b) Be aware, however, that Kohler Co. may deny warranty coverage if the engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Continued on next page.

(c) For warranty repairs, the engine must be presented to a Kohler Co. service center as soon as a problem exists. Call 1-800-544-2444 or access our website at: www.kohlerengines.com, for the names of the nearest service centers. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

If you have any questions regarding warranty rights and responsibilities, you should contact Kohler Co. at 1-920-457-4441 and ask for an Engine Service representative.

COVERAGE

Kohler Co. warrants to the ultimate purchaser and each subsequent purchaser that the engine will be designed, built and equipped, at the time of sale, to meet all applicable regulations. Kohler Co. also warrants to the initial purchaser and each subsequent purchaser, that the engine is free from defects in materials and workmanship which cause the engine to fail to conform with applicable regulations for a period of two years.

Small off-road engines produced in 2006 or later, and Class 1 LSI engines produced in 2002 and later, are warranted for two years in California. For 1997 and later model years, EPA requires manufacturers to warrant engines for two years in all other states. These warranty periods will begin on the date the engine is purchased by the initial purchaser. If any emission related part on the engine is defective, Kohler Co. will replace the part at no cost to the owner. Kohler Co. is liable for damages to other engine components caused by the failure of a warranted part still under warranty.

Kohler Co. shall remedy warranty defects at any authorized Kohler Co. engine dealer or warranty station. Warranty repair work done at an authorized dealer or warranty station shall be free of charge to the owner if such work determines that a warranted part is defective.

Listed below are the parts covered by the Federal and California Emission Control Systems Warranty. Some parts listed below may require scheduled maintenance and are warranted up to the first scheduled replacement point for that part. The warranted parts include the following if they were present in the engine purchased:

- Oxygen sensor (if equipped)
- Intake manifold (if equipped)
- Exhaust manifold (if equipped)
- Catalytic muffler (if equipped)
- Thermal reactor muffler (if equipped)
- Fuel lines, fuel line fittings and clamps (if equipped)
- Spark advance module (if equipped)
- Crankcase breather
- Air Injection System (if equipped)
  - Air pump or pulse valve assembly (if equipped)
  - Control/distribution valve (if equipped)
  - Distribution manifold (if equipped)
  - Air hoses (if equipped)
  - Vacuum lines (if equipped)
- Ignition module(s) with high tension lead
- Gaseous fuel regulator (if equipped)
- Electronic control unit (if equipped)
- Carburetor or fuel injection system
- Fuel metering valve (if equipped)
- Air filter, fuel filter, and spark plugs (only to first scheduled replacement point)
- Evaporative System (if equipped)
  - Canister (if equipped)
  - Canister filter (if equipped)
  - Vapor hose (if equipped)
  - Orifice connector (if equipped)
  - Fuel tank (if equipped)
  - Fuel cap (if equipped)
  - Primer bulb canister (if equipped)

LIMITATIONS

This Emission Control Systems Warranty shall not cover any of the following:

(a) repair or replacement required because of misuse or neglect, improper maintenance, repairs improperly performed or replacements not conforming to Kohler Co. specifications that adversely affect performance and/or durability and alterations or modifications not recommended or approved in writing by Kohler Co.,

(b) replacement of parts and other services and adjustments necessary for required maintenance at and after the first scheduled replacement point,

(c) consequential damages such as loss of time, inconvenience, loss of use of the engine or equipment, etc.,

(d) diagnosis and inspection fees that do not result in eligible warranty service being performed, and

(e) any add-on or modified part, or malfunction of authorized parts due to the use of add-on or modified parts.

MAINTENANCE AND REPAIR REQUIREMENTS

The owner is responsible for the proper use and maintenance of the engine. Kohler Co. recommends that all receipts and records covering the performance of regular maintenance be retained in case questions arise. If the engine is resold during the warranty period, the maintenance records should be transferred to each subsequent owner. Kohler Co. reserves the right to deny warranty coverage if the engine has not been properly maintained; however, Kohler Co. may not deny warranty repairs solely because of the lack of repair maintenance or failure to keep maintenance records.

Normal maintenance, replacement or repair of emission control devices and systems may be performed by any repair establishment or individual; however, **warranty repairs must be performed by a Kohler authorized service center**. Any replacement part or service that is equivalent in performance and durability may be used in non-warranty maintenance or repairs, and shall not reduce the warranty obligations of the engine manufacturer.

