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Revision History

<table>
<thead>
<tr>
<th>Rev</th>
<th>Date</th>
<th>Reason</th>
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<tbody>
<tr>
<td>B</td>
<td>01/23/15</td>
<td>Revised format</td>
</tr>
<tr>
<td>C</td>
<td>3/19/15</td>
<td>Added Hi/Low option</td>
</tr>
<tr>
<td>D</td>
<td>06/29/18</td>
<td>Added Appendix G and H</td>
</tr>
<tr>
<td>E</td>
<td></td>
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Description of Change

<table>
<thead>
<tr>
<th>Rev</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>B</td>
<td>Combined Hydraulic and Engine Troubleshooting, incorporated Safety Issues into other sections, removed appendix “Metaris Pump’, added Appendix F, removed reference to using lift eyes for lifting entire unit, and added Spare Parts List.</td>
</tr>
<tr>
<td>C</td>
<td>Added 1) Hi/Low option, 2) Sentinel system, 3) emergency shut off valve (Figure 6), 4) manifold (Figure 5 &amp; Table 3), 5) hose kit (Figure 17, 18, &amp; 19, Table 19), 6) Depressurization Air System section, and 7) Figures 11 &amp;12. Renumbered Tables and Figures. Changed 8) number of Table 8 &amp; 12 9) term ‘hydraulic oil’ to hydraulic fluid, 10) cooler p/n from 060015, and 11) BOM Item 1 from TFB914-KIT. Revised Troubleshooting section and Spare Parts List (Table 20). The turbo unit is no longer offered. Updated unit pictures.</td>
</tr>
<tr>
<td>D</td>
<td>Added Figure 12 and Appendix G &amp; H. Updated Table 3, Table 8, and Figure 5 and 10. Removed notes re: turbo including Table 18.</td>
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</tbody>
</table>
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DEUTZ ENGINE INSTALLATION, OPERATION, MAINTENANCE INSTRUCTION
.................................................................................................................................APPENDIX A
Texas International Oilfield Tools (TIOT) offers two (2) styles of Power Units which operate many types of hydraulic equipment. Each unit is mounted on a skid for easy transport and has the following attributes:

<table>
<thead>
<tr>
<th>Item</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skid</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ASTM A36 steel construction</td>
</tr>
<tr>
<td></td>
<td>Lift eyes on top to lift basket only</td>
</tr>
<tr>
<td></td>
<td>Fully welded belly pan</td>
</tr>
<tr>
<td></td>
<td>Removable drain plug</td>
</tr>
<tr>
<td></td>
<td>Full length forklift tubes</td>
</tr>
<tr>
<td></td>
<td>Removable top/basket</td>
</tr>
<tr>
<td><strong>Return Filter on tank</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sight gauge</td>
</tr>
<tr>
<td></td>
<td>Dirty element</td>
</tr>
<tr>
<td></td>
<td>No element</td>
</tr>
<tr>
<td></td>
<td>Operation OK</td>
</tr>
<tr>
<td></td>
<td>Full flow return line</td>
</tr>
</tbody>
</table>

Table 1

Large forces are involved in using this device. Operate this equipment with extreme caution.
The Hi/Low (HL) has a naturally aspirated diesel engine and a dual stage (either 40/40 or 40/20) pump, allowing the power unit to operate at a lower flow (gallon per minute) for tubing and a higher for casing. The single stage pump is also offered. All units are available with an air or electric start.

**CONVENTIONS**

<table>
<thead>
<tr>
<th>IMPORTANT SYMBOL IDENTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>![WARNING]</td>
</tr>
<tr>
<td>![CAUTION]</td>
</tr>
<tr>
<td>![NOTE]</td>
</tr>
</tbody>
</table>

Table 4
SAFETY

Texas International’s equipment is used and installed in controlled rig environments involving hazardous operations and situations.

All personnel performing installation, operations, repair or maintenance on this Power Unit must have knowledge of rig procedure. All crew in the vicinity of operations should be trained on rig safety and tool operation.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size (inches)</th>
<th>Dry weight (lbs)</th>
<th>Full weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L W H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Unit*</td>
<td>96 52 63</td>
<td>3897</td>
<td>5009</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>Item</th>
<th>Power (hp)</th>
<th>Speed (rpm)</th>
<th>Torque (ft/lbs)</th>
<th>Oil/filter change (hrs)</th>
<th>Fuel consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deutz Air Cooled Diesel Engine*</td>
<td>119</td>
<td>2500</td>
<td>255</td>
<td>500**</td>
<td>6 gph***</td>
</tr>
<tr>
<td></td>
<td>85</td>
<td>1500</td>
<td>295</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Air or Electric Start
** under severe condition - do every 250 hours
*** approximate at maximum output

Table 6

<table>
<thead>
<tr>
<th>Item</th>
<th>Group type</th>
<th>Volt</th>
<th>Size L W H</th>
<th>Cold cranking amps @ 0F</th>
<th>Cold cranking amps @ 32F</th>
<th>Reserve capacity minutes @ 25 amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery*</td>
<td>24</td>
<td>12</td>
<td>10-3/4&quot; 6-3/4&quot; 9&quot;</td>
<td>675</td>
<td>850</td>
<td>115</td>
</tr>
</tbody>
</table>

* Electric Start only

Table 7
### Pump Specifications

<table>
<thead>
<tr>
<th>Stage</th>
<th>Gear</th>
<th>Displacement (cu in/rev)</th>
<th>Mount</th>
<th>Speed (rpm)</th>
<th>Flow rate (GPM)</th>
<th>Pressure (psi)</th>
<th>Max operating pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>Heavy Duty</td>
<td>6.35</td>
<td>SAE B</td>
<td>2200</td>
<td>60</td>
<td>1000</td>
<td>2500 psi at 1800 rpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1800</td>
<td>27</td>
<td>2500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1500</td>
<td>65</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1800</td>
<td>27</td>
<td>2500</td>
<td></td>
</tr>
<tr>
<td>Dual*</td>
<td></td>
<td>10.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* for Hi/Low units

### Tanks Features

<table>
<thead>
<tr>
<th>Type</th>
<th>Features</th>
<th>Volume (gal)</th>
<th>Working (gal)</th>
<th>Recommended operating temp (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic</td>
<td>Sight and temperature gauges</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filtered breather</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Top access hatch</td>
<td>135</td>
<td>118</td>
<td>100 - 130</td>
</tr>
<tr>
<td></td>
<td>Fully welded steel construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>Top access filler</td>
<td>35</td>
<td>33</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Fully welded steel construction</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Oil Cooler Features

<table>
<thead>
<tr>
<th>Item</th>
<th>Features</th>
<th>Max operating pressure</th>
<th>Min. pressure</th>
<th>Oil flow required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Cooler</td>
<td>Oil/air type</td>
<td>2000 psi</td>
<td>675 psi</td>
<td>3.3 GPM</td>
</tr>
<tr>
<td></td>
<td>Brazed bar &amp; plate construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oversized for hot climates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjustable fan speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low press drop (&lt;18 psi) at max flow</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Relief Valve

<table>
<thead>
<tr>
<th>Item</th>
<th>Factory set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief valve - adjustable</td>
<td>2500 psi</td>
</tr>
</tbody>
</table>
Specifications continued

Do not exceed the system’s rated pressure or over tighten fittings

INSTALLATION

1) Find the best location for the unit – away from hazardous vapors
2) place the unit, connect power, and make hydraulic connections
3) test the unit for proper operation

The diesel hydraulic power unit requires a location where adequate air flow and exhaust removal are available.

Ensure that ventilation can carry away the exhaust fumes – diesel exhaust can be lethal

It’s important to consider hydraulic line losses from size, length and pressure in choosing where to place the unit. The sizes of the hydraulic lines should be large enough to limit friction losses to 300 psi or less. This may mean using hoses larger than the connections on the unit. For connection instructions, see Hydraulic section page 11.

Proper hose connection is required to fully open the check valves in the hose couplings

Ideally, the unit will be located in a non-hazardous location, with excellent ventilation, as close as possible to the equipment to be powered.
Installation continued

Location:
- Requires at least three (3) feet between the oil cooler fan and any wall or obstruction. In the best conditions, the fan will be facing open air
- Ensure power cables are placed where they won’t be cut, nicked, or squeezed
- Allow distance around the accessory drive on the front of the engine so personnel can pass easily

⚠️ The engine develops almost 300 foot-pounds of torque and at 1800 rpm; foreign objects (i.e. loose clothing, long hair, etc.) can be drawn in - with disastrous results

Transport the power unit using only the forklift tubes provided shown in Figure 2.

![Figure 2]

⚠️ Use top lift eyes, shown in Figure 2, to remove the top basket from the frame/skid – NOT designed to lift the entire skid

If the unit is full of hydraulic fluid the center of mass is approximately in the center of the forklift tubes. If the unit is empty, the center of mass is still between the forklift tubes but biased to the engine end.
Positioning forklift forks in other positions can damage the unit and can be dangerous to personnel.

Ensure the unit does not shift or move from its intended location.

**HYDRAULIC**

The power unit during operation heats the hydraulic fluid. If the reservoir temperature exceeds 150 degrees Fahrenheit (°F), shut down the unit and let it cool. If this happens regularly, have unit repaired.

Be careful not to expose skin to hot hydraulic fluid – it can scald.

<table>
<thead>
<tr>
<th>Water temperature</th>
<th>Time for a third degree burn to occur</th>
</tr>
</thead>
<tbody>
<tr>
<td>155°F 68°C</td>
<td>1 second</td>
</tr>
<tr>
<td>148°F 64°C</td>
<td>2 seconds</td>
</tr>
<tr>
<td>140°F 60°C</td>
<td>5 seconds</td>
</tr>
<tr>
<td>133°F 56°C</td>
<td>15 seconds</td>
</tr>
<tr>
<td>127°F 52°C</td>
<td>1 minute</td>
</tr>
<tr>
<td>124°F 51°C</td>
<td>3 minutes</td>
</tr>
<tr>
<td>120°F 48°C</td>
<td>5 minutes</td>
</tr>
<tr>
<td>100°F 37°C</td>
<td>safe temperature for bathing</td>
</tr>
</tbody>
</table>

*American Burn Association SCALD INJURY PREVENTION, Educator’s Guide

The hydraulic fluid may be under pressures as high as 2500 psi. Fluid can be sprayed some distance, creating a slip hazard. If a leak occurs, shut down the power unit immediately and repair. Hydraulic fluid can irritate the skin – for skin contact, wash and rinse the affected area. If fluid comes in eye contact, use an emergency eyewash or flush with saline solution. If not available, flush with distilled or lastly, tap water. Seek medical attention after flushing.
Avoid the hydraulic fluid spray— it can be injected through the skin at high pressures.

The power unit is equipped with Snaptite 78 series quick disconnect couplings (or equivalent), one (1) inch for the supply line and one and a quarter (1-1/4) inch for the return line. These couplings contain check valves to prevent the loss of hydraulic fluid during connection and disconnection.

Proper connection is required to fully open the check valves in the couplings.

Connect the hoses as follows:

1. Wipe the connections clean as needed to remove dirt and dust.

2. Connect the one (1) inch pressure hose to the one (1) inch coupling on the unit by engaging the mating coupling halves and forcing the connectors together while rotating the threaded sleeve on the hose connector.

3. Using the same method as above, connect the one and a quarter (1-1/4) inch return hose.

Put the selector switch in Start position to connect hoses.

If either the pressure or return fittings are not fully tightened, the check valve will cause a restriction in the flow. This can result in overheating the fluid, poor tool operation and damage to equipment.

Hoses, connections and fittings should be chosen carefully so as not to cause excessive restriction. Restriction in a hydraulic system equals pressure drop and pressure drop equals heat. Improper connection or restrictive circuits can cause a serious loss of power and will generate heat uselessly. Choose short, large inside diameter hoses whenever possible over long, skinny ones.

High temperatures decrease the useful life of the hydraulic fluid, the hoses and the seals in the equipment being powered.

Low hydraulic fluid level can cause overheating, or in worst cases severe damage to the pump and even the associated tools it’s driving. Keep fluid up to at least the
minimum on the sight gauge. Observe the return filtration monitor to be sure it’s operating in the green (OK) range. Change the filter if it’s not.

### Recommended Fluids

<table>
<thead>
<tr>
<th>Fluid</th>
<th>ISO viscosity grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobil DTE 24</td>
<td></td>
</tr>
<tr>
<td>Castrol Hyspin VG 32</td>
<td></td>
</tr>
<tr>
<td>Royal Purple Syndraulic 32</td>
<td></td>
</tr>
<tr>
<td>Shell Tellus 32</td>
<td></td>
</tr>
<tr>
<td>PetroCanada Environ AW 32</td>
<td></td>
</tr>
</tbody>
</table>

* for warmer climates

Table 14

---

**Figure 4 – Standard unit**

**Table 15 – Standard unit**

<table>
<thead>
<tr>
<th>Color Line</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Pressure</td>
</tr>
<tr>
<td>Aqua (blue)</td>
<td>Return</td>
</tr>
<tr>
<td>Green</td>
<td>Suction</td>
</tr>
</tbody>
</table>
OPERATION

On all units, the pump draws hydraulic fluid from the tank and delivers hydraulic fluid up to 2500 psi on the pressure line, adjustable at the relief valve (preset at 2500 psi). See the Adjustment section on page 18 for how to change the relief valve setting. The 2500 psi setting is the maximum recommended output pressure. Theoretically the unit could produce more at full engine rated output, but pump life will be shortened, possibly dramatically.

On the standard power unit, a diesel engine drives the single stage pump at a setting of 1800 rpm. The pump delivers 27 GPM at 1800 rpm and 60 GPM at the engine's maximum speed of 2200 rpm.

The Hi/Low power unit has a dual stage pump, which delivers 65 GPM at 1500 rpm and 27 GPM at 1800 rpm.

The unit is slightly overpowered for long service life. Exceeding the factory set pressures is not recommended.

Review the Deutz engine manual, Appendix A, for detailed instructions on startup, shut down and operation. The engine is controlled by the hydro-throttle, which opens the throttle as the load increases. The engine is protected from low oil pressure and high oil temperature by a Sentinel system. If the engine’s oil temperature goes above 225°F or has an oil pressure of 0.50 psi or less, the Sentinel stops the fuel flow. An emergency shut off valve is shown in Figure 6. Press stop button on the valve to stop the engine in an emergency. On newer engines, the stop button is added to LOFA control panel as shown in Figure 10. A remote stop switch is available for the electric start engine only.
Open the valve by rotating the reset lever clockwise as far as possible before restarting the engine

1) Connect the battery (Figure 7) or air supply if disconnected (Figure 8).

2) Turn the key to the ON position and then the START position on the main enclosure or push the ‘Engine Start’ button for air start units.

3) To turn the unit off, turn the key to OFF (electric) or pull the throttle rod (air) to release the spring.
Operation continued

If the power unit shuts down prematurely, check fuel tank for diesel. If the Sentinel system caused the shutdown, allow the engine to cool and check the oil level – add as needed. If this happens repeatedly, there is an abnormal condition which must be found and fixed before continuing operation.

The standard unit’s ‘Start’ position registers pressure (and generates heat in the hydraulic fluid) and the ‘Run’ position sends fluid out to the equipment.

The ‘Start’ position on the Hi/Low unit will allow the engine to warm and dump the fluid back into the tank. It also permits the system to operate at a lower flow for running tubing and a higher flow for casing. See lever example in Figure 11.

Hydraulic fluid cooling is provided on the return line with an oversized air to oil cooler (item 21 on Figure 17). The cooler is capable of removing nearly half the entire horsepower rating in heat, so hydraulic temperatures can be kept low for safety and for
system longevity with a reasonable flow of cooling air. On the standard unit, control the temperature by manually adjusting the speed of the oil cooler fan motor while observing the thermometer. The Hi/Low unit manifold automatically adjusts the cooler fan's speed. A needle valve can be added to the cooler fan for colder climates. See Figure 12 for correct fan rotation.

The suction line has a 149 micron filter in the hydraulic tank. Full filtration is equipped on the return line. The filter (item 3 on Figure 17) is mounted on the top of the tank and has a filter condition indicator mounted on the side of the filter housing. The condition indicator shows when the filter is operating properly, is bypassing (dirty filter), or is missing. Keeping the filter in good condition is strongly recommended, as dirt in the system will increase wear in the pump, valves and connected tongs or other hydraulic tools.

Hoses and fittings have JIC swivel connections, SAE flange connections, or NPT connections. A shutoff valve (Figure 13) is on the tank so it can be drained and serviced.

Be sure the equipment being operated is an ‘open center’ hydraulic circuit – meaning that in the neutral position the circuit has full flow from the inlet to the outlet. If not, a ‘closed center’ adapter must be installed.
**ADJUSTMENTS**

To adjust the relief valve, turn the adjustment screw clockwise (in) to raise the relief pressure and turn it counterclockwise to lower the relief pressure. The valve is set at 2500 psi. The relief valve, shown in Figure 14, requires a 5/32” Allen wrench (screw) and 9/16” wrench (locknut). The relief valve in the Hi/Low manifold, can be adjusted using an Allen wrench and is shown in Figure 16.

Adjustments should be made with the fluid at normal operating temperature of 80 to 130 degrees F

The relief valve setting can be determined by operating the unit without equipment connected to the quick disconnects, in ‘Start’, and observing the pressure reading on the panel gauge.

Do not operate the unit with equipment disconnected for over five (5) minutes. Keep temperature at or below 130 degree F

If installed, the oil cooler fan motor needle valve (shown in Figure 15) can be adjusted by rotating the needle clockwise (viewed from the top) to slow down and counterclockwise to speed up the fan. On Hi/Low units, the fan speed is controlled automatically by the manifold. A needle valve can be added to the fan for colder climates.

![Figure 14: Without manifold](image1.png) ![Figure 15: Oil cooler fan manual adjustment](image2.png)
To adjust hydro throttle (item 12 in Figure 17) see Appendix C.

**DEPRESSURIZE AIR SYSTEM**

When the air start power unit is disconnected from the supply air, remove air from unit by either using the pop-off valve (if supplied) or by pressing the air start button twice.

**PREVENTIVE MAINTENANCE**

⚠️ This is a suggested PM schedule. The tool owner has the responsibility to adjust the program according to actual tool usage

⚠️ Disconnect hydraulic lines and drain system’s pressure before maintenance

Verify that the equipment to be operated is properly connected to the power unit as specified in the Hydraulic section on page 12. Cracks or the appearance of damage on the hydraulic hoses or electrical cabling can indicate the need for repair, even impending failure, and requires prompt attention. See Appendix A, Sections 5 and 6 for engine maintenance.
Preventive Maintenance continued

Daily – While in use

- Verify power unit is in a secure and safe location
- Inspect the hydraulic hoses for worn or scraped areas, bubbles, wrinkles or any other wear – if found, replace
- Verify power cables and hydraulic hoses are not a trip hazard and can’t be pinched or cut
- Check for exposed wires and that electrical connections are secure
- Notice the hydraulic level using the sight gauges and ensure tank is filled to the proper level

Most items in the unit are lubricated by the hydraulic fluid and don’t require other lubrication other than to ensure the fluid is clean

- Check the diesel tank has adequate fuel for the intended operation

Refuel safely with the engine OFF

- Verify cooling air can freely flow through the oil cooler fan and on standard units, the cooling fan is properly adjusted

Fluid temperature will increase 80°F in 20 minutes without air flow from the fan

- Ensure the shutoff valve to the pump inlet is fully open
- Once operating, check the return filter state

Run electric start power unit at least once every three (3) days so that the battery stays charged

Quarterly

- Replace filter element or earlier if the filter’s indicator gauge shows a dirty element (before needle is in the red)

- Change the hydraulic fluid every three (3) to six (6) months – see recommended fluid on Table 14
## TROUBLESHOOTING

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Possible Cause</th>
<th>Possible Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump excessively noisy</td>
<td>Pump inlet flow</td>
<td>Ensure that nothing in tank blocks tank outlet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Verify suction shutoff valve is wide open</td>
</tr>
<tr>
<td></td>
<td>Viscosity is too high</td>
<td>Change to a lower ISO VG grade</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>Pour fluid over suction side fitting - if noise stops, disassemble, retape and reassemble</td>
</tr>
<tr>
<td></td>
<td>Loose or worn parts</td>
<td>Verify assembly is tight - replace worn out parts</td>
</tr>
<tr>
<td>Hydraulic system overheating</td>
<td>Cooling air - insufficient</td>
<td>Verify air flow is unobstructed</td>
</tr>
<tr>
<td></td>
<td>Open needle valve fully</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Relief valve setting</td>
<td>Reset to a maximum of 2500 psi</td>
</tr>
<tr>
<td></td>
<td>Fittings loose</td>
<td>Verify fittings fully tightened</td>
</tr>
<tr>
<td></td>
<td>Fluid viscosity</td>
<td>Change fluid</td>
</tr>
<tr>
<td></td>
<td>Excessive internal leakage</td>
<td>Check parts for wear - replace/repair</td>
</tr>
<tr>
<td></td>
<td>Check for contamination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Excess friction</td>
<td>Look at moving parts inside pump for proper fit</td>
</tr>
<tr>
<td></td>
<td>Valves not operating properly</td>
<td>Check pressure and check flow with flow meter. Repair/replace valves</td>
</tr>
<tr>
<td>Excessive wear of moving parts</td>
<td>Fluid contaminated</td>
<td>Change fluid. Replace filter element. Clean breather.</td>
</tr>
<tr>
<td></td>
<td>Engine/Motor to pump alignment</td>
<td>Verify fastener tightness. If OK, replace motor to pump housing and coupling</td>
</tr>
<tr>
<td></td>
<td>Relief valve setting</td>
<td>Reset to a maximum of 2500 psi</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>Pour fluid over suction side fitting - if fluid disappears, disassemble, retape and reassemble</td>
</tr>
<tr>
<td></td>
<td>Viscosity is too low</td>
<td>Change to a higher ISO VG grade</td>
</tr>
<tr>
<td>Flow rate (tool speed) is low</td>
<td>Pump inlet flow</td>
<td>Ensure the nothing blocks tank outlet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Verify suction shutoff valve is wide open</td>
</tr>
<tr>
<td></td>
<td>Pump</td>
<td>Inspect parts and replace as necessary</td>
</tr>
<tr>
<td></td>
<td>Fittings</td>
<td>Confirm fittings are tight</td>
</tr>
<tr>
<td></td>
<td>Viscosity</td>
<td>Change to a proper ISO VG grade</td>
</tr>
<tr>
<td></td>
<td>Hoses</td>
<td>Use shorter or larger hoses</td>
</tr>
<tr>
<td></td>
<td>Engine speed is low</td>
<td>Ensure hydro throttle is operational. RPM should be between 1800 and 2500</td>
</tr>
<tr>
<td>System pressure will not build up</td>
<td>Leak</td>
<td>Check hoses and fittings</td>
</tr>
<tr>
<td></td>
<td>Relief valve setting</td>
<td>Adjust or replace</td>
</tr>
</tbody>
</table>

Table 16
Troubleshooting continued

<table>
<thead>
<tr>
<th>Failure Mode</th>
<th>Possible Cause</th>
<th>Possible Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot or noisy operation</td>
<td>Fan</td>
<td>Remove interference with fan cover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tighten hold down bolts</td>
</tr>
<tr>
<td></td>
<td>Misalignment</td>
<td>See engine vibrates below</td>
</tr>
<tr>
<td></td>
<td>Insufficient oil</td>
<td>Lubricate per engine manual</td>
</tr>
<tr>
<td></td>
<td>Deterioration of oil</td>
<td>Change</td>
</tr>
<tr>
<td></td>
<td>Excess oil</td>
<td>Drain excess oil</td>
</tr>
<tr>
<td></td>
<td>Engine/Motor loose</td>
<td>Check mounting bolts are tight</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine will not start</td>
<td>Electric Connections</td>
<td>Verify wiring connections/tighten</td>
</tr>
<tr>
<td></td>
<td>Battery dead</td>
<td>Recharge then find source of drain</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine stalls</td>
<td>Electric Connections</td>
<td>Verify wiring connections/tighten</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>Bleed fuel system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine runs and then slows/stops</td>
<td>Electric Connections</td>
<td>Verify wiring connections/tighten</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>Bleed fuel system</td>
</tr>
<tr>
<td></td>
<td>Both Fuel filter</td>
<td>Dirty - replace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sentinel system</td>
<td>Check oil level - if good - check oil pump operation</td>
</tr>
<tr>
<td></td>
<td>Both Overload</td>
<td>Adjust or replace hydraulic valves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dirty - replace</td>
</tr>
<tr>
<td>Engine overheats</td>
<td>Overload</td>
<td>Adjust or replace hydraulic valves</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>Check for clogged air vents. Remove and clean</td>
</tr>
<tr>
<td>Engine vibrates</td>
<td>Loose pump mounting bolts</td>
<td>Tighten</td>
</tr>
</tbody>
</table>

Table 16 continued

For additional engine troubleshooting, see Appendix A, Section 7.

**STORAGE AND TRANSPORTATION**

- Unpainted surfaces should be coated with rust preventing agent
- Prevent excessive exposure to water and moisture
- Clean the tool after use - steam clean as needed; remove mud, debris and any other substances
- For long term storage, 1) depressurize the system and 2) flush hydraulic fluid. The fuel tank level indicates when the diesel contains water. 3) Drain tank as necessary
Figure 17 – Air operated naturally aspirated unit with hoses
<table>
<thead>
<tr>
<th>#</th>
<th>Component</th>
<th>Qty</th>
<th>P/N</th>
<th>TFBD914-AIR-V1-HL</th>
<th>TFBD914-ELEC-V1-HL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SKID, BASKET, TANKS</td>
<td>1</td>
<td>TFBD914-FKIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PUMP, HI/LO</td>
<td>1</td>
<td>060201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>RETURN FILTER - RFP</td>
<td>1</td>
<td>060017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FEMALE QUICK DISCONNECT RETURN</td>
<td>1</td>
<td>030061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RETURN CAP</td>
<td>1</td>
<td>030060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>FEMALE QUICK DISCONNECT PRESSURE</td>
<td>1</td>
<td>030063</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PRESSURE CAP</td>
<td>1</td>
<td>030062</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>BALL VALVE, SHUT OFF*</td>
<td>1</td>
<td>060070</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>DIESEL ENGINE</td>
<td>1</td>
<td>D914L06 - AIR START</td>
<td>D914L06 - ELECTRIC</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>SIGHT LEVEL GAUGE/TEMP</td>
<td>1</td>
<td>060066</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>THROTTLE</td>
<td>1</td>
<td>080005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>GAUGE, PRESSURE</td>
<td>2</td>
<td>060012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>START/RUN BALL VALVE</td>
<td>2</td>
<td>060013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>FUEL FILTER</td>
<td>1</td>
<td>DEU1181917</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>OIL FILTER</td>
<td>1</td>
<td>DEU1183574</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>BATTERY</td>
<td>1</td>
<td>N/A</td>
<td>TFBD914-BATKIT</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>ANALOG PANEL THERMOMETER</td>
<td>1</td>
<td>060064</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>SIGHT GAUGE PLUG</td>
<td>5</td>
<td>060065</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>OIL COOLER</td>
<td>1</td>
<td>060075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>FILLER CAP/FILLER BREATHER</td>
<td>1</td>
<td>T17567-38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>HANDLE SS</td>
<td>2</td>
<td>060113</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>MANIFOLD</td>
<td>1</td>
<td>060071</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Not shown

Table 17: Figure 17/18 BOM
Parts List continued

Figure 18 – Hoses – front view

Figure 19 – Hoses top view with basket removed
### Table 18 - Hoses Figure 18, 19 and 20

<table>
<thead>
<tr>
<th>#</th>
<th>P/N</th>
<th>Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>050018</td>
<td>COOLER TO TANK</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>050027</td>
<td>RETURN LINE</td>
<td>1</td>
</tr>
<tr>
<td>32</td>
<td>050053</td>
<td>FUEL LINES</td>
<td>2</td>
</tr>
<tr>
<td>33</td>
<td>050061</td>
<td>MANIFOLD TO COOLER</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>050111</td>
<td>TO COOLER INLET</td>
<td>1</td>
</tr>
<tr>
<td>36</td>
<td>050113</td>
<td>RETURN 1&quot; INLET TO MANIFOLD</td>
<td>1</td>
</tr>
<tr>
<td>37</td>
<td>050020</td>
<td>SWITCH TEE TO MANIFOLD</td>
<td>1</td>
</tr>
<tr>
<td>38</td>
<td>050112</td>
<td>START/RUN SWITCH TO MANIFOLD</td>
<td>1</td>
</tr>
<tr>
<td>42</td>
<td>050004</td>
<td>TUBING/CASING SWITCH TO MANIFOLD</td>
<td>1</td>
</tr>
<tr>
<td>43</td>
<td>050123</td>
<td>SYSTEM PRESSURE</td>
<td>1</td>
</tr>
<tr>
<td>44</td>
<td>050124</td>
<td>UNLOADING PRESSURE</td>
<td>1</td>
</tr>
<tr>
<td>45</td>
<td>050125</td>
<td>THROTTLE SETTING</td>
<td>1</td>
</tr>
<tr>
<td>46</td>
<td>050127</td>
<td>PUMP RELIEF</td>
<td>1</td>
</tr>
<tr>
<td>47</td>
<td>050126</td>
<td>PUMP UNLOADING</td>
<td>1</td>
</tr>
<tr>
<td>48</td>
<td>050128</td>
<td>PUMP RETURN</td>
<td>1</td>
</tr>
<tr>
<td>49</td>
<td>050129</td>
<td>MANIFOLD TO COOLER</td>
<td>1</td>
</tr>
</tbody>
</table>
## SPARE PARTS LIST

<table>
<thead>
<tr>
<th>Component</th>
<th>Req</th>
<th>P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element for Return Filter</td>
<td>2</td>
<td>060040</td>
</tr>
<tr>
<td>Fuel Filter</td>
<td>1</td>
<td>DEU1181917</td>
</tr>
<tr>
<td>Oil Filter</td>
<td>1</td>
<td>DEU1183574</td>
</tr>
<tr>
<td>Hose Kit</td>
<td>1</td>
<td>TFBD914-V1-HKIT</td>
</tr>
<tr>
<td>100' Return Hose (1&quot;)</td>
<td>1</td>
<td>050055</td>
</tr>
<tr>
<td>100' Hose (1-1/4&quot;)</td>
<td>1</td>
<td>050054</td>
</tr>
<tr>
<td>Suction Filter</td>
<td>1</td>
<td>060039</td>
</tr>
<tr>
<td>Pump (single)</td>
<td>1</td>
<td>060022</td>
</tr>
<tr>
<td>Pump (dual 40/40)</td>
<td>1</td>
<td>060201</td>
</tr>
</tbody>
</table>

Table 19
Please read and observe the information given in this Operation Manual. This will enable you to avoid accidents, preserve the manufacturer’s warranty and maintain the engine in peak operating condition.

This engine has been built exclusively for the application specified in the scope of supply, as described by the equipment manufacturer and is to be used only for the intended purpose. Any use exceeding that scope is considered to be contrary to the intended purpose. The manufacturer will not assume responsibility for any damage resulting therefrom. The risks involved are to be borne solely by the user.

Use in accordance with the intended purpose also implies compliance with the conditions laid down by the manufacturer for operation, maintenance and servicing. The engine should only be operated by personnel trained in its use and the hazards involved.

The relevant accident prevention guidelines and other generally accepted safety and industrial hygiene regulations must be observed.

When the engine is running, there is a risk of injury through:
- turning/hot components
- engines with positive ignition
- ignition systems (high electrical voltage)
You must avoid contact at all times!

Unauthorized engine modifications will invalidate any liability claims against the manufacturer for resultant damage. Manipulations of the injection and regulating system may also influence the performance of the engine, and its emissions. Adherence to legislation on pollution cannot be guaranteed under such conditions.

Do not change, convert or adjust the cooling air intake area to the blower. The manufacturer shall not be held responsible for any damage which results from such work.

When carrying out maintenance/repair operations on the engine, the use of DEUTZ original parts is prescribed. These are specially designed for your engine and guarantee perfect operation. Non-compliance results in the expiry of the warranty!

Maintenance and cleaning of the engine should only be carried out when the engine is switched off and has cooled down. You must ensure that the electrical systems have been switched off and the ignition key has been removed. Accident prevention guidelines concerning electrical systems (e.g. VDE-0100/-0101/-0104/-0105 Electrical protective measures against dangerous touch voltage) are to be observed. When cleaning with fluids, all electrical components are to be covered impermeably.
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- 2.1.2 Position of the Rating Plate
- 2.1.3 Engine Serial Number
- 2.1.4 Cylinder numbering
- 2.1.5 Direct injection

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- 2.2.2 Air outlet side BF3L 914
- 2.2.3 Operation side F4L 914
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### 10.13 Service
2.1.1 Rating Plate

The model A, the engine serial number B and the performance data are stamped on the rating plate. The model and engine serial number must be given when ordering parts.

2.1.2 Position of the Rating Plate

The rating plate C is attached to the crankcase. Depending on the model, a second rating plate may be affixed to the air duct hood.

2.1.3 Engine Serial Number

The engine serial number is stamped on the crankcase (arrow) as well as the rating plate.
Cylinders are numbered consecutively, beginning at the flywheel.