KOHLER ENGINES

FOR SALES AND SERVICE INFORMATION
IN U.S. AND CANADA, CALL **1-800-544-2444**

KohlerEngines.com

ENGINE DIVISION, KOHLER CO., KOHLER, WISCONSIN 53044

FORM NO.:	24 590 01-B
ISSUED:	11/04
REVISED:	8/08

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TRONAIR®

APPENDIX V

Continental
PVR6 Flanged Series Pump

SERVICE MANUAL

PVR6-Flanged Series Pump

Installation, Startup, Operating Instructions, Parts Pages, Repair Procedures

"H" Design Series

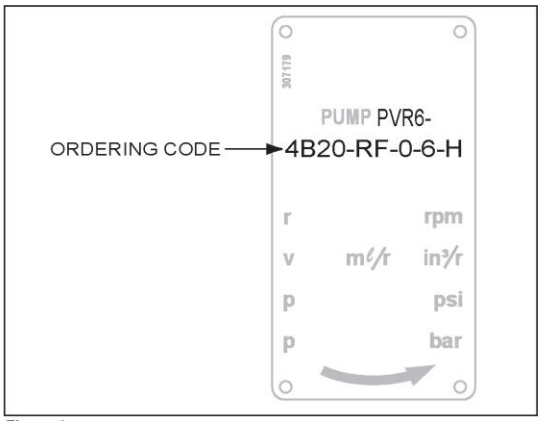
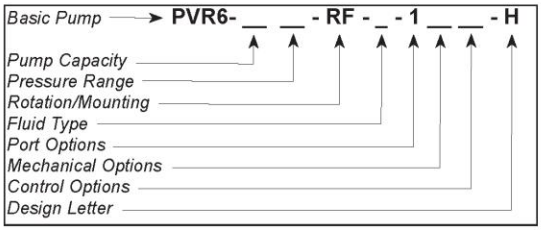


Figure 1

This service manual applies to products with Ordering Codes like the sample shown below.



CAUTION - Before performing any service operation on any pump, be sure that all pressure has been relieved from BOTH SIDES of the system.

CAUTION - Before performing any service operation on any pump, disconnect or lock off power supply.

CAUTION - Before starting pump, be sure that any resulting machine function will not endanger persons or equipment.

PRODUCT IDENTIFICATION

Each pump has an Ordering Code stamped on its nameplate. See Figure 1 above for the location of the Ordering Code.

INSTALLATION

PUMP DRIVE AND MOUNTING

When mounting the pump and motor, care must be taken to align the pump and motor shafts within .003 T.I.R. (0.076 mm) direct inline through a jaw type/ flexible web coupling. This is recommended for all pumps. Tire-type flexing elements and chain-type drives are not recommended. With belt drives, please consult factory.

To avoid axial and radical end loading of the pump shaft, do not couple the pump and motor shafts rigidly. Allow freedom at the coupling for the two shafts to ride independently.

To prevent end loading, the space between the pump and motor shaft ends should be 1/2 inch (12.7 mm) for PVR6 pumps, or as the coupling manufacturer specifies.

PIPING AND RESERVOIR
The pump should be mounted with a minimum number of elbows or fittings. The pump suction should be at least 1 inch (25.4 mm) tube/pipe for PVR6 pumps.

For any system and combination of piping except High Water Based Fluids (HWBF), the vacuum at the pump inlet must not exceed seven inches of Mercury, (5 inch Hg. for fire resistant fluids). HWBF Pumps are to have a positive inlet head in the range of 0.5-inch Hg. to 20 inch Hg.

Piping should be done with pickled pipe or seamless tubing free of dirt and scale. Do not use galvanized or other pipe that tends to flake off.

A 100-mesh screen (60 mesh for fire resistant and HWBF) should be used on the pump suction line. The screen should be located approximately two inches (50.8 mm) from the bottom of the tank. All lines returning oil to the tank should discharge at least two inches (50.8 mm) below the minimum oil level and should be separated from the pump suction area by means of a baffle. These lines should also include a 10-micron return line filter, with the exception of the case drain line.

The pump case drain should be connected directly to the tank. Pressure in excess of 10 psi (0.7 bar) in the case drain line can result in shaft seal leakage. It is recommended that the case drain be returned to the tank by a separate 3/8 inch (9.5 mm) line.

STARTUP PROCEDURES

The following instructions apply for initial startup of the hydraulic pump. After an extended shutdown period, start with item 5.

CAUTION - Never start a new pump installation against a blocked system.

1. Check the nameplate for model number and rpm. The arrow on the pump casting indicates direction of rotation.

2. Pump suction line should extend below the lowest point of oil level but not less than two inches (50.8 mm) above reservoir bottom.

3. The pump and motor shafts must be aligned within .003 inches (0.076 mm). See Pump Drive and Mounting directions above for restrictions.

4. Connect the case drain directly to tank (or to a heat exchanger if the pump will be deadheading for long periods of time during operation), using a full-size line corresponding to the case drain in the pump or manifold. If connected to a heat exchanger, the case drain line should be protected with a 10 psi (0.7 bar) maximum relief valve in parallel with the heat exchanger. No other return lines should be connected in common with the case drain return.

5. Rotate pump and motor by hand to insure free rotation.

6. Set the machine controls to open the circuit and allow free flow from the pump back to tank or connect the pump outlet line directly to tank. Jog the motor on and off several times (on, two seconds, off three seconds) until the pump is primed. Check pump for proper direction of rotation during the jogging.

7. After the pump has been primed, run it for several minutes at lower than normal pressures with an open or intermittently open system which permits oil flow. This will purge entrapped air from the pump and system.

8. Neither volume adjustment nor pressure adjustment should be adjusted until the pump has been primed and running, and air is purged.

9. After air has been purged from the system, the system can be closed and the pump adjusted to the required operating pressure.