Engines with direct injection are used if high output is required.
2.2 Engine Illustrations

2.2.1 Operation side

BF3L914

1. Cooling fan
2. V-Belts (fan)
3. Optional attachment of hydraulic pumps
4. V-belt washer
5. Tension roller
6. Oil pan
7. Oil drain screw
8. Oil filler neck
9. Oil dipstick
10. Fuel change filter
11. Solenoid (shut-off magnet)
12. Lube oil filter
13. Full-stop depending on charge air pressure
14. Air duct hood
15. Cylinder head cover
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BF3L914

16 Air-intake line
17 Shielding plate
18 Flywheel
19 Oil drain screw
20 Starter
21 Exhaust turbocharger manifold
2.2.3 Operation side
F4L 914

1 Cooling fan
2 V-Belts (fan)
3 Optional attachment of hydraulic pumps
4 V-belt washer
5 Tension roller
6 Oil filler neck
7 Fuel pump
8 Fuel change filter
9 Injection pump
10 Oil dipstick
11 Shut-off magnet
12 SAE housing
13 Lube oil filter
14 Air duct hood
15 Cylinder head cove
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19 Starter
20 Oil pan
21 Air-intake manifold
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2.2.5 Operation side
BF6L 914 C- intercooler over air-intake line

1. Cooling fan
2. V-Belts (fan)
3. V-belt pulley on crankshaft
4. Tension roller
5. Oil filler neck
6. Oil drain screw
7. Fuel pump with fuel precleaning
8. Fuel filter cartridge
9. Injection pump
10. Shut-off lifting magnet
11. Oil dipstick
12. LDA
13. Lube oil filter cartridge
14. Engine oil cooler
15. Air duct hood
16. Cylinder head cover
2.2 Engine Illustrations

2.2.6 Exhaust side
BF6L 914 C- intercooler over air-intake line

17 Intercooler
18 Air-intake line
19 Exhaust manifold line
20 Date plate
21 Flywheel
22 Starter
23 Oil drain screw
24 Turbocharger
25 Air-intake manifold to exhaust turbocharger
26 Alternator
2.2.7 Operation side
BF6L 914 C- intercooler over flywheel

1 Cooling fan
2 V-Belts (fan)
3 V-belt pulley on crankshaft
4 Tension roller
5 Oil filler neck
6 Oil drain screw
7 Fuel pump with fuel precleaning
8 Fuel filter cartridge
9 Injection pump
10 Shut-off lifting magnet
11 Oil dipstick
12 LDA
13 Lube oil filter cartridge
14 Engine oil cooler
15 Air duct hood
16 Cylinder head cover
2.2.8 Exhaust side
BF6L 914 - intercooler over flywheel

17 Intercooler
18 Flywheel
19 Starter
20 Oil drain screw
21 Alternator
22 Exhaust connection supports
23 Exhaust manifold line
24 Air-intake manifold to exhaust turbocharger
2.3 Lube Oil Circuit Schematic

- Oil pan
- Intake manifold
- Oil pump
- Oil pressure regulating valve
- Pressure oil line
- Short-circuit line or alternative
- Ribbed tube coil or alternative
- Block oil cooler
- Lube oil filter
- Safety valve
- Main oil channel
- Crankshaft bearing
- Con-rod bearing
- Camshaft bearing
- Tappet
- Pushrod (hollow, for oil intake to lubricate rocker arm)
- Rocker arm bearings
- Rocker arm lubrication
- Pushrod protective tube
- Throttle bore (to lubricate cogwheels)
- Spray nozzle for piston cooling
- Connection for oil pressure gauge
- Oil pressure gauge
- Injection pump connected to lube oil circuit schematic
- Connection option for oil heater **

** here the filter carrier must be exchanged. Please contact DEUTZ Service when changing-over.
2.3 Lube Oil Circuit Schematic

1. Oil pan
2. Intake line
3. Oil pump
4. Oil pressure regulating valve
5. Pressure oil line
6. Connection line to oil cooler
7. Block oil cooler
8. Lube oil filter
9. Safety valve
10. Main oil channel
11. Crankshaft bearing
12. Con-rod bearing
13. Camshaft bearing
14. Tappet (with impulse lubrication of rocker arm)
15. Pushrod (hollow, for oil intake to lubricate rocker arm)
16. Rocker arm bearings
17. Rocker arm lubrication
18. Pushrod protective tube (oil return from the cylinder head to crankcase)
19. Throttle bore (to lubricate cogwheels)
20. Spray nozzle for piston cooling
21. Oil line to lubricate turbocharger
22. Oil return line from exhaust turbocharger to crankcase
23. Oil pressure gauge
24. Bypass lube oil fine filter
25. Connection option for oil heater **
26. Injection pump connected to lube oil circuit schematic

** here the filter carrier must be exchanged. Please contact DEUTZ Service when changing-over.
2.4.1 Fuel System

1. Fuel tank
2. Fuel line from tank to fuel pump
3. Fuel pump
4. Fuel change filter
5. Injection pump
6. Injection line
7. Injection valve
8. Fuel overflow pipe

A Distance: must be routed as far away from each other as possible
2.5 Engine cooling

2.5.1 Amount of cool air regulated by exhaust thermostat

1 Pressure oil line from engine to exhaust thermostat
2 Air line to exhaust thermostat
3 Exhaust manifold line
4 Exhaust thermostat
5 Control line to hydraulic coupling
6 Hydraulic coupling
7 Cooling fan
8 Cooling fan drive
9 Oil return line to crankcase
10 Ventilation line
11 Adjusting screw with special seal ring
2.5.2 Amount of cool air regulated by exhaust thermostat and solenoid valve

1. Pressure oil line from engine to exhaust thermostat
2. Air line to exhaust thermostat
3. Exhaust manifold line
4. Exhaust thermostat
5. Control line to hydraulic coupling
6. Hydraulic coupling
7. Cooling fan
8. Cooling fan drive
9. Oil return line to crankcase
10. Ventilation line
11. Adjusting screw with special seal ring
12. Solenoid valve
3.1 Commissioning
3.2 Starting
3.3 Monitoring Operation
3.4 Shutting off
3.5 Operating Conditions
3.1 Commissioning

3.1.1 Pour in Engine Oil

As a rule, engines are delivered without oil. Pour lube oil into the oil filler neck (arrow). For oil grade and viscosity, see 4.1.

3.1.2 Oil Bath Air Filter with Engine Oil

Fill oil cup 1 of the oil bath air cleaner with oil up to the arrow. For oil grade and viscosity, see 4.1.

3.1.3 Pour in Fuel

Use only commercial-grade diesel fuel. For fuel grade, see 4.2. Use summer or winter-grade fuel, depending on the ambient temperature.

Do not fill the precleaner dust collector (if fitted) with oil.

Never fill the tank while the engine is running. Ensure cleanliness! Do not spill fuel!
3.1 Commissioning

3.1.4 Bleed

Model: “Motorpal” model

- Position collecting tank below the injection pump.
- Unscrew ventilation valve 1 with screw-driver.
- Move hand hump 2 in the direction of the arrow until bubble-free fuel escapes from the ventilation valve 1.
- Tighten ventilation valve 1, still pumping.
- Remove collecting tank and dispose of the fuel in an environmentally-friendly manner.
3.1.5 Other Preparations

- Checking battery and cable connectors
  see 6.7.1

- Transport hooks
  Remove if fitted (see 6.7.3)

- Trial run
  After the engine has been prepared, let it run for about 10 minutes without load.
  During and after trial run
  -- Check the engine for leaks.
  After the engine has been turned off
  -- Check the oil level, see 6.1.2
  If necessary, top up oil, see 3.1.1
  -- Retension V-belts, see 6.5.

- Breaking in
  During the break-in phase, about 200 operating hours, check the oil level twice a day.
  After the engine is broken in, checking once a day will be sufficient.

3.1.6 Additional maintenance work

After 50-150 operating hours, the following maintenance work is to be carried out:

- Change lube oil,
  see 6.1.2

- Change oil filter cartridge,
  see 6.1.3

- Change fuel filter cartridge,
  see 6.2.1

- Check V-belts and retension as necessary, see 6.5.

- Check valve clearance (adjust if necessary) see 6.6.1

- Check the engine for leaks

- Check engine mounts (retighten if necessary) see 9.2.

3.1.7 Change-over switch for oil heater

Position of change-over switch for oil filter consoles with an oil heater connected:
Pos. 1: open
Pos. 2: closed

For engines without an oil heater, the change-over switch should always be fixed to Pos. 2: closed.
3.2.1 Electric Starting

Before starting, make sure that nobody is standing in the immediate vicinity of the engine or driven machine. After repair work:
Check that all guards have been replaced and that all tools have been removed from the engine.
When starting with glow plugs, do not use any other starter substance (e.g. injection with start pilot). Risk of accident!

Caution:
If the speed regulator has been removed, the engine must not be tested under any circumstances: disconnect the battery!

Do not actuate the starter for more than 20 seconds. If the engine does not catch, wait a minute then try again.
If the engine does not catch after two attempts, refer to the Diagnosis Chart (see 7.1).

- Where possible, disengage the clutch to separate the engine from any driven parts.
- Move speed control lever 1 into idle position.
- Move cut-out handle 2 in direction of “I” and start.
- Regarding electric starting with a solenoid, the cut-out handle 2 is pulled in direction “I” and held when current is flowing. The charge pilot light and the oil pressure pilot light go out.

- Insert key
  - Position 0 = no operating voltage
  - Turn key clockwise
  - Position 1 = operating voltage
  - Pilot lights illuminate
  - Push key in and turn further clockwise against spring pressure.
  - Position 2 = no function
  - Position 3 = start
- Release key as soon as engine fires
  - The pilot lights will go out.
3.2 Starting

with cold start assistance/glow lamps
FR 60 = 9.5 and 19 Volt

- Insert key
  - Position 0 = no operating voltage
- Turn key clockwise
  - Position 1 = operating voltage
  - Pilot lights illuminate
- Push key in and turn further clockwise against spring pressure
  - Preheat lamp comes on
  - Position 2 = preheat for approx. 60 secs. (holding key*)
  - Preheat lamp extinguishes
  - Position 3 = start
- Release key as soon as engine fires
  The pilot lights will go out.

with cold start assistance/glow lamps
FR 20/30 = 11 and 23 Volt

- Insert key
  - Position 0 = no operating voltage
- Turn key clockwise
  - Position 1 = operating voltage
  - Pilot lights illuminate
- Push key in and turn further clockwise against spring pressure
  - Preheat lamp comes on.
  - Position 2 = preheat for approx. 20-30 secs. (holding key*)
  - Preheat lamp extinguishes
  - Position 3 = start
- Release key as soon as engine fires
  The pilot lights will go out.

* Fuel particles not burnt during initial combustion in the cylinder are subjected to a second stage combustion process for approx. 3 minutes in order to let the exhaust gases become more transparent in the start-up phase.
3.3.1 Engine Oil Pressure

- The oil pressure pilot light comes on with operating voltage on and engine off.
- The oil pressure pilot light should go out when the engine is running.
- The pointer must remain in the green sector over the entire operating range.
- The pointer of the oil pressure gauge must display the minimum oil pressure (see 9.1).
3.3 Monitoring Operation

3.3.2 Engine temperature

The engine temperature gauge pointer should remain in the green sector most of the time. It should rarely enter the yellow-green sector. If the pointer enters the orange sector, the engine is overheating. Turn off and establish the cause from the Fault Table (see 7.1).

3.3.3 Cooling fan drive

When the V-belt is torn, the pressure pin 1 of electrical switch is actuated by the tension roller and an audio signal or a light signal is emitted. Switch off the engine immediately to avoid overheating.
3.4 Shutting Off

3.4.1 Mechanical shut-off

- Move speed adjustment lever 1 to low idle.
- Move shut-off lever 2 in the direction of “0” until the engine comes to a stop. The charge pilot light and the oil pressure pilot light will come on when the engine stops.
- Turn key counterclockwise (to position 0) and remove. The pilot lights will go out.

3.4.2 Electrical shut-off

- Turn key counterclockwise (to position 0) and remove. The pilot lights will go out.

Concerning electrical shut-off or power failure, the shut-off lever 2 is disabled by the solenoids until the engine stops. The charge pilot light and the oil pressure pilot light illuminate when the engine stops.

If possible, do not suddenly switch off the engine when under full load.
3.5 Operating Conditions

3.5.1 Winter Operation

- **Lube Oil Viscosity**
  - Select the oil viscosity (SAE grade) according to the ambient temperature when starting the engine, see 4.1.2.
  - Increase oil change frequency when operating below -10 °C, see 6.1.1.

- **Diesel Fuel**
  - Use winter-grade diesel fuel for operation below 0 °C, see 4.2.2

- **Additional Maintenance Work**
  - Drain the sludge from the fuel tank once a week. (Unscrew the sludge drain plug)
  - If necessary, allow the oil in the oil bath air cleaner and the engine oil to settle at the ambient temperature.
  - Below -20 °C, after removing the starter if necessary, smear the ring gear on the fly wheel via the pinion bore from time to time with cold-resistant grease (e.g. Bosch FT 1 V 31 grease).

- **Cold Start Assistance**
  At temperatures near or below freezing point, use sheathed glow plugs if necessary, see 3.2.1. This not only lowers the starting limit temperature, but provides easier starting at temperatures normally not requiring a starting aid.

- **Battery**
  - Efficient cold starting requires the battery to be well-charged, see 6.7.1.
  - The starting limit temperatures can be lowered by 4-5 °C by heating the battery up to about +20 °C. (To do so, remove the battery and store in a warm place).
3.5.2 High Ambient Temperature, High Altitude

- Air density decreases as altitude or ambient temperature increase. As a result of this, the engine’s maximum output, the quality of the exhaust gas, the temperature level and, in extreme cases, starting behaviour, are impeded. Under transient conditions, the engine can be used at altitudes up to 1000 m and temperatures up to 30 °C. If the engine is to operate under more severe conditions (at higher altitudes or temperatures), it will be necessary to reduce the injected fuel quantity and thus, engine power.

- If you have any doubts about engine operation under these or similar conditions, ask your engine or equipment supplier whether the engine has been derated in the interests of reliability, service life and exhaust gas quality (smoke). Otherwise contact DEUTZ SERVICE.
4.1 Lube Oil
4.2 Fuel
Lube oils are differentiated according to their performance and quality class. In common use are specifications named after the API (American Petroleum Institute) and ACEA (European Engine Oil Sequences).

**Approved API Oils:**
At least: CF-4

**Approved ACEA Oils:**
At least: E1-96

It is recommended to operate the engines with **Deutz Oil TLX10W-40FE Europe**. If this is not available, use the appropriate oil as described above.

As the viscosity of the lube oil is dependent on temperature, the choice of SAE grade should be governed by the ambient temperature prevailing at the engine operating site. Optimum operating behaviour will be attained if you take the accompanying oil viscosity diagram as a guide.

Should the temperature fall temporarily below the limits of SAE grade selected, cold starting may be affected but the engine will not be damaged. In order to keep wear to a minimum, do not exceed application limits for extended periods of time.

Oil changes dictated by the seasons can be avoided by using multi-grade lube oils. Multi-grade oils, particularly light-flowing oils, also reduce fuel consumption.
4.1 Lube Oil Operating Media

4.1.2.1 Specific lube oil definitions

Turbocharged engines with increased output and engines with high capacity. For the following engines, or applications:

● for engines with an output >141kW the oils listed in the following table are to be used.

Firstly, these oils are of high quality in accordance with ACEA or API. Additionally, these oils are mainly partly synthetic, some even fully synthetic (5W-40) and thus achieve thermal stability if required for the application and sediments are less likely if the crankcase ventilation is closed in the turbocharger and in the air-intake lines.

Emission optimised engines for commercial vehicles from EURO II and mobile driven machines from position 2, corresponding to the following emission requirements:

a) from EURO II, the 88/77/EEC and 91/542/EEC guidelines for commercial vehicles in Europe
b) from position 2, the 97/68/EC guidelines for mobile driven machines in Europe
c) from position 2, the US non-road engines guidelines, only the following oil qualities are permitted:
   - ACEA E3-96 and ACEA E4-98 for requirements a) and b)
   - API CG-4 and API CH-4 for the requirements c)

The table can be extended if required.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Lube oil type</th>
<th>SAE Class</th>
<th>Availability</th>
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<td>Deutz TLX Oil</td>
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</table>
4.2 Fuel

4.2.1 Quality

Use commercially available diesel fuel with less than 0.5 % sulphur content. If the sulphur content is higher, oil change intervals should be reduced (see 6.1.1).

The following fuel specifications / standards are approved: (also see TR 0199-3002)

- **Diesel fuel**
  - DIN EN 590
  - BS 2869: A1 and A2 (with A2, take note of the sulphur content)
  - ASTM D 975-88; 1-D and 2-D
  - NATO Code F-54 and F-75
  - ISO 8217 DMX
  - ISO 8217 DMA

- **Light fuel oils**
  - in accordance with DIN 51603
  - ASTM D 396; 1 and 2
  - BS 2869 Class D

- **Jet fuel**
  - F34/F35/F44 (Kerosene)
  - F54 (corresponds to diesel fuel in accordance with DIN EN 590)
  - XF 63 (corresponds to F34+F35 with additives)

- **Bio diesel fuel**
  - in accordance with DIN 51606- FAME

Exhaust emission values which may be determined in the case of type approval tests always refer to the reference fuel prescribed by the authorities for the type approval test.

4.2.2 Winter Fuel

Waxing may occur at low temperatures, clogging the fuel system and reducing engine efficiency. If the ambient temperature is less than 0 °C, winter-grade fuel (suitable down to -20 °C) should be used. (This fuel is available from the filling stations well in advance of the cold months).

- Kerosene must be added at temperatures below -20 °C. The relevant percentages are given in the adjacent diagram.
- Special diesel fuels may be used in arctic climatic zones up to -44 °C.

If summer-grade diesel fuel must be used at temperatures below 0 °C, up to 60% kerosene can be added (see diagram).

In most cases, adequate resistance to cold can be obtained by adding a flow improver (additive). Please ask your DEUTZ partner.

---

Legend:

| I | Summer-grade diesel fuel |
| II | Winter-grade diesel fuel |
| A | Ambient temperature |
| B | Percentage of kerosene added |

- **Mix in tank only! Fill with the appropriate amount of kerosene first, then add the diesel fuel.**

**Diesel fuel should never be mixed with petrol (normal or super petrol).**
APPENDIX A
Routine Maintenance

5.1 Maintenance Plan
5.2 Maintenance Schedules
5.3 Maintenance Work Completed
# Routine Maintenance

## 5.1 Maintenance Schedule

- **check = ●**
- **adjust = ○**
- **clean = ◆**
- **replace = ■**

Prior to or during 1st trial run, check 2x daily during the breaking in phase or when commissioning new and overhauled engines.

**Every 10 hours of operation or daily**

### In hours of operation (HO) every years

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<th>E20</th>
<th>E30 125</th>
<th>E40 250</th>
<th>E50 500</th>
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</table>

**Operation**

- Top up lube oil if necessary (also with separate container) 6.1.2/3.3.4
- Lube oil (oil change intervals depending on engine use), see TR 0199-99-3002 6.1.1/6.1.2
- Oil filter cartridge (at each lube oil change)
- Oil bath air filter 6.3
- Bypass – oil filter 6.1.4
- Fuel filter cartridge #
- Fuel pre-cleaner 4.2/ 6.2.2
- Intake air cleaner/dry type air cleaner (If available, maintain according to maintenance indicator) 6.4.3 /6.4.4
- Battery and cable connectors 6.7.1
- Engine monitoring system, warning system 3.3 #
- Valve clearance (set if necessary, earlier if noises occur) 6.6.1#
- V-belts (retension or replace if necessary) 6.5.1
- Sheathed glow lamps 6.9.3
- Check engine for leaks (visual inspection) –
- Engine suspension (replace if damaged) 9.2
- Fastenings, hose connections / clamps 6.9.1
- Basic overhaul #

**Industrial engines**

The specified engine maintenance values are permissible recommended maximums. Depending on usage, reduced maintenance intervals may be necessary, comply with the unit manufacturer’s operating instructions. # Maintenance must only be carried out by authorised service personnel.

## Operation Section

- Top up lube oil if necessary (also with separate container) 6.1.2/3.3.4
- Lube oil (oil change intervals depending on engine use), see TR 0199-99-3002 6.1.1/6.1.2
- Oil filter cartridge (at each lube oil change)
- Oil bath air filter 6.3
- Bypass – oil filter 6.1.4
- Fuel filter cartridge #
- Fuel pre-cleaner 4.2/ 6.2.2
- Intake air cleaner/dry type air cleaner (If available, maintain according to maintenance indicator) 6.4.3 /6.4.4
- Battery and cable connectors 6.7.1
- Engine monitoring system, warning system 3.3 #
- Valve clearance (set if necessary, earlier if noises occur) 6.6.1#
- V-belts (retension or replace if necessary) 6.5.1
- Sheathed glow lamps 6.9.3
- Check engine for leaks (visual inspection) –
- Engine suspension (replace if damaged) 9.2
- Fastenings, hose connections / clamps 6.9.1
- Basic overhaul #

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5.1 Maintenance Schedule

Additions and modifications for engines with EPA approval

The specified engine maintenance values are permissible recommended maximums. Depending on usage, reduced maintenance intervals may be necessary, comply with the unit manufacturer’s operating instructions.

# Maintenance must only be carried out by authorised service personnel

max. recommended standard times in operating hours (HO) of all

prior to or during 1st trial run, check 2x daily during the breaking in phase or when commissioning new and overhauled engines
every 10 hours of operation or daily

<table>
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<th>Operation</th>
<th>Section</th>
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<tr>
<td>Injection valve</td>
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<tr>
<td>Intercooler (drain lube oil/condensation)</td>
<td>#</td>
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<tr>
<td>CPD compressor outlet</td>
<td>#</td>
</tr>
<tr>
<td>Basic overhaul of emission related parts</td>
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check = ● adjust = ○ clean = ◆ replace = ■
In hours of operation (HO) every

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<th>Section</th>
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Prior to or during the 1st trial run, check 2x daily during the breaking in phase or when commissioning new and overhauled engines.

Every 10 hours of operation or daily.

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</tr>
<tr>
<td>CPD compressor outlet</td>
<td>#</td>
</tr>
<tr>
<td>Basic overhaul of emission related parts</td>
<td>#</td>
</tr>
</tbody>
</table>

The specified engine maintenance values are permissible recommended maximums. Depending on usage, reduced maintenance intervals may be necessary, comply with the unit manufacturer’s operating instructions.

# Maintenance must only be carried out by authorised service personnel.

Check = ●, Adjust = ○, Clean = ◆, Replace = ■.

Max. recommended standard times in operating hours (HO) of all.

Prior to or during the 1st trial run, check 2x daily during the breaking in phase or when commissioning new and overhauled engines.

Every 10 hours of operation or daily.

In hours of operation (HO) every

<table>
<thead>
<tr>
<th>E10</th>
<th>E20</th>
<th>E30</th>
<th>E40</th>
<th>E50</th>
<th>E60</th>
<th>E70</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection valve</td>
<td>#</td>
</tr>
<tr>
<td>Intercooler (drain lube oil/condensation)</td>
<td>#</td>
</tr>
<tr>
<td>CPD compressor outlet</td>
<td>#</td>
</tr>
<tr>
<td>Basic overhaul of emission related parts</td>
<td>#</td>
</tr>
</tbody>
</table>
## 5.2.1 Routine maintenance work plan

<table>
<thead>
<tr>
<th>Intervals with/after</th>
<th>Maintenance</th>
<th>Activity levels</th>
<th>Plan executed by:</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 [OH]  daily</td>
<td>E 10</td>
<td>after operation and E 50 - E 70</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
<tr>
<td>250 [OH]</td>
<td>E 25</td>
<td>Inspection</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
<tr>
<td>500 [OH]</td>
<td>E 30</td>
<td>further inspection</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
<tr>
<td>1000 [OH]</td>
<td>E 40</td>
<td>intermediate repair</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
<tr>
<td>3000 [OH]</td>
<td>E 50</td>
<td>further intermediate repair</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
<tr>
<td>6 000 [OH]</td>
<td>E 60</td>
<td>partial repair</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
<tr>
<td>12 000 [OH]</td>
<td>E 70</td>
<td>major repair</td>
<td>authorised specialised staff</td>
<td></td>
</tr>
</tbody>
</table>
The maintenance charts shown on this page are supplied as self-adhesive labels with each engine. They should be affixed where they can be seen clearly on the engine or driven equipment.

Check that this is the case.

If necessary, ask your engine or equipment supplier for a fresh supply of labels! Routine work should be carried out according to the schedule (see chapter 5.1).

Stop the engine before carrying out any maintenance work.
<table>
<thead>
<tr>
<th>Op. hours</th>
<th>Date</th>
<th>Signature/stamp</th>
<th>Op. hours</th>
<th>Date</th>
<th>Signature/stamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-150*</td>
<td></td>
<td></td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>250</td>
<td></td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>375</td>
<td>500</td>
<td></td>
<td>750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>625</td>
<td>750</td>
<td></td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>875</td>
<td>1000</td>
<td></td>
<td>1250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1125</td>
<td>1250</td>
<td></td>
<td>1500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1375</td>
<td>1500</td>
<td></td>
<td>1750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1625</td>
<td>1750</td>
<td></td>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1875</td>
<td>2000</td>
<td></td>
<td>2250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2115</td>
<td>2250</td>
<td></td>
<td>2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2375</td>
<td>2500</td>
<td></td>
<td>2750</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* following commissioning of new and overhauled engines.
Duly completed maintenance jobs can be recorded and signed off in the above chart.
Duly completed maintenance jobs can be recorded and signed off in the above chart.
<table>
<thead>
<tr>
<th>Op. hours</th>
<th>Date</th>
<th>Signature/stamp</th>
<th>Op. hours</th>
<th>Date</th>
<th>Signature/stamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>5875</td>
<td></td>
<td></td>
<td>6000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6125</td>
<td></td>
<td></td>
<td>6250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6375</td>
<td></td>
<td></td>
<td>6500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6625</td>
<td></td>
<td></td>
<td>6750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6875</td>
<td></td>
<td></td>
<td>7000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7125</td>
<td></td>
<td></td>
<td>7250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7375</td>
<td></td>
<td></td>
<td>7500</td>
<td></td>
<td></td>
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<tr>
<td>7625</td>
<td></td>
<td></td>
<td>7750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7875</td>
<td></td>
<td></td>
<td>8000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8125</td>
<td></td>
<td></td>
<td>8250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8375</td>
<td></td>
<td></td>
<td>8500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8625</td>
<td></td>
<td></td>
<td>8750</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Duly completed maintenance jobs can be recorded and signed off in the above chart.
6.1 Lubrication System
6.2 Fuel System
6.3 Cooling system
6.4 Combustion Air Filter
6.5 Belt Drives
6.6 Adjustments
6.7 Accessories
6.8 Engine cleaning
6.9 Additional Maintenance Work
## Service and Maintenance

### 6.1.1 Oil change intervals

- The oil change intervals are dependent on the engine application and the quality of the lube oil.
- If the engine runs fewer hours during the year than stated in the table, the oil should be changed at least once a year.
- The table refers to the following conditions:
  - For diesel fuel: sulphur content max. 0.5% by weight.
  - Continuous ambient temperatures down to -10 °C (+14 °F).
- If the sulphur content is > 0.5 to 1% or the continuous ambient temperature below the oil change intervals must be halved.
- In the case of fuels with a sulphur content higher than 1%, contact your Service representative.
- Change the oil with the engine off but still warm (lube oil temperature approx. 80 °C).

<table>
<thead>
<tr>
<th>Engines for installation</th>
<th>Lube oil change intervals in HO</th>
<th>Lube oil change intervals in km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lube oil quality</td>
<td>API specification</td>
<td>Naturally aspirated engines</td>
</tr>
<tr>
<td></td>
<td>ACEA-specification</td>
<td></td>
</tr>
<tr>
<td>Normal oil requirement, e.g.:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road vehicles, cranes, construction machines, ships electrical modules, pumps, railway vehicles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High oil requirement, e.g.:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combines, emergency pumps, underground mining units, sweeping machines, winter service vehicles, emergency power units.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service group</th>
<th>Year’s kilometrage km</th>
<th>medium driving speed approx. km/h</th>
<th>Naturally aspirated engines</th>
<th>Turbocharged engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&gt; 30 000</td>
<td>20</td>
<td>10 000</td>
<td>5 000</td>
</tr>
<tr>
<td>II</td>
<td>30 000 -100 000</td>
<td>40</td>
<td>20 000</td>
<td>10 000</td>
</tr>
<tr>
<td>III</td>
<td>&lt; 100 000</td>
<td>60</td>
<td>30 000</td>
<td>15 000</td>
</tr>
</tbody>
</table>

APPENDIX A
6.1 Lubrication System

6.1.2 Checking Oil Level / Changing Engine Oil

6.1.2.2 Changing Engine Oil

- Run the engine warm
- Ensure that the engine or vehicle is on a level surface
  - Lube oil temperature approx. 80°C.
- Switch off the engine.
- Place an oil tray beneath the engine
- Unscrew drain plug.
- Drain oil.
- Fit oil drain plug with new gasket and tighten firmly (for torque, see 9.2).
- Fill with lube oil
  - For grade/viscosity, see 4.1.
  - For quantity, see 9.1.
- Check oil level, see 6.1.2.1

6.1.2.1 Checking Oil Level

- Ensure that the engine or vehicle is on a level surface.
- Warm engine
- Switch off engine, wait 5 minutes and check the oil level
- Cold engine
  - Check the oil level
  - Remove the dipstick
  - Wipe off with a non-fibrous, clean cloth.
  - Insert up to the stop and pull out again.
  - Check oil level, if required top up to the "MAX" level
    - If the oil level is just above the "MIN" mark, it should be topped up.

The oil level must not drop below the "MIN" mark.

Be careful when draining hot oil - danger of scalds! Do not let used oil run into the soil but catch it in a container ready for proper disposal.
6.1 Lubrication System

6.1.3 Replace Oil Filter

- Undo the lube oil filter cartridge using a commercial tool and spin off.
- Catch any escaping oil.
- Clean any dirt from the filter carrier sealing surface.
- Lightly oil the rubber gasket of the new lube oil filter cartridge.
- Manually screw in the new cartridge until the gasket is flush.
- Tighten the lube oil filter cartridge with another half-turn.
- Check the oil level, see 6.1.2
- Check oil pressure, see 3.3.1.
- Check lube oil filter cartridge seal for leaks.

Caution is required in the case of hot oil: Risk of scalding! Please dispose of oil in an environmentally-friendly manner!
6.1.4 Change bypass-oil filter

- Remove oil drain screw 1 and let the oil run out.
- Catch any escaping oil.
- Remove tensioning screw 2. Remove cover.
- Remove soiled filter 3. Clean filter casing.
- Check cover 4 for leaks, and replace if necessary.
- Screw in oil drain screw with a new seal ring 5.
- Insert new filter.
- Screw on cover with seal ring 6.
- During trial, observe oil pressure and check for leaks.
6.2 Fuel System

6.2.1 Replace Fuel Filter

- Close the fuel shut-off valve.
- Undo fuel filter cartridge with commercial tool and spin off.
- Catch any escaping fuel.

 Keep naked flames away when working on the fuel system. Do not smoke!

- Clean any dirt from the filter carrier sealing surface.
- Apply light film of oil or diesel fuel to the rubber gasket of the new fuel filter cartridge.
- Manually screw in the new cartridge until the gasket is flush.

- Tighten the fuel filter cartridge with a final half-turn.
- Open fuel shutoff valve.
- Check for leaks.

The fuel system does not need to be bled.
6.2 Fuel System

6.2.2 Fuel precleaning

Clean fuel filter
“Motorpal” model

- Close the fuel shut-off valve.
- Screw out and remove filter cap 4.
- Catch any escaping fuel.
- Remove strainer 3 and clean with fuel.
- Remove seal ring 2.
- Clean filter casing 1 with fuel.
- Screw on filter cap 4 and strainer 3 with new seal 2.
- Bleed fuel system (see 3.1.4).
- Open fuel shutoff valve.
- Check for leaks.

⚠ Keep naked flames away when working on the fuel system. Do not smoke!
6.3.1 Cleaning Intervals

- The amount of contamination in the cooling system depends on the engine application.
- Oil and fuel residues on the engine increase the risk of contamination. Therefore pay special attention to leaks if the engine is used in dusty environments.
- Serious contamination can occur, for example:
  - On construction sites where there is a high level of air-borne dust.
  - In harvesting application where there are high concentrations of chaff and chopped straw in the vicinity of the machine.
- Because applications vary, cleaning intervals have to be determined from case to case. The cleaning intervals given in the table on the right can be used as a guide.

<table>
<thead>
<tr>
<th>Checking or cleaning intervals</th>
<th>Engine application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard values</td>
<td></td>
</tr>
<tr>
<td>OH</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Ships, electrical modules in enclosed areas, pumps</td>
</tr>
<tr>
<td>1000</td>
<td>Vehicles on paved roads</td>
</tr>
<tr>
<td>500</td>
<td>Tractors, fork-lift trucks, drivable electric units.</td>
</tr>
<tr>
<td>250</td>
<td>Vehicles on construction sites and unpaved roads,</td>
</tr>
<tr>
<td></td>
<td>construction machines compressors, underground mining units</td>
</tr>
<tr>
<td>125</td>
<td>Agricultural machines, tractors in harvesting application</td>
</tr>
</tbody>
</table>
6.4 Combustion Air Filter Service and Maintenance

6.4.1 Cleaning Intervals

- The amount of dirt in the air cleaner depends on the amount of dust in the air and the size of the air cleaner used. If a high level of dust is anticipated, a cyclone-type precleaner can be fitted to the air cleaner.

- Cleaning intervals will have to be determined from case to case.

- If dry type air filters are used, cleaning should only be carried out according to the service indicator or service switch.

- Air cleaner servicing is needed when
  - **Service indicator**
    the red signal 1 is fully visible when the engine is off.
  - **Service switch**
    the yellow pilot light comes on when the engine is running.

- After carrying out service work, reset the signal by pressing the button on the service indicator. The service indicator is now ready for operation again.
6.4.2 Emptying Cyclone Type Precleaner

- Undo wing nut 1 and remove cover 2.
- Remove collector bowl 3 from lower section 4 and empty. Clean leaves, straw and other foreign matter from lower section of pre-cleaner.
- Reposition collector bowl 3 onto lower section 4, fasten cover 2 in place by tightening wing nut 1.

6.4.3 Clean Oil Bath Air Filter

- Turn engine off and wait about 10 minutes for the oil to drain from filter housing 1.
- Loosen quick fasteners 2 and remove oil cup 3 with filter element 4; if necessary, loosen filter element with the aid of a screwdriver at the separating point. Do not damage rubber gasket 5!
- Remove dirty oil and sludge. Clean oil cup.
- Clean filter element 4 in diesel fuel and allow to drip-dry.
- Clean filter housing 1 if very dirty.
- Inspect and replace rubber gasket 5 and 6 if necessary.
- Fill oil cup with engine oil up to the mark (arrow) (for viscosity, see 4.1.2).
- Refit oil cup and element to filter housing and secure with snap clips.
6.4.4 Dry type air cleaner

Dust discharge valve

- Empty dust discharge valve 1 by pressing apart lips of discharge slot as indicated by arrows.
- Clean discharge slot from time to time.
- Remove any caked dirt by pressing together the upper section of the valve.

Filter Cartridge

- Undo clip fasteners 1.
- Take off hood 2 and remove cartridge 3.
- Clean cartridge (replace at least once a year).
- Clean cartridge 3.
  Blow out using dry compressed air (max. 5 bar), (or in difficult cases, tap out, taking care not to damage the cartridge, or wash according to manufacturer’s instructions).
- Through regular removal and replacement, the gaskets on the filter cartridge can become damaged. Check paper filter (light showing through) and gaskets for damage. Replace if necessary.

- After five cleaner services (or after two years at the latest), replace safety cartridge 4 (never clean).
  To do so:
  - Undo hex. nut 5 and remove cartridge 4.
  - Install new cartridge, insert and tighten hex nut.
- Install cartridge 3, replace hood 2 and do up clip fasteners 1.

Never clean filter cartridge with gasoline or hot fluids.
6.5 Belt Drives

6.5.1 Check V-belts

- Visually inspect entire V-belt for damage.
- Replace damaged V-belts.
- After installing new belts, run engine for 15 minutes, then check belt tension.
- To check the tension of the V-belt, use a tension gauge (see 9.3).
  - Place indicator arm 1 into gauge.
  - Position guide 3 on V-belt 2, midway between the pulleys, with flange 3 on bottom of gauge against the edge of belt.
  - Push slowly on the black pad 4 at right angles to V-belt 2 until the spring is heard or felt to trigger.
  - Carefully remove the gauge without altering the position of the indicator arm 1.