10. If necessary, the volume adjustment can be adjusted to the required operating pressure.

11. When replacing pumps, the suction screen in the reservoir must be removed and thoroughly cleaned. Also, the suction line from the reservoir to the pump should be flushed inside and out to remove any contaminants. Pieces of metal from a damaged pump can back up into this line. If they are not removed, they will be drawn into the new pump and destroy it. Start unit by using proper pump start-up procedure items 1 through 10.

CAUTION - If both pressure and volume modifications are supplied on the pump, the pressure should be adjusted before the volume. Volume should be adjusted at minimum pump pressure or at deadhead. Stop adjustment at the volume screw when pressure begins to drop.

OPERATION

PRESSURE AND VOLUME ADJUSTMENTS

Pressure Control

All pumps are adjusted to reduced pressure before shipment and must be readjusted to the required system pressure after installation and start-up.

The pressure adjusting screw is located at the end face of the compensator chamber. See parts page item number 30. The adjusting screw has a right hand thread; clockwise adjustment increases pressure; counterclockwise reduces pressure.

A pressure gauge located at the pump must be used when making adjustment to insure the pressure settings do not exceed limits specified for the particular pump of maximum system pressure.

Make all pressure settings with pump operating against a closed circuit, that is with the output of the pump blocked, and then check pressure throughout the pump flow range.

Volume Control

Adjust volume at minimum pump pressure or at pump deadhead. The volume adjusting screw is directly opposite the pressure adjusting screw, see parts page item number 55. The adjusting screw has a right hand thread, turning the screw clockwise decreases the maximum volume, turning the screw counterclockwise increases the maximum volume. Pumps are set at a maximum rated volume at the factory unless otherwise specified.

Stop adjustment of the volume screw when pressure begins to drop. See Sales Catalog for complete pump performance specifications.

ADJUSTMENT PROCEDURES

To adjust the maximum output volume, use the following steps:

1. Set the pump at minimum pressure.

2. Hand tighten the volume screw until it touches the pressure ring. **NOTE:** The pump should be at full flow for this step.

3. See Pressure and Volume Adjustment Sensitivity chart below.

4. Deadhead the pump, turn the volume screw the proper number of turns to obtain the flow desired.

5. Return pump to flow condition and check flow rate. If output flow is incorrect, switch pump to deadhead and readjust per above.

CAUTION - Turning the maximum volume control in too far can force the pressure ring over center and destroy the pump.

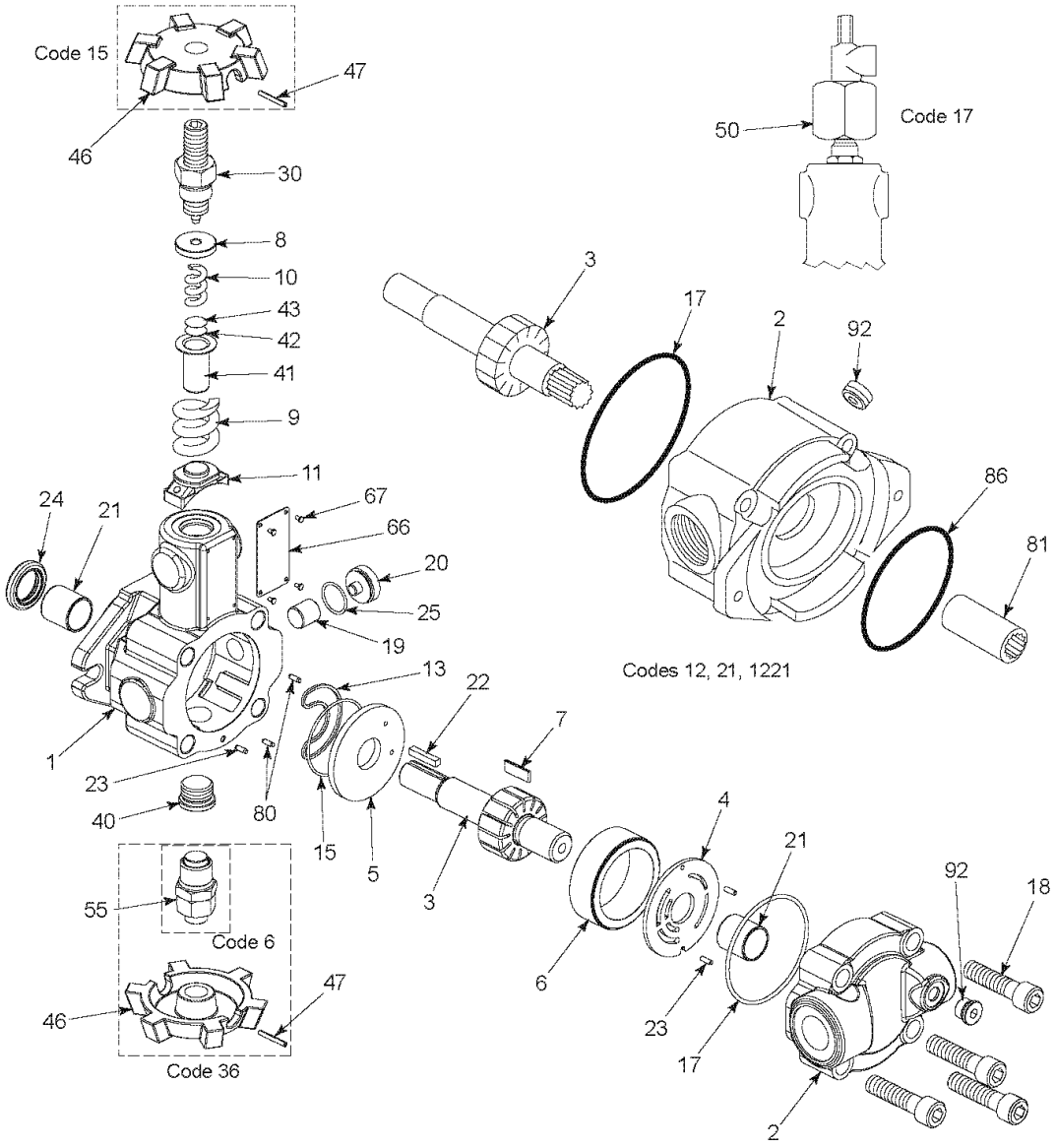
PRESSURE and VOLUME ADJUSTMENT SENSITIVITY

PUMP SIZE			4B	6B		8B	
PRESSURE CODE			20	06	15	06	15
Pressure Adjustment	Pressure Change/Turn	psi (bar)	315 (21.7)	220 (15.2)	315 (21.7)	210 (14.5)	240 (16.6)
	Maximum Torque	ft.-lbs. (m.kg)	8.0 (1.10)	2.7 (0.37)	6.8 (0.94)	2.7 (0.37)	6.8 (0.94)
Volume Adjustment	Flow Change/Turn	gpm (lpm)	3.4 (12.9)	4.6 (17.4)		4.6 (17.4)	
	Approx. Min. Flow Adjust.	gpm (lpm)	1.0 (3.7)	1.0 (3.7)		1.0 (3.7)	
	Maximum Torque	ft.-lbs (m.kg)	5.5 (0.76)	3.5 (0.48)		3.5 (0.48)	

PVR6 PARTS LIST

ITEM NO.	CODE	PART NO.	DESCRIPTION	QTY. REQ.	ITEM NO.	CODE	PART NO.	DESCRIPTION	QTY. REQ.
1		550177	Pump Body	1	13		307257	Teflon Seal Ring	1
1	4B	550660	Pump Body	1	15	Buna-N	124194	O-Ring	1
2		550541	Cover	1	15	Viton	147177	O-Ring	1
2	4B	550658	Cover	1	17	Buna-N	144929	O-Ring	1
2	6B,8B,10B; 12,	550547	Cover	1	17	Viton	144966	O-Ring	1
	1221				18		198297	Soc. Hd. Cap Screw	4
2	4B; 21	550659	Cover	1	18	4B - 21; 6B, 8B,	198301	Soc. Hd. Cap Screw	4
						10B; 21, 1221			
3		407929	Rotorshaft	1	19		252792	Thrust Screw	1
3	4B	407930	Rotorshaft	1	20		250371	Thrust Screw Plug	1
3	4B, 12	506066	Rotorshaft	1	21		163797	Bushing	2
3	6B,8B,10B; 12	506069	Rotorshaft	1	22		126225	Key	1
3	6B,8B,10B;	550325	Rotorshaft	1	23		004223	Roll Pin	3
	1221				24		130795	Lip Seal	1
3	4B; 21	550326	Rotorshaft	1	25	Buna-N	104617	O-Ring	1
3	6B,8B,10B; 21	550327	Rotorshaft	1	25	Viton	166069	O-Ring	1
4	4B,6B	550101	Port Plate Assembly	1	30		309977	Pressure Adj. Screw Ass'y.	1
4	8B	550074	Port Plate Assembly	1	40	Buna-N	250058	SAE O-Ring Plug	1
4	10B	550280	Port Plate Assembly	1	40	Viton	254789	SAE O-Ring plug	1
5		550351	Thrust Plate	1	41		306466	Spring Retainer	1
6	4B	114592	Pressure Ring	1	42		144927	Shim (.005)	1
6	6B	112021	Pressure Ring	1	43		144928	Shim (.0149)	1
6	8B	123175	Pressure Ring	1	46	15, 36	252152	Handwheel	1
6	10B	251715	Pressure Ring	1	47	15, 36	261323	Spring Pin	1
7	4B	250516	Vane Kit (Set of 13)	1	50	17	350952	Dual Pressure Control Ass'y.	1
7	6B,8B,10B	250517	Vane Kit (Set of 13)	1	53	8, 9	256508	Flow Control Valve	1
8		306465	Spring Seat	1	55	6, 36	450196	Volume Adj. Screw Ass'y.	1
8	6B3L,6B5L,	350988	Spring Seat	1	66		307179S	Name Plate	1
	8B3L, 8B5L				67		250597	Self-Tapping Screw	4
8	10B3L,10B5L	166620	Spring Seat	1	80		002586	Dowel Pin	2
9	4B20	165223	Governor Spring	1	81	1221, 21	350663	Spline Coupling	1
9	6B06	149917	Governor Spring	1	85*	1221, 21	147655	Flange Cover (Shipping)	1
9	8B06	251193	Governor Spring	1	86	Viton	112222	O-Ring	1
9	6B15,8B15	165225	Governor Spring	1	86	1221, 21	111298	O-Ring	1
9	6B20,8B20	165226	Governor Spring	1	92		256708	SAE O-Ring Plug	1
9	6B3l,8B3L	257653	Governor Spring	1	93*		166288	Caplug (C-D)	1
9	10B3L	109792	Governor Spring	1	94*		160259	Caplug (In)	1
9	6B5L,8B5L	255809	Governor Spring	1	95*		137020	Caplug (Out)	1
9	10B5L	113079	Governor Spring	1	96*	1221, 21	130437	Caplug (Flange)	2
10	6B06,8B06	165221	Follower Spring	1	97*	12, 21,1221	253841	Spline Warning Tag	1
10	10B10	165220	Follower Spring	1	98*		143391	Grease	A.R.
10	6B15,8B15	165222	Follower Spring	1	99*		132779	LED Plate #250	A.R.
11	4B	144926	Ring Shoe Assembly	1	* Not Shown				
11	6B	144913	Ring Shoe Assembly	1					
11	8B	162770	Ring Shoe Assembly	1					
11	10B	350448	Ring Shoe Assembly	1					
11	6B3L, 6B5L	112022	Ring Shoe Assembly	1					
11	8B3L,8B5L	123174	Ring Shoe Assembly	1					