6.5.2 Fan V-belt

- To replace the tension roller 1, press inwards with a commercial tool and remove the V-belt.

Check, tension and change belts only with the engine off. Reinstall V-belt guard

Retension V-belt after it has ran for 15 minutes.
6.5 Belt Drives

6.5.3 Alternator belts

- Loosen bolts 1, 2 and 3 slightly.
- Press alternator 4 outwards in direction of arrow A until correct belt tension is achieved.
- Retighten bolts 1, 2 and 3.

6.5.4 Change alternator belt

- Remove fan belt, as shown in 6.5.2.
- Slacken off bolts 1, 2 and 3.
- Swing alternator inwards in the direction of arrow B.
- Remove and replace belt.
- Swing alternator 4 outwards in direction of arrow A until correct belt tension is achieved.
- Retighten bolts 1, 2 and 3.
- Fit fan belt.

6.5.5 Check warning system

- When the V-belt is torn, the pressure pin 1 of electrical switch is actuated by the tension roller and an audio signal or a light signal is emitted.
- Check the function by pressing pin 1.

Check, tension and change belts only with the engine off. Reinstall V-belt guard.

Retension V-belt after it has ran for 15 minutes.

Only check function when the engine is off!
6.5.6 Tensioning or changing V-belts

- Unscrew hex screw 1.
- Remove outer belt pulley half 2.
- Replace V-belt if necessary.

- In order to retension, remove one or more inner washers 3. Place the removed washers on the outside on the removed belt pulley half 2.
- Tighten screw 1 again. Whilst tightening, turn engine over simultaneously in order to prevent crushing the V-belt.

After installing new belts, run engine for 15 minutes, then check belt tension.
6.5.7 Air compressor model with dual belts

- Undo hex nut 1, remove V-belt pulley half 2, V-belt 3 and inner washer kit 7.
- Remove inner washers 4, posterior V-belt 3, inner washer kit 6 and pulley half 5.
- To retension, remove one or more inner washers from kits 6 and 7. Place removed washers in front of or behind pulley half 2 to ensure belt alignments. Always remove only the same number of washers from each kit.
- For installation, now proceed in the reverse order. Whilst tightening the nut 1, turn engine over simultaneously in order to prevent crushing the V-belt.

If one belt locks or is damaged, always replace both belts. The difference of length between the new belts may not exceed 0.15%.

Check and change belts only with the engine off.
Reinstall V-belt guard, if necessary. Retension V-belt after it has ran for 15 minutes.
6.6.1 Check valve clearance, adjust if necessary

- Remove the cylinder head cover.
- Position crankshaft as per schematic, see 6.6.1.1.
- Before adjusting valve clearance, allow engine to cool down for at least 30 minutes. The oil temperature should be below 80 °C.
- Check valve clearance 1 between rocker arm / tappet contact face 2 and valve stem 3 with feeler gauge 6 (there should be only slight resistance when feeler blade is inserted).
  For permissible valve clearance, see 9.1.

- Adjust valve clearance if necessary:
  - Release locknut 4.
  - Use allen key 7 to turn setscrew 5 so that the correct clearance is attained after locknut 4 has been tightened.
- Check and adjust valve clearance on all cylinders.
- Reinstall cylinder head cover with new gasket if necessary.

For high output settings, the engines are fitted with an additional oil nozzle to lubricate bearings. If necessary, readjustment may only be carried out in an authorised specialist workshop!
6.6 Adjustments

6.6.1.1 Schematic for Valve Clearance Adjustments

- **Crankshaft Position 1:**
  Turn crankshaft until both valves in cylinder 1 overlap (exhaust valve about to close, inlet valve about to open). Adjust clearance of valves marked in black on schematic. Mark respective rocker arm with chalk to show that adjustment has been carried out.

- **Crankshaft Position 2:**
  Turn crankshaft one full revolution (360°). Adjust clearance of valves marked in black on schematic.
6.7.1 Battery
6.7.1.1 Checking battery and cable connectors

- Keep battery clean and dry.
- Undo dirty clamps.
- Clean terminal posts (+ and -) and clamps of the battery, and grease with acid-free and acid-resistant grease.
- When reassembling, ensure that clamps make good contact. Tighten clamp bolts hand-tight.

6.7.1.2 Check Electrolyte Level

- Remove sealing caps 1.
- If testers 2 are present: Electrolyte level should reach the base of these.
- Without testers: The electrolyte level should be 10-15 mm above the top of the plates.
- If necessary, top up with distilled water.
- Screw sealing caps back in.

6.7.1.3 Check electrolyte density

- Measure the electrolyte density of individual cells with a commercial hydrometer.

The hydrometer reading (see table on following page) indicates the battery’s state of charge. During measurement, the temperature of the electrolyte should preferably be +20 °C.
### 6.7 Accessories

#### Service and Maintenance

<table>
<thead>
<tr>
<th>in [kg/l]</th>
<th>in [°Bé (Baumé scale)*]</th>
<th>Charge status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Tropical</td>
<td>Normal</td>
</tr>
<tr>
<td>1,28</td>
<td>1,23</td>
<td>32</td>
</tr>
<tr>
<td>1,20</td>
<td>1,12</td>
<td>24</td>
</tr>
<tr>
<td>1,12</td>
<td>1,08</td>
<td>16</td>
</tr>
</tbody>
</table>

* Measurement of electrolyte density in °Bé (Baumé scale) is out of date and rarely used today.

---

The gases emitted by the battery are explosive! Keep sparks and naked flames away from the battery! Do not allow battery acid to come into contact with skin or clothing! Wear protective goggles! Do not rest tools on the battery!
Notes on the three-phase system:
● Never disconnect the cables between battery, alternator and regulator while the engine is **running**.
● If, however, it is necessary to start and operate the engine without the battery, disconnect the regulator from the alternator before starting.
● Be sure not to confuse the battery terminals.
● Replace defective charge pilot lamp bulb immediately.
● When washing the engine, cover up the alternator and regulator.
● The habit of touching a lead against the frame to check whether it is live must under no circumstances be exercised with three-phase electrical systems.
● In case of electric welding, connect the ground terminal on the welder directly to the piece being welded.

Always use proper lifting tackle 1 when transporting the engine.

After transportation and before commissioning of the engine: Remove attachment eyes 2.

Use only the correct lifting gear!
6.8.1 Engine cleaning

Using compressed air

- Switch off the engine.
- Remove engine covers and cooling air hood. Replace them after cleaning and before the test run.
- Cover electrical / electronic components / connections (e.g. generator, starter, governor, solenoid).
- Blow air through the engine, taking particular care not to damage the cooler and cooling fins (begin to blow through air from the exhaust side).
- Remove the dirt which has blown into the interior space.

Using cold-cleaning compound

- Switch off the engine.
- Remove engine covers and cooling air hood. Replace them after cleaning and before the test run.
- Cover electrical / electronic components / connections (e.g. generator, starter, governor, solenoid).
- Spray the engine with the commercial cold-cleaning compound and allow to react for approx. 10 mins.
- Spray clean the engine with a strong water jet, repeat if necessary.
- Allow the engine to run warm so that the remaining water evaporates.

Using high pressure device

- Switch off the engine.
- Remove engine covers and cooling air hood. Replace them after cleaning and before the test run.
- Cover electrical / electronic components / connections (e.g. generator, starter, governor, solenoid).
- Clean the engine with a steam jet (max. spray pressure of 60 bar, max. steam temperature of 90°C).
- Allow the engine to run warm so that the remaining water evaporates.

Clean the engine only when the engine is switched off!
6.9 Additional Maintenance Work

6.9.1 Check fastenings

- Cylinder head cover 1
- Air intake manifold 2
- Connection sockets
- Exhaust line 3
- Engine mounts 4

6.9.2 Checking the function of the glow plugs

- With perfect function, the air-intake pipe 4 warms up near the glow lamps 2 from pre-glowing.

Test step 1

- Place speed control lever or shut-off lever in “stop” position.
- Insert key
  - Position 0 = no operating voltage
  - Key clockwise
  - Position 1 = operating voltage
  - Pilot lights illuminate
- Push key in and turn further clockwise against spring pressure.
  - Position 2 = Preheat, hold for approx. 1 minute.
  - Preheat lamp comes on
- Otherwise the glow lamps are defective or the transmission line interrupted.
6.9 Additional Maintenance Work

Service and Maintenance

Test step 2

- Loosen screw 1.
- Turn engine over with starter, key in switching position 3.
- Fuel must be present on the loosened pipe connection. Otherwise, the system and solenoid valve should be checked by a specialist!

Test step 3

- Loosen screw 1.
- Remove glow lamps 2.
- Turn engine over with starter, key in switching position 3.
- Fuel must be present on the glow lamps 2, or replace glow lamps 2 if necessary.
- When fitting glow lamps 2, use DEUTZ DW 47 sealants.
- Reinstall glow lamps to fuel line.

Keep away from moving parts! Collect any escaping fuel and dispose of this in an environmentally-friendly manner.
7.1 Fault Table
## Faults, Causes and Remedies

### 7.1 Fault Table

<table>
<thead>
<tr>
<th>Faults</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine does not start or is difficult to start</td>
<td>Check P</td>
</tr>
<tr>
<td>Engine starts, but runs irregularly or fails</td>
<td>Adjust E</td>
</tr>
<tr>
<td>Engine overheats, temperature warning system responds</td>
<td>Replace W</td>
</tr>
<tr>
<td>Engine output is deficient</td>
<td>Clean R</td>
</tr>
<tr>
<td>Engine does not run on all cylinders</td>
<td>Top up A</td>
</tr>
<tr>
<td>Engine oil pressure is non-existent or excessively low</td>
<td>Reduce S</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td></td>
</tr>
<tr>
<td>Engine smokes - blue</td>
<td></td>
</tr>
<tr>
<td>- white</td>
<td></td>
</tr>
<tr>
<td>- black</td>
<td></td>
</tr>
<tr>
<td>Cause Section</td>
<td>Section</td>
</tr>
<tr>
<td>Cause</td>
<td></td>
</tr>
<tr>
<td>Not declutched (where possible)</td>
<td>Engine Operation P</td>
</tr>
<tr>
<td>Below starting limit temperature</td>
<td>P</td>
</tr>
<tr>
<td>Engine shut-off lever still in stop position (shut-off magnet defective)</td>
<td>P</td>
</tr>
<tr>
<td>Oil level too low</td>
<td>A</td>
</tr>
<tr>
<td>Oil level too high</td>
<td>S</td>
</tr>
<tr>
<td>Excessive inclination of engine</td>
<td>P/E</td>
</tr>
<tr>
<td>Engine runs mainly with low load</td>
<td>P</td>
</tr>
<tr>
<td>Air cleaner clogged / turbocharger defective</td>
<td>Combustion air W</td>
</tr>
<tr>
<td>Air cleaner service switch / indicator defective</td>
<td>P/W</td>
</tr>
<tr>
<td>CPD defective (connection line leaks) only with turbocharged engines</td>
<td>P/W</td>
</tr>
<tr>
<td>Exhaust gas backpressure too high</td>
<td>P</td>
</tr>
<tr>
<td>Charge air line leaking, only with supercharged engines</td>
<td>P/E</td>
</tr>
<tr>
<td>Cooling fins soiled</td>
<td>Cooling system P/R</td>
</tr>
<tr>
<td>Intercooler soiled</td>
<td>P/R</td>
</tr>
<tr>
<td>Oil cooler soiled on the air and/or the oil side</td>
<td>P/R</td>
</tr>
<tr>
<td>Cooling fan or exhaust tension defective, torn or loose V-belt</td>
<td>P/W</td>
</tr>
<tr>
<td>Cooling air temperature rise / heating short circuit</td>
<td>P</td>
</tr>
<tr>
<td>Cooling air guide loose, torn or missing</td>
<td>P</td>
</tr>
</tbody>
</table>
### 7.1 Fault Table

#### Faults Measures

<table>
<thead>
<tr>
<th>Faults</th>
<th>Cause</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine does not start or is difficult to start</td>
<td>Battery defective or discharged</td>
<td>Electrics</td>
</tr>
<tr>
<td>Engine starts, but runs irregularly or fails</td>
<td>Cable connections, starter, electrical circuit loose or oxidised</td>
<td>P</td>
</tr>
<tr>
<td>Engine overheats, temperature warning system responds</td>
<td>Starter defective or pinion does not engage</td>
<td>P/W</td>
</tr>
<tr>
<td>Engine output is deficient</td>
<td>Oil pressure switch / gauge defective</td>
<td>P/W</td>
</tr>
<tr>
<td>Engine does not run on all cylinders</td>
<td>Incorrect valve clearance</td>
<td>Engine</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Injection line leaks</td>
<td>P/E</td>
</tr>
<tr>
<td>Engine oil consumption non-existent or excessively low</td>
<td>Ventilation line blocked</td>
<td>P/R</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Glow plugs</td>
<td>P/R/W</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Injection valve defective</td>
<td>P/W</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Air in the fuel system</td>
<td>P/W</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Fuel filter / fuel pre-cleaner soiled</td>
<td>P/R/W</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Oil filter defective</td>
<td>W</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Incorrect engine lube oil SAE class or quality</td>
<td>P</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Compression too low</td>
<td>P/R</td>
</tr>
<tr>
<td>Engine oil consumption excessive</td>
<td>Oil in combustion chamber</td>
<td>P/R</td>
</tr>
</tbody>
</table>
If the engine is to remain idle for an extended period of time, it is necessary to take protective measures to prevent the formation of corrosion. The preservative measures described here will protect the engine for up to approx. 6 months. The procedure will have to be reversed before the engine is recommissioned.

- **Anti-corrosion oils to specification:**
  - MIL-L 21260B
  - TL 9150-037/2
  - Nato Code C 640 / 642

- **Recommended cleaning agent to remove preservatives:**
  - Petroleum benzine (hazardous materials class A3)

### 8.1.1 Preserve engine

- Clean engine (with cold cleansing agent if preferred) using high pressure equipment (see 6.8.1).
- Run engine until warm, then turn off.
- Drain engine oil, (see 6.1.2), and fill with anti-corrosion oil.
- If necessary, clean oil bath cleaner (see 6.4.3), and fill with anti-corrosion oil.
- Drain fuel tank.
- Make up a mixture of 90% diesel fuel and 10% anti-corrosion oil, and refill fuel tank.
- Allow the engine to run for approx. 10 mins.
- Switch off the engine.
- Turn engine over manually several times to preserve the cylinders and combustion chamber. When turning over with starter, set shut-off lever to stop position.
- Remove V-belts and store wrapped, dry and recumbent.
- Spray grooves on V-belt pulleys with anti-corrosion spray.
- Close off intake ports and exhaust ports, possibly with plugs.

### 8.1.2 Remove engine preservation

- Remove anti-corrosion agent from grooves in V-belt pulleys.
- Install V-belt, retension after brief operation if necessary (see 6.5).
- Remove covers from intake port and exhaust ports.
- Commission engine.
9.1 Engine Specifications and Settings
9.2 Screw Tightening Torques
9.3 Tools
## 9.1 Engine Specifications and Settings

### Model Specifications

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>F3L 914</td>
<td>3</td>
<td>vertical in line</td>
<td></td>
<td>102</td>
<td>3236</td>
<td>20</td>
<td>4-stroke naturally aspirated diesel engine</td>
<td>Direct injection</td>
<td>counter-clockwise</td>
<td>270 5)</td>
<td>1)</td>
<td>1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inlet 0,15 + 0,05 / exhaust 0,15 + 0,05</td>
<td></td>
<td>1)</td>
<td>1–2–3</td>
<td>1–3–4–2</td>
<td>1–2–4–5–3</td>
<td>1–5–3–6–2–4</td>
<td>450 / 300 ± 20</td>
</tr>
<tr>
<td>F4L 914</td>
<td>4</td>
<td></td>
<td></td>
<td>132</td>
<td>4314</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>300 5)</td>
<td>1)</td>
<td>1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1)</td>
<td>1–3–4–2</td>
<td>1–2–4–5–3</td>
<td>1–5–3–6–2–4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F5L 914</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>5393</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>380 5)</td>
<td>1)</td>
<td>1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1)</td>
<td></td>
<td>1–2–4–5–3</td>
<td>1–5–3–6–2–4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F6L 914</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>6472</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>410 5)</td>
<td>1)</td>
<td>1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1)</td>
<td></td>
<td>1–5–3–6–2–4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Engine output, speed, start of delivery are stamped on engine rating plate, etc., (see also 2.1).
2) Re-tension 15 minutes after the engine has been operated under load.
3) Approx. values may vary depending on version. The upper oil dipstick mark is always authoritative.
4) Values for engines without engine oil heating.
5) Approx. values may vary depending on version.
### 914/C/CT Model