PVR6 PARTS DRAWING



PVR6 KIT LIST

WEAR PLATE KITS		SEAL KITS		ROTATING KITS		COMPLETE REBUILD KITS	
Includes Items: 4 & 5		Includes Items: 13,15,16,17,24,28,30,99		Includes Items: 3, 6 & 21		Includes Items: All Kits Listed Here Plus Item 11.	
Model	**Kit Number**	**Model**	**Kit Number**	**Model**	**Kit Number**	**Model**	**Kit Number**
4B	257094	All Buna-N, HW	257093	4B	250758	4B	257095
6B	250747	All Viton	250457	4B-21	250815	4B-12	257096
8B06/15	250748			6B	250760	6B	250822
10B10	254911	**VANE KITS**		6B-12	254763	6B-12	250826
		Includes Items 7		6B-21	250817	8B15	250823
		Model	**Kit Number**	8B	250759	8B15-12	250827
		4B	250516	8B-12	250762	10B	254917
		6B, 8B, 10B	250517	8B-21	250816	10B-12	254918
				10B	254912	10B-21	254919

PVR6 PUMP REPAIR PROCEDURES

DISASSEMBLY PROCEDURE

NOTE: Disassembling pump to change components, or for any other reason, may void the warranty. Refer to Policy Statement and Discounts Summaries.

1. Remove the key (22) in the rotor shaft keyway.

2. A small amount of oil may remain in the pump. Remove the four cover bolts and slide the cover back far enough on the shaft to break the seal between the housing and cover to allow the pump to drain.

3. Remove the cover (2). Take care to avoid damage to the bearing with the end of the shaft when the cover is removed.

4. The port plate (4) may come out with the cover. Do not let it drop off the locating pins.

5. Remove the vanes (7) with a long nosed pliers or tweezers. There is one vane in each slot, 13 vanes total.

6. Remove the rotorshaft (3) from the pump. Be sure that the key (22) has been removed from the keyway so that it will not damage the shaft seals when the rotorshaft is removed.

7. Turn the pressure adjustment screw (30) counterclockwise to release the tension on the governor spring.

8. Remove the pressure ring (6), ring shoe (11), governor spring (9), retainer (41) and follower spring (10).

9. If the shaft seal (24) are to be removed they should be pushed out from the inside of the housing at this time. Care must be taken not to damage the journal bearing in the housing while the shaft seal is being removed. It is recommended that the shaft seal be replaced whenever the pump is disassembled for maintenance. The seal cannot be reused once they have been removed.

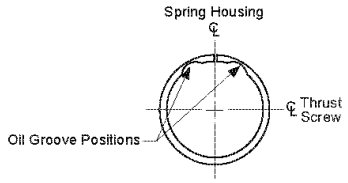
10. The bushings (21) in the pumps are assembled with a press fit. If they are to be removed at this time, the bushing in the housing should be pressed out from the front. The cover bearing should be pulled out using an expanding type puller. The bushings should not be reused once they have been removed.

11. It is unlikely that further disassembly will be necessary in order to perform routine maintenance on the pump.

REASSEMBLY PROCEDURE

1. Clean and inspect parts to determine which parts are worn enough to require replacement.

2. Assemble the new bushings (21) in the housing and cover. The bushing OD's should be lubricated before they are pressed in the bores. Care must be taken to orient the "split" and the "oil groove" in the bushing as shown in the illustration below.



Item #21
Bushing Orientation

3. After the bearings are in place, check to see that the rotor shaft will fit into the bearings and provide a smooth turning fit. If the shaft turns hard, the bearings should be removed and the bore checked closely for nicks or burrs before pressing in the new bearings.