<table>
<thead>
<tr>
<th>Specified Values</th>
<th>BF3L 914</th>
<th>BF4L 914</th>
<th>BF6L 914</th>
<th>BF6L 914 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Cylinder arrangement</td>
<td>vertical in line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bore [mm]</td>
<td></td>
<td></td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>Stroke [mm]</td>
<td></td>
<td></td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Total displacement [cm³]</td>
<td>3236</td>
<td>4314</td>
<td>6472</td>
<td>6472</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working cycle</td>
<td>4-stroke turbocharged diesel engine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustion system</td>
<td>Direct injection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of rotation seen on flywheel</td>
<td>counter-clockwise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight including cooling system to DIN 70020-A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without starter or alternator [approx. kg]</td>
<td>320 5)</td>
<td>360 5)</td>
<td>485 5)</td>
<td>510 5)</td>
</tr>
<tr>
<td>Engine output [kW]</td>
<td></td>
<td></td>
<td>1)</td>
<td>1)</td>
</tr>
<tr>
<td>Speed [rpm]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubrication</td>
<td>Pressure lubrication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAE oil</td>
<td>15W 40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil temperature in oil pan [°C]</td>
<td>135</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min. oil pressure when warm (120 °C) and low idle [bar]</td>
<td>0,5 4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil plate filling quantity without filter [approx. litres]</td>
<td>9 3)</td>
<td>12 3)</td>
<td>16,0 3)</td>
<td>16,0 3)</td>
</tr>
<tr>
<td>Oil plate filling quantity with filter [approx. litres]</td>
<td>9,6 3)</td>
<td>13 3)</td>
<td>17,5 3)</td>
<td>17,5 3)</td>
</tr>
<tr>
<td>Valve clearance with cold engine [mm]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector opening pressure [bar]</td>
<td></td>
<td></td>
<td>200 + 10</td>
<td></td>
</tr>
<tr>
<td>Start of feed [°KW of TDC]</td>
<td></td>
<td></td>
<td>1)</td>
<td></td>
</tr>
<tr>
<td>Firing order of the engine</td>
<td>1–2–3</td>
<td>1–3–4–2</td>
<td>1–5–3–6–2–4</td>
<td>1–5–3–6–2–4</td>
</tr>
<tr>
<td>V-Belt tension: Pretension / Retension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternator fan [N]</td>
<td></td>
<td></td>
<td>Pretension / Retension 2)</td>
<td></td>
</tr>
<tr>
<td>Compressor [N]</td>
<td></td>
<td></td>
<td>400 / 250 ± 20</td>
<td>500 / 350 ± 20</td>
</tr>
</tbody>
</table>

1) Engine output, speed, start of delivery are stamped on engine rating plate, etc., (see also 2.1).
2) Re-tension 15 minutes after the engine has been operated under load.
3) Approx. values may vary depending on version. The upper oil dipstick mark is always authoritative.
4) Values for engines without engine oil heating.
5) Approx. values may vary depending on version.
### 9.2 Torque Wrench Settings

<table>
<thead>
<tr>
<th>Installation</th>
<th>Pretension [Nm]</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; position</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; position</th>
<th>Retension 3&lt;sup&gt;rd&lt;/sup&gt; position</th>
<th>4&lt;sup&gt;th&lt;/sup&gt; position</th>
<th>Total</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securing the alternator</td>
<td>20</td>
<td>180°</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>180°</td>
<td>M10 x 180</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>180°</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>180°</td>
<td>M14 x 230</td>
</tr>
<tr>
<td>Cylinder head cover</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>12 ± 1,2 Nm</td>
<td>–</td>
</tr>
<tr>
<td>Valve clearance adjusting screw Foot</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>22 ± 2 Nm</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>60°</td>
<td>15°</td>
<td>–</td>
<td>–</td>
<td>75°</td>
<td>M14 x 100</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>60°</td>
<td>45°</td>
<td>–</td>
<td>–</td>
<td>105°</td>
<td>M14 x 110</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>60°</td>
<td>45°</td>
<td>–</td>
<td>–</td>
<td>105°</td>
<td>M14 x 125</td>
</tr>
<tr>
<td>Intake manifold</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>21 ± 2 Nm</td>
<td>–</td>
</tr>
<tr>
<td>Exhaust manifold</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>40 ± 4 Nm</td>
<td>–</td>
</tr>
<tr>
<td>Oil drain screw</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>150 ± 10 Nm</td>
<td>M30 x 1,5</td>
</tr>
<tr>
<td>Oil drain screw</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>80 ± 10 Nm</td>
<td>M22 x 1,5</td>
</tr>
<tr>
<td>Injection valve attachment</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>25–30 Nm</td>
<td>–</td>
</tr>
</tbody>
</table>
V-belt tension gauge

The V-belt tension gauge can be obtained under order number 8115 from:

WILBÄR
Postfach 14 05 80
D-42826 Remscheid
**Introduction**

This document provides general information on LOFA Industries EP250 control systems operation and troubleshooting. EP250 control systems are a very flexible platform for diesel engine control, monitoring, and protection, featuring LOFA’s powerful First Fault Diagnostics (FFD). After pinpointing the initial failure, FFD stores it in memory and alerts the end user via a single bright LED. FFD monitors battery charge, low oil pressure, high temperature, overspeed and up to three additional contact closure inputs. The field configurable, expandable microprocessor-based solid-state design uses high-power semiconductors instead of outdated electromechanical relays to ensure reliable high-current switching.

The EP250 features LOFA’s new modular Function Enhancement Packs (FEP). The plug-and-play FEP modules allow various feature upgrades to be easily added to the standard platform. FEPs include:

- Diagnostic Program Gauge (DPG)
- Auto-Start with Real-time Clock
- Data Logging
- Closed Loop Speed Control
- Precision Actuator Control
- Custom OEM Solutions

The Diagnostic Program Gauge (DPG) features a backlit LCD display with three push buttons all in a compact 2 inch gauge. The LCD is clearly readable in both bright sunlight as well as total darkness. The DPG provides a complete user interface for other Function Enhancement Packs and allows each system to be field configured to suit the customer’s unique requirements. After configuring, the DPG can be removed in cost-sensitive applications.

Some of the EP250 configurable features include:

- Automatic preheat duration
- Afterglow duration
- Failure indication with shutdown or indication only
- Over-speed shutdown
- Normally open or normally closed shutdown switches

All standard panels include feature a 12 inch wiring harness terminating into a sealed weather proof plug. This robust universal wiring connection performs well in harsh environments and allows interchanging a number of different panels and harnesses. This design allows for simplified installation as well as a flexible means to incorporate custom plug-and-play engine wiring harnesses and standard harness extension.

**Note**

The engine harness is not included with the panel.

A number of standard engine harnesses are available or LOFA can develop a custom harness for your exact needs.

Generic harnesses in various lengths are available for field customization.
Warning

When replacement parts are required, LOFA Industries recommends using replacement parts supplied by LOFA or parts with equivalent specifications.

Failure to heed this warning can lead to premature failure, product damage, personal injury or death.

Important Safety Information

The warnings in this publication are not all inclusive.

LOFA Industries cannot anticipate every potential hazard.

Appropriate safety rules and precautions should be followed with any tool, work method or operating procedure.

Improper procedures, tools and materials may cause damage or make the equipment unsafe to operate.

Only persons with appropriate training, skills and tools should perform these functions.

Improper operation, maintenance or repair of this product can be dangerous and may result in injury or death.

Do not operate or perform any maintenance or repair on this product until all operation, maintenance and repair information is read and understood.

The information, specifications, and illustrations in this publication are based on information available at the time of publication.

All items are subject to change at any time without notice.
**Operation**

Turning the control system key to the run position starts a self-test which causes all LEDs to illuminate once, activates the alarm output for one second and enables the fuel run/stop solenoid output. After self-test, the LEDs indicate the state of the inputs they monitor. The normal indications are battery charge and oil pressure on most applications. If these LEDs are not illuminated at this time it may indicate the inputs are not properly connected.

The Preheat LED is illuminated when the key switch is turned to the run position if automatic preheat is configured or if an external preheat control is connected (See Preheat Options). Preheat time varies from application to application. After waiting for the Preheat LED to extinguish, the engine is cranked by turning and holding the key switch in the start position until the engine starts. The key switch is spring loaded to return automatically to the run position when released. The Preheat LED is illuminated during afterglow if enabled.

**Note**

The key switch is equipped with a mechanical start locking device. An attempt to re-crank the engine can only be made by turning the key switch to the off position to reset the start locking mechanism.

If the engine is not started within 10 seconds of turning on the system, the fuel run/stop solenoid output is turned off to prevent battery discharge when the key switch is left in the run position. The fuel run/stop solenoid output is turned off after 10 seconds even if preheating. As soon as the key switch is turned to the start position the solenoid output is enabled. The afterglow cycle begins when the key switch returns to the run position.

**Note**

If conditions do not warrant preheat, the engine may be started by turning the key to the start position without waiting for the preheat time to expire.

Control system instrument power, including the hourmeter and voltmeter, is provided by the fuel run/stop solenoid output. If the instruments do not power up when the key is turned to the run position, this indicates a problem with the solenoid circuit (see Troubleshooting).

After the engine starts, the control system electronics ignore all shutdown conditions for the first 10 seconds. This delay eliminates the requirement to hold a by-pass override button during starting and allows the system conditions such as oil pressure to normalize. The 10 second timer starts when the key switch returns to the run position.

**Note**

Starter input is required for correct system operation. If the starter motor input is not activated (connected to battery positive) and the engine is started through another means (i.e. air starter) the engine will shutdown 10 seconds after the key switch is turned to the run position.
To prevent unintentional engine shutdowns caused by intermittent conditions (i.e., pressure spikes, coolant movement) the control system requires a constant 1 second fault input to cause engine shutdown.

**Warning**

When used in combination with mechanical float type switches engine vibrations may prevent constant contact closure. The control system can be configured to shutdown with no delay.

See the *EP250 Configuration Guide* for detailed preheat control instructions.

The control system has the ability to shut down the engine for over speed. Over speed will be indicated via a blinking *Battery Charge* LED. If the control system is equipped with the DPG, the display will also indicate over speed shutdown. The control system senses RPM either by the frequency terminal of the alternator, proximity switch or magnetic pick-up.

**Preheat Options**

**Preheat Output**

Preheat is a 1A output for control of an external power relay with predetermined preheat and afterglow times. A relay should be selected with appropriate amperage capacity for the installed cold starting aid (glowplug, intake air heater, etc.). Applications using multiple cold starting aids may require multiple relays. Optional or additional components may allow preheat time to be modified by sensing ambient temperature. Depending on specific configuration, this output may provide either high side (battery positive) or low side (ground) control.

**Note**

Consult engine documentation when selecting cold starting aid, power relay and heating specifications.

**Preheat Indication Input**

With this option, the preheat LED provides indication for an external preheat control system. Depending on specific controls and configuration, this input can be configured to accept either high side (battery positive) or low side (ground) control.

**Indicators**

**Battery LED (Red)**

A solidly illuminated Battery LED indicates a battery charge failure. A battery charge failure may be caused by a faulty alternator, broken drive belt or the alternator not excited. A battery voltage reading of approximately 14 volts on a 12 volt system (28 volts on a 24 volt system) while the engine is running indicates the battery is charging properly. Irregular blinking of the Battery LED may indicate a failing charge circuit. The system can be configured for battery charge failure to indicate only.

**Overspeed Indication**

A regularly blinking Battery LED indicates the configured overspeed RPM has been exceeded. The overspeed RPM can be verified, changed or disabled (see the *EP250 Configuration Manual* for details).
**Oil Pressure LED (Red)**

A solidly illuminated Oil Pressure LED indicates low oil pressure failure. The control system typically senses low oil pressure from a ground contact switch on the engine. When a sender/switch combination is used on the engine, the marking **WK** generally indicates the switch terminal. This input typically expects a normally closed switch (ground contact when oil pressure is low). A defective switch or shorting the shutdown input to ground can cause low pressure fault indication. Additionally, when using sender/switch combinations, swapping the **WK** and **G** terminal can cause unintended shutdowns. The system can be configured for oil pressure failure to indicate only.

**Warning**

Low oil pressure is not an indication of low oil level.

For best possible protection LOFA recommends using our solid-state oil level shutdown switch.

**Note**

Most shutdown switches are grounded through the switch body.

Do not use insulating sealant (i.e. Teflon tape) when installing switches.

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**Temperature LED (Red)**

A solidly illuminated Temperature LED indicates high engine temperature failure. The control system typically senses high temperature from a ground contact switch on the engine. When a sender/switch combination is used on the engine, the marking **WK** or **W** generally indicates the switch terminal. This input typically expects a normally open switch (ground contact when engine temperature is too high). A defective switch or shorting the shutdown input to ground can cause over temperature fault indication. Additionally, when using sender/switch combinations, swapping the **WK** or **W** and **G** terminal can cause unintended shutdowns. The system can be configured for temperature failure to indicate only.

**Warning**

If the temperature switch is not in contact with coolant due to coolant loss the engine is not protected from overheating.

For best possible protection, LOFA recommends using our solid-state coolant level shutdown switch.

**Note**

Most shutdown switches are grounded through the switch body.

Do not use insulating sealant (i.e. Teflon tape) when installing switches.

Some thermostat housings are composites and do not provide ground for the switch.

---

**AUX 1 LED (Red)**

A solidly illuminated AUX 1 LED indicates auxiliary 1 failure (i.e., coolant level, oil level, belt breakage, hydraulic pressure, etc.). The control system typically senses failure using a ground contact switch. Auxiliary inputs are equipment specific and determined by the equipment manufacturer. A defective switch or shorting
the shutdown input to ground can cause fault indications. The system can be configured for auxiliary 1 failure to indicate only.

A blinking AUX 1 LED indicates SW input failure. The control system typically senses failure using a ground contact switch. The SW input is equipment specific and determined by the equipment manufacturer. A defective switch or shorting the shutdown input to ground can cause fault indications.

\[ \text{AUX 2 LED (Red)} \]

A solidly illuminated AUX 2 LED indicates auxiliary 2 failure (i.e., air flow restriction, fuel level, etc.) but by default does not cause a shutdown. The control system typically senses failure using a ground contact switch. Auxiliary inputs are equipment specific and determined by the equipment manufacturer. A defective switch or shorting the shutdown input to ground can cause fault indications. The system can be configured for auxiliary 2 failure to indicate only.

\[ \text{Preheat LED (Red)} \]

A solidly illuminated Preheat LED is the system preheat indication. When the LED extinguishes the preheat period is complete and the engine may be cranked. The LED illuminates again to indicate afterglow.

**Gauges**

**Voltmeter**

The voltmeter is connected to the fuel run/stop solenoid output. If the voltmeter does not indicate in the run position, this indicates a problem with the solenoid circuit. A battery voltage reading of approximately 14 volts on a 12 volt system (28 volts on a 24 volt system) while the engine is running indicates the battery is charging properly.

**Tachometer**

The tachometer indicates engine RPM using a frequency signal derived from the engine. This signal may be provided by an alternator frequency tap, proximity switch. An optional amplifier/divider can be added for use with a magnetic pickup.

**Note**

If the alternator is not excited (not charging), no frequency is generated and the tachometer will indicate 0 RPM.

The tachometer is factory calibrated to indicate correctly when the panel is preconfiguring or field calibrated with a Diagnostic Programming Gauge (DPG). The tachometer can be calibrated using standard procedures if the configuration is not performed (see Tachometer Calibration Instructions for details).

**Oil Pressure Gauge**

The gauge measures oil pressure with a resistance sender on the engine referenced to ground. When a sender/switch combination is used on the engine, the marking \( G \) generally indicates the gauge terminal. The gauge expects a low resistance for low pressure and a higher resistance for higher pressure. If the gauge is not connected to the sender, the gauge will read full scale (pegged). A defective sender or shorting the gauge input to ground will cause the gauge to read 0 pressure. When using sender/switch combinations, swapping the \( WK \) and \( G \) terminal prevents the gauge from working and may cause unintended shutdowns.
Warning
Low oil pressure is an indication of engine wear, not an accurate indication of low oil level.

Note
Senders and gauges must be matched to indicate correctly.
Most senders are grounded through the sender body.
Do not use insulating sealant (i.e. Teflon tape) when installing senders.

Temperature Gauge
The gauge measures engine temperature with a resistance sender on the engine referenced to ground. When a sender/switch combination is used on the engine, the marking G generally indicates the gauge terminal. The gauge expects a high resistance for low temperatures and a lower resistance for higher temperatures. If the gauge is not connected to the sender, the gauge will read 0. A defective sender or shorting the gauge input to ground will cause the gauge to read full scale (pegged). When using sender/switch combinations, swapping the WK and G terminal prevents the gauge from working and may cause unintended shutdowns.

Warning
If the temperature sensor is not in contact with coolant due to coolant loss the gauge will not accurately indicate engine temperature.

Note
Senders and gauges must be matched to indicate correctly.
Most senders are grounded through the sender body.
Do not use insulating sealant (i.e. Teflon tape) when installing senders.
Some thermostat housings are composites and do not provide ground for the sender.

Hourmeter
The hourmeter is connected to the fuel run/stop solenoid output. If the hourmeter does not count in the run position, this may indicate a faulty hourmeter or a problem with the solenoid circuit. If the engine shutdown or is not started within 10 second the hourmeter stops counting.

Additional Gauges
Additional gauges can be added by removing blind covers and installing the gauge. Power connections are provided with the standard configuration.
Harness

Sealed Connectors
The provided sealed weather proof plug includes a grey locking device which must be released to separate the connectors. Press the tab on the connector housing to release the connectors.

Warning
LOFA does not recommend using dielectric grease or sealant with sealed connectors. These chemicals may cause seal damage and allow water entry.

Use LOFA provided cavity plugs to seal the connector if wires are removed.

Unsealed Connectors
For unsealed connectors exposed to the elements, LOFA recommends using dielectric grease to protect contacts.

Warning
LOFA does not recommend using sealant with unsealed connectors. Sealant traps moisture in the connector and encourages corrosion.

Harness Routing
The minimum routing of radius of the wiring harnesses should be at least two times the diameter of the wiring harness. Bends should be avoided within 1 inch (25 mm) of any connector in order to avoid seal distortion allowing moisture to enter the connector.

Note
For harness length in excess of 10 ft a relay must be added to the start solenoid circuit.

LOFA offers starter relay kits for mounting near the engine.
Battery Circuit Requirements

Battery Positive Connection
The electronic control system operates on either a 12 VDC or 24 VDC electrical systems. The unswitched battery positive connection to the control system is made at the weather proof connector. The control system provides switched positive battery protected by a 15 Amp fuse (12 V or 24 V system).

Protection for the unswitched battery positive circuit is dependent on specific equipment configuration. The overload protection should not exceed 125% of the sum of all output currents plus 5 Amps for the control system. Powering the control system through dedicated circuits with appropriate overload protection reduces the possibility of system damage.

Circuit breakers are preferred over in-line fuses for circuit protection. Over current protection devices should ideally be located in a central location. If automatic reset circuit breakers are used, consideration of the environment of the breaker is critical and may affect the trip point. The trip point of some circuit breakers can be significantly reduced below the rated trip point if the circuit breaker is exposed to high temperatures.

Warning
Disconnecting the battery while the engine is running may damage electrical components.

When using a battery disconnect switch, LOFA recommends using a 2 pole switch to disconnect both the battery and alternator output.

Battery Negative Connection (Grounding)

Warning
Improper grounding can cause electrical noise, unreliable operation and may damage the control system or other components. All ground connections must be free from foreign materials, including paint, which may interfere with proper grounding.

A reliable ground must be provided for the control system.
LOFA recommends the ground connection be made directly to the battery negative.
Grounding through frame members is not recommended.

All ground paths must be capable of carrying any likely fault currents.

Do not reverse the battery polarity. Attempting to crank the engine when the polarity of the battery connections is reversed may damage the control system.

Note
A maximum of three ring terminals should be connected to a ground stud in order to ensure integrity of the ground connection. The use of more than three terminals can cause the connection to become loose.

Voltage Drop
If control system voltage drops below 6 volts for more than one tenth of a second, the control system may reset causing the self test to reactivate and the engine to shutdown after 10 seconds. Resetting the control
system is equivalent to quickly turning the key switch to off and back to run without starting the engine. Since the control system did not sense a start signal, the fuel run/stop solenoid deactivates after 10 seconds. Voltage drops can be caused by transients from external equipment, improper wire sizes, faulty wiring or nearby lightning strikes. In the absence of a LOFA Power Box, relays may be needed for long wire runs.

**Suppression of Voltage Transients (Spikes)**

**Warning**

The installation of voltage transient suppression at the transient source is required.

LOFA follows SAE recommended electrical environment practices.

Inductive devices such as relays, solenoids and motors generate voltage transients and noise in electrical circuits. Unsuppressed voltage transients can exceed SAE specifications and damage electronic controls.

Relays and solenoids with built-in voltage transient suppression diodes are recommended whenever possible. Refer to the illustration for proper installation of diodes when built-in voltage transient suppression is not available.

Locate inductive devices as far as possible from the components of the electronic control system. When using electric motors it may also be necessary to add isolation relays to eliminate voltage transients, noise and prevent back feed.

**Note**

LOFA harness assemblies typically include all required engine control suppression devices. Added equipment will require additional protection.
Welding on Equipment with Electronic Controls
Proper welding procedures are required to avoid damage to electronic controls, sensors, and associated components. The component should be removed for welding if possible.

The following procedure must be followed if the component must be welded while installed on equipment with electronic controls. This procedure will minimize the risk of component damage.

**Warning**

Do not ground the welder to electrical components such as the control ground or sensors. Improper grounding can cause damage to electrical components.

Clamp the ground cable from the welder to the component being welded. Place the clamp as close as possible to the weld to reduce the possibility of damage.

1. Stop the engine. Turn the key switch to the OFF position.
2. Disconnect the negative battery cable from the battery.
3. Open any installed battery disconnect switch.
4. Unplug the control system if possible.
5. Connect the welding ground cable as close as possible to the area to be welded.
6. Protect the wiring harness from welding debris and spatter.
7. Use standard welding methods to weld the materials.
## General Troubleshooting

For additional information, refer to engine manufacturer troubleshooting guide.

### No response from starter motor

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No battery voltage to starter</td>
<td>Verify wiring and battery connection (power and ground)</td>
</tr>
<tr>
<td>Battery discharged</td>
<td>Charge or replace battery, verify alternator charging</td>
</tr>
<tr>
<td>Tripped overcurrent protection</td>
<td>Correct fault, replace or reset overcurrent protection</td>
</tr>
<tr>
<td>No signal from control system</td>
<td>No power to control system [see Control System Troubleshooting below]</td>
</tr>
<tr>
<td>Defective starter solenoid</td>
<td>Replace starter solenoid</td>
</tr>
<tr>
<td>Defective starter motor</td>
<td>Replace starter motor</td>
</tr>
</tbody>
</table>

### Engine will crank but not start

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine not getting fuel</td>
<td>Check fuel level, filter, fuel pump, verify no air in fuel lines</td>
</tr>
<tr>
<td>Fuel run/stop solenoid not engaged</td>
<td>See Fuel Solenoid Run/Stop Troubleshooting (below)</td>
</tr>
<tr>
<td>Tripped overcurrent protection</td>
<td>Correct fault, replace or reset overcurrent protection</td>
</tr>
<tr>
<td>No preheat (cold condition)</td>
<td>See Preheat Troubleshooting</td>
</tr>
</tbody>
</table>

### Engine runs for 10 seconds and shuts down

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown switch input active</td>
<td>Verify shutdown source exists, correct condition or correct faulty circuit</td>
</tr>
<tr>
<td>Battery not charging</td>
<td>Verify alternator charging [see Alternator not charging battery below]</td>
</tr>
<tr>
<td>Control board did not sense start signal</td>
<td>Engine started through alternate method (i.e., manual air start, push start, etc.)</td>
</tr>
<tr>
<td>Defective control system</td>
<td>See Control Panel Troubleshooting (below)</td>
</tr>
</tbody>
</table>

### Engine runs longer than 10 seconds and shuts down

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown switch input active</td>
<td>Correct engine fault, verify shutdown switch wiring</td>
</tr>
<tr>
<td>Circuit overload protection tripped</td>
<td>Correct overload, keep control system from overheating (over 185°F/85°C)</td>
</tr>
<tr>
<td>Voltage transients (spikes)</td>
<td>Add suppressor diodes, protect from nearby lightening strikes, shield induced spikes from other equipment, add electric motor control relay</td>
</tr>
<tr>
<td>Defective control system</td>
<td>See Control System Troubleshooting (below)</td>
</tr>
</tbody>
</table>

### Alternator not charging battery

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broken or slipping alternator drive belt</td>
<td>Adjust or replace alternator drive belt</td>
</tr>
<tr>
<td>Alternator not excited</td>
<td>Verify excitation circuit connected, replace faulty regulator, add additional excitation resistor</td>
</tr>
<tr>
<td>Alternator output not connected</td>
<td>Install charge wire</td>
</tr>
<tr>
<td>Alternator not grounded</td>
<td>Clean or add ground connection</td>
</tr>
<tr>
<td>Alternator faulty</td>
<td>Replace faulty alternator</td>
</tr>
</tbody>
</table>
**Fuel Run/Stop Solenoid Troubleshooting**

**Engine does not stop immediately**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back feed from motor (i.e., cooling fan)</td>
<td>Add relay or blocking diode</td>
</tr>
<tr>
<td>Sticking solenoid linkage</td>
<td>Repair or replace solenoid linkage</td>
</tr>
<tr>
<td>Fuel valve without check valve</td>
<td>Install or repair check valve</td>
</tr>
</tbody>
</table>

**Fuel run/stop solenoid does not engage**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No power to solenoid</td>
<td>Locate reason for lack of power and correct (Circuit overloaded? Failed suppressor diode? Faulty wiring?)</td>
</tr>
<tr>
<td>No power to solenoid pull coil</td>
<td>Correct faulty wiring, check pull control circuit (see Power Box Troubleshooting below)</td>
</tr>
<tr>
<td>Incorrect linkage adjustment</td>
<td>Adjust solenoid linkage</td>
</tr>
<tr>
<td>Faulty solenoid</td>
<td>Replace solenoid</td>
</tr>
<tr>
<td>Failed suppressor diode</td>
<td>Correct wiring (diode reversed?), replace suppressor diode</td>
</tr>
<tr>
<td>Optional e-stop engaged</td>
<td>Disengage e-stop</td>
</tr>
</tbody>
</table>

**Engine not getting fuel**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty fuel tank</td>
<td>Fuel engine</td>
</tr>
<tr>
<td>Clogged filter</td>
<td>Replace filter</td>
</tr>
<tr>
<td>Air in fuel lines</td>
<td>Bleed fuel lines</td>
</tr>
<tr>
<td>Low fuel pressure</td>
<td>Replace faulty fuel pump and/or clogged filter</td>
</tr>
<tr>
<td>Faulty fuel pump</td>
<td>Replace fuel pump, correct wiring fault (electric fuel pump)</td>
</tr>
</tbody>
</table>

**Preheat Troubleshooting**

**Engine is hard to start in cold conditions**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start attempt before preheat complete</td>
<td>Wait for preheat time to elapse, crank as soon as time elapses</td>
</tr>
<tr>
<td>Incorrect preheat specification</td>
<td>Correct control system configuration, install correct control system</td>
</tr>
<tr>
<td>Heater faulty</td>
<td>Replace heater</td>
</tr>
<tr>
<td>Heater relay faulty</td>
<td>Replace relay</td>
</tr>
<tr>
<td>Preheat control not functioning</td>
<td>Correct wiring, correct control system configuration</td>
</tr>
<tr>
<td>Faulty control system</td>
<td>See Control System Troubleshooting (below)</td>
</tr>
</tbody>
</table>

**Engine produces excessive white smoke after starting**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afterglow not enabled</td>
<td>Reconfigure control system</td>
</tr>
<tr>
<td>Heater faulty</td>
<td>Replace heater</td>
</tr>
<tr>
<td>Heater relay faulty</td>
<td>Replace relay</td>
</tr>
<tr>
<td>Preheat control not functioning</td>
<td>Correct wiring, correct control system configuration</td>
</tr>
<tr>
<td>Faulty control system</td>
<td>See Control System Troubleshooting (below)</td>
</tr>
</tbody>
</table>
**Control System Troubleshooting**

**Control system does not perform self test**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tripped overcurrent protection</td>
<td>Correct fault, replace or reset overcurrent protection</td>
</tr>
<tr>
<td>Faulty connection to battery</td>
<td>Correct battery connections (see Battery Circuit Requirements above)</td>
</tr>
</tbody>
</table>

**Control system performs normal self test, engine cranks, runs and shuts down**

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only Battery LED illuminated</td>
<td>Correct battery charge failure (see Battery not charging above)</td>
</tr>
<tr>
<td>Only Oil Pressure LED Illuminated</td>
<td>Correct low oil pressure condition or faulty switch, correct wiring fault</td>
</tr>
<tr>
<td>Only Temperature LED Illuminated</td>
<td>Correct overheating condition or faulty switch, correct wiring fault</td>
</tr>
<tr>
<td>Only Aux LED Illuminated</td>
<td>Correct fault condition (i.e. v-belt, coolant level) or faulty switch, correct wiring fault</td>
</tr>
<tr>
<td>All normally closed shutdowns</td>
<td>Add suppressor diodes, protect from nearby lightening strikes, shield induced spikes from other equipment, add electric motor control relay</td>
</tr>
</tbody>
</table>

illuminate for one second (control system reset)

**Testing Shutdown Inputs**

Shutdown switches signal a fault by ground contact in most systems. Shutdown operation can be verified by grounding the shutdown inputs individually. It may be necessary to remove the wire from the shutdown switch to perform this test.

**Note**

Most shutdown switches are grounded through the switch body.
Do not use insulating sealant (i.e. Teflon tape) when installing switches.

Some thermostat housings are composites and do not provide ground for the switch.

**Revision History**

Initial Release.


The following pages show typical schematics.
Details vary from installation to installation.
See the specific schematics for installation for details.
DESCRIPTION

Muncie’s STA-9020 Hydro-Throttle Control, used in conjunction with hydraulic powered equipment, will automatically advance engine speed to a pre-selected R.P.M.

The STA-9020 Hydro-Throttle Control is connected into the hydraulic pressure line between the pump and control valve. Activation of any spool of the control valve will cause a pressure build-up in the pressure sensing part of the STA-9020. The internal piston, moving against the leaf springs, causes the springs to pull the throttle linkage to advance the engine speed.

When the control valve is de-activated, pressure drops and allows the STA-9020 to release its pull against the throttle linkage, returning the engine speed to idle. Note: For use on tandem pumps, incorporate Muncie’s HSV-250 shuttle valve to isolate two circuits.

Note: For use on tandem pumps, incorporate Muncie’s HSV-250 shuttle valve to isolate two circuits.

SPECIFICATIONS

Net Weight ....................3 lbs.
Overall Width ..................2-3/8”
Overall Length ..................6-3/8”
Overall Thickness ............1-1/4”
Piston Diameter ..............7/16”
Port Size ......................3/8 O.D.T.
FULLY ADJUSTABLE
The Muncie STA-9020 Hydro-Throttle is fully adjustable to meet a wide variance of operating conditions and system requirements.

The spring rate is adjustable by moving the fulcrum screw (5) and changing the number of leaf springs (three are furnished).

Spring tension is adjustable by changing the adjusting screw (4) at the base of the casting.

The amount of travel of the accelerator rod is adjustable by changing the activating rod (9) from spring hold 4 through 1 and by changing the amount of cable slack at engine idle.

The Hydro-Throttle was shipped to you assembled in a medium configuration. The table below indicates five variations of settings. Your unit is set up for variation 2. Try this variation first unless prior installations have indicated another set up is best for your application.

**ADJUSTMENT TABLE**

<table>
<thead>
<tr>
<th>Variation Number</th>
<th>No. of Springs</th>
<th>Fulcrum Hole</th>
<th>Spring Tension * Turns</th>
<th>Spring Tension * Pressure</th>
<th>Actuating Rod Hole Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>A</td>
<td>3</td>
<td>1100</td>
<td>11X</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>B</td>
<td>3</td>
<td>780</td>
<td>3X</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>C</td>
<td>2-1/2</td>
<td>640</td>
<td>Normal</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>C</td>
<td>2</td>
<td>370</td>
<td>3/4X</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>D</td>
<td>5/8</td>
<td>300</td>
<td>1/4X</td>
</tr>
</tbody>
</table>

*Note: Apply turns from when the screw (4) just begins to deflect the spring at zero load. Pressure is approximate when piston will begin to move.

**INSTALLATION INSTRUCTIONS**

1. Attach the "L" shaped mounting bracket to the control (1).
2. Mount the bracket to the engine so that the cable will be in line with the accelerator rod. Modify or bend the mounting bracket if necessary.
3. Attach the cable (10) and actuating rod assembly (9) to hole 4 of the leaf spring.
4. Mount the clamp (11) to the throttle rod and attach cable eyelet to one of the clamp studs.
5. Install a tee in the hydraulic line between the pump and control valve. This tee should be as close as possible to the valve.
6. Connect a 1/4" (minimum) high pressure hose between the tee and the pressure sensing port of the Hydro-Throttle control. Use a small amount of sealer on male threads only. DO NOT USE TEFLOON TAPE. Do not allow any sealer to enter the piston area of the throttle control.

YOU ARE NOW READY TO ADJUST THE HYDRO-THROTTLE.

**ADJUSTMENT PROCEDURE**

1. Start engine and engage PTO and pump, but do not energize any control valves yet. Allow system to warm up and run at idle without choke (slow idle).
2. Air bleed the pressure line by cracking the fitting at the Hydro-Throttle control.
3. Turn speed adjusting screw (7) in until it touches spring. Then turn out one turn temporarily to limit stroke and prevent engine overspeeding.

4. Activate a highly loaded valve circuit. (Bottom out a cylinder to trip the pressure relief valve.) The Hydro-Throttle will attempt to pull accelerator rod.

5. Turn speed adjusting screw (7) outward until the desired engine speed (under load) is reached. Tighten lock nut (3).

6. Return valve to neutral position. The Hydro-Throttle will allow the engine to return to idle. If not, see Trouble Shooting Guide for probable causes.

7. Determine which hydraulic circuit produces the lowest pressure. (Lowering outriggers, boom swing, etc.) Operate this circuit and see if Hydro-Throttle will pull accelerator rod. If not, see Trouble Shooting Guide for probable cause.