4. Check all of the replacement parts for nicks or burrs and then lubricate them with clean oil before reassembly.

5. Worn port and thrust plates should not be reground to clean up the wear surface. If the plates are ground, the assembly clearance will become excessive and the seal rings in the thrust plate may rupture. Replace worn port and thrust plates if necessary.

6. Assemble the springs (9, 10) and ring shoe (11), pressure ring (6) and rotorshaft (3).

7. To assure proper vane assembly, place the vanes (7) with the beveled edge out against the pressure ring.

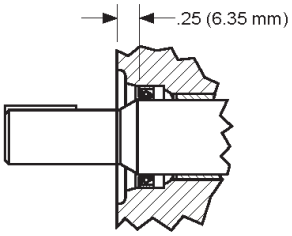
8. Assemble the square seal rings into the cavity in the back of the thrust plate. The soft rubber seal ring (15) should be assembled first and the hard seat ring (13) should be assembled on top of them. Stretch the larger soft seal ring slightly so it clings to the ID at the cavity. Apply clean oil or STP to the back of the thrust plate before it is placed in the locating pins in the body to help hold the parts together while they are assembled.

9. Before fitting the cover into the housing, check to assure that the bore in the port plate is concentric to the bearing bore in the cover. If the bores are not concentric, the port place must be relocated 180° on the locating pins.

10. Assemble the cover (2) and port plate (4) onto the housing and align the bolt holes. Rotate the shaft (3) as the bolts are tightened to assure that the vanes are not cocked.

11. Torque the cover bolts (18) to 50 lbs-ft (67.8 Nm). The shaft should turn by hand when assembly is complete.

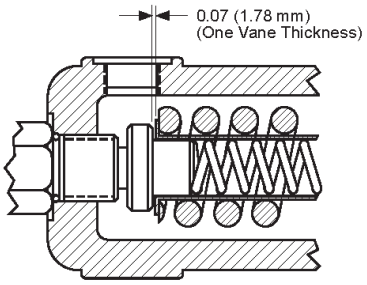
12. Lubricate the ID of the shaft seal (24) and press it into the housing to the depth shown below. Note the "lip to the inside" orientation of the seal.



13. Adjust the pressure adjustment screw (30) until it just touches the spring and then give it one more turn clockwise.

14. Turn pump upside down. Pour one cup of good grade hydraulic fluid into the intake port while slowly rotating the shaft in the direction shown by the rotation arrow.

15. The pump is now ready to test. Refer to front of this manual for start-up procedure.



Continental Hydraulics
5505 West 123rd Street
Savage, MN 55378
Phone: (952) 895-6400 Fax: (952) 895-6444
www.continentalhydraulics.com

Because Continental Hydraulics is continually improving its' products, specifications and appearance are subject to change without notice.

Form No. 265664 Rev. 11/08 Printed in U.S.A

APPENDIX VI

Safety Data Sheet
(SDS)

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)

APPENDIX VII

Safety Data Sheet
(SDS)
Battery

JOHNSON CONTROLS

MATERIAL SAFETY DATA SHEET

MSDS No.
L 8
Date Issued
Nov. 15, 1985
Date Revised
Jan 19, 2005

Chemical/Trade Name (identity used on label)	Chemical Family/Classification	HMIS Rating for Sulfuric Acid
Lead Acid Battery	**Electric Storage Battery**	**3 0 2 X X= Acid**

Synonyms/Common Name	DOT, IATA and IMO Description
SLI Battery	**Battery, Wet, Filled with Acid, UN 2794, Class 8**

Company Name	Address
Johnson Controls Battery Group Inc.	**P.O. Box 591**
Division or Department	**Milwaukee, WI 53201**
Automotive Systems Group	

CONTACT	TELEPHONE NUMBER
Questions Concerning MSDS **Industrial Hygiene, Safety & Security - Automotive Systems, Battery**	**Day:** **SLI: (800) 333-2222 ext. 3138**
Transportation Emergencies **CHEMTREC**	**24 Hours: (800) 424-9300**

II. Hazardous Ingredients

Material	% by Wt.	CAS Number	Eight Hour Exposure Limits		
			OSHA PEL	ACGIH TLV	Other
Specific Chemical Identity: **Lead** Common Name: **Grid**	34	7439-92-1	50 µg/m³	150 µg/m³	NIOSH REL 100 µg/m³
Specific Chemical Identity: **Lead Dioxide** Common Name: **Lead Oxide**	31	1309-60-0	50 µg/m³	150 µg/m³	NIOSH REL 100 µg/m³
Specific Chemical Identity: **Lead Sulfate** Common Name: **Anglesite**	<1	7446-14-2	50 µg/m³	150 µg/m³	NIOSH REL 100 µg/m³
Specific Chemical Identity: **Sulfuric Acid (35%)** Common Name: **Battery Electrolyte (Acid)**	34	7664-93-9	1mg/m³	1 mg/m³ STEL 0.2 mg/m³ (respirable thoracic fraction)	NIOSH REL 1 mg/m³

NOTE: The contents of this product are toxic chemicals that are subject to the reporting requirements of section 302 and 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (40CFR 355 and 372).

III. Physical Data

Material is (at normal temperatures)	Boiling Point (at 760 mm Hg)	Melting Point	Appearance and Odor
☑Solid ☑Liquid	**Lead 1755°C Batt. Electrolyte (Acid) 110-112°C**	**Lead 327.4°C**	**Battery Electrolyte (acid) is a clear to cloudy liquid with slight acidic odor. Acid saturated lead oxide is a dark reddish-brown to gray solid with slight acidic odor.**

Specific Gravity (H_2O =1)	Vapor Pressure ☑(mm Hg at 20°C) ☐(PSIG)
Battery Electrolyte (Acid) 1.210 - 1.300	**Battery Electrolyte (Acid) 11.7**
Vapor Density (Air =1) **Battery Electrolyte (Acid) 3.4**	Solubility is H_2O **Lead and Lead Dioxide are not soluble.** **Battery Electrolyte (acid) is 100% soluble in water.**
% Volatile By Weight **Not Determined**	Evaporation rate (Butyl Acetate = 1) **Not Determined**

IV. Health Hazard Information

NOTE: Under normal conditions of battery use, internal components will not present a health hazard. The following information is provided for battery electrolyte (acid) and lead for exposure that may occur during battery production or container breakage or under extreme heat conditions such as fire

ROUTES AND METHODS OF ENTRY

Inhalation

Acid mist generated during battery formation may cause respiratory irritation. Spillage of acid from batteries in confined areas may also lead to exposure to sulfuric acid mist.

Skin Contact

Battery electrolyte (acid) can cause severe irritation, burns and ulceration.

Skin Absorption

Skin absorption is not a significant route of entry.

Eye Contact

Battery electrolyte (acid) can cause severe irritation, burns, and cornea damage upon contact.

Ingestion

Hands contaminated by contact with internal components of a battery can cause ingestion of lead/lead compounds. Hands should be washed prior to eating, drinking, or smoking.

SIGNS AND SYMPTOMS OF OVEREXPOSURE

Acute Effects

Acute effects of overexposure to lead compounds are GI (gastrointestinal) upset, loss of appetite, diarrhea, constipation with cramping, difficulty in sleeping, and fatigue. Exposure and/or contact with battery electrolyte (acid) may lead to acute irritation of the skin, corneal damage of the eyes, and irritation of the mucous membranes of the eyes and upper respiratory system, including lungs.

Chronic Effects

Lead and its compounds may cause chronic anemia, damage to the kidneys and nervous system. Lead may also cause reproductive system damage and can affect developing fetuses in pregnant women. Battery electrolyte (acid) may lead to scarring of the cornea, chronic bronchitis, as well as erosion of tooth enamel in mouth breathers in repeated exposures.

POTENTIAL TO CAUSE CANCER

The National Toxicological Program (NTP) and The International Agency for Research on Cancer (IARC) have classified "strong inorganic acid mist containing sulfuric acid" as a Category 1 carcinogen, a substance that is carcinogenic to humans. The ACGIH has classified "strong inorganic acid mist containing sulfuric acid" as an A2 carcinogen (suspected human carcinogen). These classifications do not apply to liquid forms of sulfuric acid or sulfuric acid solutions contained within a battery. Inorganic acid mist (sulfuric acid mist) is not generated under normal use of this product. Misuse of the product, such as overcharging, may result in the generation of sulfuric acid mist.

The NTP and the IARC have classified lead as an A3 carcinogen (animal carcinogen). While the agent is carcinogenic in experimental animals at relatively high doses, the agent is unlikely to cause cancer in humans except under uncommonly high levels of exposure. For further information, see the ACGIH's pamphlet, *1996 Threshold Limit Values and Biological Exposure Indices.*

EMERGENCY AND FIRST AID PROCEDURES

Inhalation

Remove from exposure and consult a physician if any of the acute effects listed above develop.

Skin

Wash thoroughly with soap and water. If acid is splashed on clothing, remove and discard. If acid is splashed in shoes, remove them immediately and discard. Acid cannot be removed from leather.

Eyes

Immediately rinse with cool running water for at least 15 minutes. Seek medical attention immediately after rinsing.

Ingestion

Lead/Lead compounds: Consult a physician.
Battery Electrolyte (Acid): Do not induce vomiting. Refer to a physician immediately.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Inorganic lead and its compounds can aggravate chronic forms of kidney, liver, and neurological diseases. Contact of battery electrolyte (acid) with the skin may aggravate skin diseases such as eczema and contact dermatitis.

V. Fire and Explosion Data

Flash Point (test method)	Autoignition Temperature	Flammable Limits in Air, % by Vol.
Hydrogen - 259°C	Hydrogen 580°C	Hydrogen LEL - 4.1 UEL - 74.2

Extinguishing Media
Dry chemical, foam, or CO_2

Special Fire Fighting Procedures
Use positive pressure, self-contained breathing apparatus.

Unusual Fire and Explosion Hazard
Hydrogen and oxygen gases are produced in the cells during normal battery operations, hydrogen is flammable and oxygen supports combustion. These gases enter the air through the vent caps. To avoid the chance of a fire or explosion, keep sparks and other sources of ignition away from the battery.

VI. Reactivity Data

Stability	Conditions to Avoid
☐ Unstable ☑ Stable	Sparks and other sources of ignition may ignite hydrogen gas.

Incompatibility (materials to avoid)
Lead/lead compounds: Potassium, carbides, sulfides, peroxides, phosphorus, sulfur.
Battery electrolyte (acid): Combustible materials, strong reducing agents, most metals, carbides, organic materials, chlorates, nitrates, picrates, and fulminates.

Hazardous Decomposition Products
Lead/Lead compounds: Oxides of lead and sulfur
Battery electrolyte (acid): Hydrogen, sulfur dioxide, sulfur trioxide

Hazardous Polymerization	Conditions to Avoid
☐ May Occur ☑ Will Not Occur	High temperature. Battery electrolyte (acid) will react with water to produce heat. Can react with oxidizing or reducing agents.

VII. Control Measures

Engineering Controls
Store lead acid batteries with adequate ventilation. Room ventilation is required for batteries utilized for standby power generation. Never recharge batteries in an unventilated, enclosed space.

Work Practices
Make certain vent caps are on tightly. Place a minimum of two layers of corrugated cardboard between layers of batteries. When stacking in trailer, stack no more than three layers high. Use a battery carrier to lift a battery or place hands at opposite corners to avoid spilling acid through the vents. Avoid contact with internal components of the batteries.

PERSONAL PROTECTIVE EQUIPMENT

Respiratory Protection
None required under normal handling conditions. During battery formation (high-rate charge condition), acid mist can be generated, which may cause respiratory irritation. If irritation occurs, wear a respirator suitable for protection against acid mist.

Eyes and Face
Chemical splash goggles are preferred. Also acceptable are "Visor-Gogs" or a chemical face shield worn over safety glasses with solid side shields.

Hands, Arms, and Body
Vinyl-coated, PVC, gauntlet-type gloves with rough finish.

Other Special Clothing and Equipment
Safety shoes worn with rubber or neoprene boots or steel-toed rubber or neoprene boots worn over socks. Place pants legs over boots to keep acid out of boots. All footwear must meet requirements of ANSI Z41.1-1991.

VIII. Safe Handling Precautions

Hygiene Practices

Wash hands thoroughly before eating, drinking, or smoking after handling batteries.

Protective Measures to be Taken During Non-Routine Tasks, Including Equipment Maintenance

Wear recommended eye protection. If clothing becomes saturated with acid, remove and wash affected area with water for 15 minutes. Discard saturated clothing.

SPILL OR LEAK PROCEDURES

Protective Measures to be Taken if Material is Released or Spilled

Remove combustible materials and all sources of ignition. Contain spill by diking with soda ash (sodium carbonate) or quicklime (calcium oxide). Cover spill with either chemical. Mix well. Make certain the mixture is neutral, then collect residue and place in a drum or other suitable container. Dispose of as a hazardous waste.

Wear acid-resistant boots, chemical face shield, chemical splash goggles, and acid-resistant gloves.

DO NOT RELEASE UNNEUTRALIZED ACID!

Waste Disposal Method

Battery Electrolyte (Acid): Neutralize as above for a spill, collect residue, and place in a drum or suitable container. Dispose of as a hazardous waste.

DO NOT FLUSH LEAD-CONTAMINATED ACID INTO SEWER.

Batteries: Send to lead smelter for reclamation following applicable Federal, state, and local regulations.

OTHER HANDLING AND STORAGE PRECAUTIONS

An eyewash fountain and safety shower should be located in or near the production or storage area(s) for lead/lead acid batteries. Such storage areas should be equipped with a containment facility which captures acid spills so that they may be neutralized, collected, and disposed of properly.

IX. Other Regulatory Information

TSCA Registry: Ingredients listed in the TSCA Registry are lead, lead oxide, lead sulfate and sulfuric acid.

Proposition 65 Warning: Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Batteries also contain other chemicals known to the State of California to cause cancer. Wash hands after handling.

TRONAIR®

APPENDIX VIII

Instrument Certification Notice

Instrument Certification Notice

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

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

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

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

APPENDIX IX

Declaration of Conformity

EU Declaration of Conformity

Model Number(s) 50111ZZG
Product Type/Name: Gasoline Engine Driven Hydraulic Power Unit

Declaration: Tronair has assessed the equipment described above against the Essential Health and Safety Requirements of one or more Directives. Based on this assessment, the equipment described above is deemed to comply with the directive(s) listed below.

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Directives**:** prEN 1915-1:1995
prEN 982:1996
prEN 60204-1:1997

Standards: HFPA/JIC T2.24.1-1990
ISO 4021:1997
ARP 1247B
NFPA 70/NEC 1999

Markings: CE

The technical documentation for the machinery is available from:

RAUH Hydraulic GmbH
Hallstadtler Straße 63
Email: tronair@rauh-hydraulik.de

Location of Issue: Tronair, 1 Air Cargo Parkway East, Swanton, OH 43558

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

Patrick Finch
Quality Assurance Representative