---

STA-9020 PARTS LIST

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QTY</th>
<th>PART NO.</th>
<th>DESCRIPTION</th>
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<td>28T35118</td>
<td>Bracket</td>
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<tr>
<td>2</td>
<td>1</td>
<td>47TA3790</td>
<td>Piston Assembly</td>
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<tr>
<td>3</td>
<td>1</td>
<td>22T35145</td>
<td>Nut, Jam 3/8-16</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>19T35127</td>
<td>Screw 3/8-16 x 2.00 Spring Tension Adjusting</td>
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<tr>
<td>5</td>
<td>1</td>
<td>19T35133</td>
<td>Screw, Fulcrum</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>01T35641</td>
<td>Housing (for Screw-In Liner)</td>
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<tr>
<td>7</td>
<td>1</td>
<td>19T35141</td>
<td>Screw 3/8-16 x 1.00 Speed Adjusting</td>
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<tr>
<td>8</td>
<td>3</td>
<td>27T35130</td>
<td>Spring, Leaf</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>47TA3796</td>
<td>Rod, Actuating, with Nuts and Set Screws</td>
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<td>10</td>
<td>1</td>
<td>47TA3794</td>
<td>Cable Assembly</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>47TA3795</td>
<td>Clamp</td>
</tr>
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<td>12</td>
<td>1</td>
<td>47TA3792</td>
<td>Rod/Cable/Clamp Assembly</td>
</tr>
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<td>13</td>
<td>2</td>
<td>21T35143</td>
<td>Lockwasher</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>19T35144</td>
<td>Capscrew 5/16-24 x .75 Grade 5</td>
</tr>
<tr>
<td>NS*</td>
<td>1</td>
<td>28T35648</td>
<td>Screw-In Liner</td>
</tr>
</tbody>
</table>
APPENDIX C

TROUBLE SHOOTING HINTS

A. Problem: Engine Does Not Idle But Speeds Up When PTO is Engaged

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control lever stuck open.</td>
<td>1. Return all valves to neutral.</td>
</tr>
<tr>
<td>2. Low leaf spring tension.</td>
<td>2. Repeat calibration.</td>
</tr>
<tr>
<td>3. Cold oil.</td>
<td>3. Warm oil.</td>
</tr>
</tbody>
</table>

B. Problem: Engine Does Not Speed Up When Light Load Is Applied

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PTO not engaged.</td>
<td>1. Engage PTO.</td>
</tr>
<tr>
<td>3. Connecting cable.</td>
<td>3. Reduce slack to minimum.</td>
</tr>
<tr>
<td>5. Hot oil.</td>
<td>5. Allow oil to cool.</td>
</tr>
<tr>
<td>6. Your engine throttle linkage.</td>
<td>6. Oil &amp; repair. Check manufacturer for lighter spring if it’s excessive.</td>
</tr>
<tr>
<td>7. Circuit pressure is too low.</td>
<td>7. Revise plumbing to increase spread between your circuit and by-passing pressures.</td>
</tr>
<tr>
<td>8. Excessive leaf spring tension.</td>
<td>8. Repeat calibration.</td>
</tr>
</tbody>
</table>

C. Problem: Engine Does Not Return To Idle After A Load Is Applied

<table>
<thead>
<tr>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Your engine.</td>
<td>2. Make sure it can idle.</td>
</tr>
<tr>
<td>3. Connecting cable.</td>
<td>3. Check for slack.</td>
</tr>
<tr>
<td>4. Low leaf spring rate.</td>
<td>4. Increase spring rate. See adjustment table.</td>
</tr>
<tr>
<td>5. Low leaf spring rate.</td>
<td>5. Repeat calibration.</td>
</tr>
<tr>
<td>6. Excessive by-passing pressure.</td>
<td>6. Remove “bottlenecks” or increase line size downstream of the control connection.</td>
</tr>
</tbody>
</table>

WARNING: The Muncie Hydro-Throttle is only to be operated when the vehicle is stationary and the parking brake is set. The installer is responsible for providing a lockout system which makes the Hydro-Throttle inoperable if the parking brake is not set and the transmission is not in neutral.
Applications for Moduflow Filters

- Power Unit Fabrication
- Off-line Filter Loops
- Mobile Equipment

The Moduflow filter is widely considered the most versatile filter available on the market. The unique diverter valve assembly, and inside to outside flow through the element, allows the Moduflow to be configured for in-line, in-tank or suction filtration.

The flow diverter minimizes turbulence and pressure loss through the filter, improving system performance.

The newly designed closed bottom elements for the RFP and ILP models insures all contamination remains trapped within the element as the filter is serviced.

A wide variety of visual and electrical indicators allows you to know exactly when the element needs to be serviced. There is even a "no element" indicator that can sense when there is not an element installed in the filter.

From top to bottom, the Moduflow filter series provides the high level of filtration and long term dependability so vital to today’s hydraulic systems.

Parker’s new patented Moduflow element was designed with built-in diverter cone and bypass valve, to meet your application needs.
Features

**Flanges**
- NPT or SAE ¾” to 2”
- Lightweight aluminum

**Indicators**
- Visual or electrical
- Mounted on either side
- Standard “no element” indication

**Bypass** (not visible)
- Integral 35 psi bypass replaced with every element change

**Cover**
- Slotted for quick release
- Lightweight aluminum

**Bowl**
- Single or double length
- Durable steel construction

**Element** (not visible)
- Available in cellulose, wire mesh or high performance Microglass III media
- Single or double length

<table>
<thead>
<tr>
<th>Feature</th>
<th>Advantage</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top access element service</td>
<td>Oil remains in housing</td>
<td>No Spills</td>
</tr>
<tr>
<td></td>
<td>Quicker elements change</td>
<td>Reduced maintenance costs</td>
</tr>
<tr>
<td>Slotted cover</td>
<td>Quick release cover</td>
<td>Reduced maintenance costs</td>
</tr>
<tr>
<td></td>
<td>Cap screws remain in housing</td>
<td>No loose parts to lose</td>
</tr>
<tr>
<td>Closed bottom elements</td>
<td>Removes all contaminant during element service</td>
<td>No downtime contamination from servicing</td>
</tr>
<tr>
<td>Visual or electrical indicators</td>
<td>Know exactly when to service elements</td>
<td>Helps prevent bypass condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No premature disposal</td>
</tr>
<tr>
<td>Flange face ports</td>
<td>Flexible mounting (3/4” to 2”)</td>
<td>Easy plumbing to your system</td>
</tr>
</tbody>
</table>
Low Pressure Filters
Moduflow™ Plus Series

RFP-1 & ILP-1 Element Performance

Efficiency

Beta Rating
10000
1000
200
100
20
2
Efficiency %
99.9
99.5
99.0
95.0
50.0

Micron Size [μ]
0 4 8 12 16 20

Capacity

PSID
50
40
30
20
10
0
BAR
3.0
2.5
2.0
1.5
1.0
0.5
0.0

Capacity grams
0 20 40 60 80 100

Multipass tests run @ 40 gpm to 50 psid terminal – 5mg/L BUGL

Flow vs. Pressure Loss

LPM

0 50 100 150 200 250 300 350

PSID
0 20 40 60 80 100

GPM
0 20 40 60 80 100

LPM

0 50 100 150 200 250 300 350

PSID
0 0.2 0.4 0.6 0.8 1.0 1.2

GPM
0 0.2 0.4 0.6 0.8 1.0 1.2

150SUS
0.5
0.4
0.3
0.2
0.1
0.0

1½” SAE
0.6
0.5
0.4
0.3
0.2
0.1
0.0

2” SAE flange
0.6
0.5
0.4
0.3
0.2
0.1
0.0

Empty Housing

150SUS
0.5
0.4
0.3
0.2
0.1
0.0

2” SAE flange
RFP-2 & ILP-2 Element Performance

Efficiency

Beta Rating 10000
1000
200
20
0
Micron Size [c] 0 4 8 12 16 20

Efficiency % 100.0 99.5 99.0 99.9

Capacity

PSID 0 25 50 75 100 125 150
0 20 40 60 80 100 120 140 160
LPM 0 100 200 300 400 500
BAR 0.0 0.5 1.0 1.5 2.0 2.5 3.0

Capacity grams

Capacity

2Q 5Q 10Q 20Q

Multipass tests run @ 80 gpm to 50 psid terminal - 5mg/L BUGL

Flow vs. Pressure Loss

LPM

LPM

GPM

GPM

Parker Hannifin Corporation
Hydraulic Filter Division
Metamora, OH
Specifications: RFP, ILP

**Pressure Ratings:**
- Maximum Allowable Operating Pressure (MAOP): 200 psi (13.8 bar)
- Design Safety Factor: 2:1
- Rated Fatigue Pressure: 150 psi (10.3 bar)

**Element Burst Rating:** 70 psid (4.8 bar)

**Filter Materials:**
- Head, Cover, Flanges: die cast aluminum
- Bowl: steel

**Operating Temperatures:**
- Nitrile: -40°F to 225°F (-40°C to 107°C)
- Fluorocarbon: -15°F to 275°F (-26°C to 135°C)

**Weight (approximate):**
- Single: 20 lbs. (9.1 kg)
- Double: 25 lbs. (11.3 kg)

**Indicators:**
- Visual (optional)
- Electrical (optional) 15A @ 250VAC / .5A @ 125 VDC
- Electrical ("D" option) 5A @ 250VAC / 3A @ 28 VDC

**Color Coding:**
- White (normally closed)
- Red (normally open)
- Black (common)

**Dimensions:**

<table>
<thead>
<tr>
<th>Model Description</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFP-1 without optional 2” fitting</td>
<td>65.0</td>
<td>330.2</td>
<td>13.0</td>
<td>4.3</td>
</tr>
<tr>
<td>RFP-1 with optional 2” fitting</td>
<td>68.3</td>
<td>383.4</td>
<td>15.07</td>
<td>4.5</td>
</tr>
<tr>
<td>RFP-2</td>
<td>68.3</td>
<td>617.5</td>
<td>24.31</td>
<td>24.56</td>
</tr>
<tr>
<td>ILP-1</td>
<td>65.0</td>
<td>330.2</td>
<td>N/A</td>
<td>110.0</td>
</tr>
<tr>
<td>ILP-2</td>
<td>68.3</td>
<td>617.5</td>
<td>24.31</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Linear Measure:** millimeter (inch)

---

*Parker Hannifin Corporation*

Hydraulic Filter Division

Metamora, OH
ISO 4406 Code

Cleanliness levels are defined by three numbers divided by slashes (/). These numbers correspond to 4, 6, and 14 micron, in that order. Each number refers to an ISO Range Code, which is determined by the number of particles for that size (4,6, & 14µm) and larger present in 1 ml of fluid. Each range is double the range below. Refer to the chart below to see the actual ranges.

Example:
- larger than 4µm = 22,340
- larger than 6µm = 1,950
- larger than 14µm = 43

ISO Code = 22 / 18 / 13

Achieving the appropriate cleanliness level in a system

The only way to achieve and maintain the appropriate cleanliness level in a hydraulic or lubrication system, is to implement a comprehensive filtration program. HYDAC offers all of the products that are needed to do just that! - They include:

**Solid Contamination**
- pressure filters
- return line filters
- offline filtration loops
- oil transfer units for precleaning of new oil
- portable and online contamination monitors
- reservoir breathers and filler/breathers

**Water Content**
- water content sensors
- reservoir breathers with silica gel desiccant
- vacuum dehydration water removal units
- water removal elements

**Fluid Analysis**
- bottle sampling kits
- complete analysis kits
Finding the cleanliness level required by a system
1. Starting at the left hand column, select the most sensitive component used in the system.
2. Move to the right to the column that describes the system pressure and conditions.
3. Here you will find the recommended ISO class level, and recommended element micron rating.

<table>
<thead>
<tr>
<th>ISO Cleanliness Levels</th>
<th>Micron Ratings</th>
<th>ISO Cleanliness Levels</th>
<th>Micron Ratings</th>
<th>ISO Cleanliness Levels</th>
<th>Micron Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low/Medium Pressure Under 2000 psi</strong></td>
<td><strong>High Pressure 2000 to 2999 psi</strong></td>
<td><strong>Very High Pressure 3000 psi and over</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>ISO Target Levels</strong></td>
<td><strong>ISO Target Levels</strong></td>
<td><strong>ISO Target Levels</strong></td>
<td><strong>Micron Ratings</strong></td>
<td><strong>Micron Ratings</strong></td>
<td><strong>Micron Ratings</strong></td>
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<tr>
<td><strong>Pumps</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fixed Gear or Fixed Vane</td>
<td>20/18/15</td>
<td>19/17/14</td>
<td>18/16/13</td>
<td>17/15/12</td>
<td>16/14/11</td>
</tr>
<tr>
<td>Fixed Piston</td>
<td>19/17/14</td>
<td>18/16/13</td>
<td>17/15/12</td>
<td>16/14/11</td>
<td>15/13/10</td>
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<tr>
<td>Variable Vane</td>
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<td>17/15/12</td>
<td>16/14/11</td>
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<tr>
<td>Variable Piston</td>
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<td>15/13/10</td>
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<td>Directional (solenoid)</td>
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<td>18/16/13</td>
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<td>13/11/10</td>
<td>12/11/10</td>
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<td><strong>Actuators</strong></td>
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<td>Cylinders, Vane Motors, Gear Motors</td>
<td>20/18/15</td>
<td>19/17/14</td>
<td>18/16/13</td>
<td>17/15/12</td>
<td>16/14/11</td>
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<tr>
<td>Piston Motors, Swash Plate Motors</td>
<td>19/17/14</td>
<td>18/16/13</td>
<td>17/15/12</td>
<td>16/14/11</td>
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<tr>
<td>Hydrostatic Drives</td>
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<td>15/14/10</td>
<td>14/13/10</td>
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<td>Test Stands</td>
<td>15/13/10</td>
<td>14/12/10</td>
<td>13/11/10</td>
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<td><strong>Bearings</strong></td>
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<td>Journal Bearings</td>
<td>17/15/12</td>
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<td>15/13/10</td>
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<td>Industrial Gearboxes</td>
<td>17/15/12</td>
<td>16/14/11</td>
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<td>13/11/10</td>
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<tr>
<td>Ball Bearings</td>
<td>15/13/10</td>
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<td>11/09/10</td>
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<tr>
<td>Roller Bearings</td>
<td>16/14/11</td>
<td>15/13/10</td>
<td>14/12/10</td>
<td>13/11/10</td>
<td>12/10/10</td>
</tr>
</tbody>
</table>

1. Severe conditions may include high flow surges, pressure spikes, frequent cold starts, extremely heavy duty use, or the presence of water
2. Two or more system filters of the recommended rating may be required to achieve and maintain the desired Target Cleanliness Level.

**FREE Poster!**
The information on these two pages is also available on our **ISO Cleanliness Guidelines** poster.
Visit our web site to request your FREE copy.

www.hydacusa.com/poster
SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Lead Acid Battery Wet, Filled With Acid
OTHER PRODUCT NAMES: Electric Storage Battery, SLI or Industrial Battery, UN2794
MANUFACTURER: East Penn Manufacturing Company, Inc.
DIVISION: Deka Road
ADDRESS: Lyon Station, PA 19536 USA
EMERGENCY TELEPHONE NUMBERS: US: CHEMTREC 1-800-424-9300
CN: CHEMTREC 1-800-424-9300
Outside US: +1-703-527-3887
NON-EMERGENCY HEALTH/SAFETY INFORMATION: 1-610-682-6361
CHEMICAL FAMILY: This product is a wet lead acid storage battery. May also include gel/absorbed electrolyte type lead acid battery types.
PRODUCT USE: Industrial/Commercial electrical storage batteries.

This product is considered a Hazardous Substance, Preparation or Article that is regulated under US-OSHA; CAN-WHMIS; IOSH; ISO; UK-CHIP; or EU Directives (67/548/EEC-Dangerous Substance Labeling, 98/24/EC-Chemical Agents at Work, 99/45/EC-Preparation Labeling, 2001/58/EC-MSDS Content, and 1907/2006/EC-REACH), and an MSDS/SDS is required for this product considering that when used as recommended or intended, or under ordinary conditions, it may present a health and safety exposure or other hazard.

Additional Information
This product may not be compatible with all environments, such as those containing liquid solvents or extreme temperature or pressure. Please request information if considering use under extreme conditions or use beyond current product labeling.

SECTION 2: HAZARDS IDENTIFICATION

GHS Classification:

<table>
<thead>
<tr>
<th>Health</th>
<th>Environmental</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Toxicity – Not listed (NL)</td>
<td>Aquatic Toxicity – NL</td>
<td>NFPA – Flammable gas, hydrogen (during charging)</td>
</tr>
<tr>
<td>Eye Corrosion – Corrosive*</td>
<td></td>
<td>CN - NL</td>
</tr>
<tr>
<td>Skin Corrosion – Corrosive*</td>
<td></td>
<td>EU - NL</td>
</tr>
<tr>
<td>Skin Sensitization – NL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutagenicity/Carcinogenicity – NL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive/Developmental – NL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target Organ Toxicity (Repeated) – NL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*as sulfuric acid

GHS Label: Lead Acid Battery, Wet

Symbols: C (Corrosive)

Hazard Statements: Contact with internal components may cause irritation of severe burns. Irritating to eyes, respiratory system, and skin.

Precautionary Statements: Keep out of reach of children. Keep containers tightly closed. Avoid heat, sparks, and open flame while charging batteries. Avoid contact with internal acid.

EMERGENCY OVERVIEW: May form explosive air/gas mixture during charging. Contact with internal components may cause irritation or severe burns. Irritating to eyes, respiratory system, and skin.
Prolonged inhalation or ingestion may result in serious damage to health. Pregnant women exposed to internal components may experience reproductive/developmental effects.

**POTENTIAL HEALTH EFFECTS:**

**EYES:** Direct contact of internal electrolyte liquid with eyes may cause severe burns or blindness.

**SKIN:** Direct contact of internal electrolyte liquid with the skin may cause skin irritation or damaging burns.

**INGESTION:** Swallowing this product may cause severe burns to the esophagus and digestive tract and harmful or fatal lead poisoning. Lead ingestion may cause nausea, vomiting, weight loss, abdominal spasms, fatigue, and pain in the arms, legs and joints.

**INHALATION:** Respiratory tract irritation and possible long term effects.

**ACUTE HEALTH HAZARDS:**
Repeated or prolonged contact may cause mild skin irritation.

**CHRONIC HEALTH HAZARDS:** Lead poisoning if persons are exposed to internal components of the batteries. Lead absorption may cause nausea, vomiting, weight loss, abdominal spasms, fatigue, pain in the arms, legs and joints. Other effects may include central nervous system damage, kidney dysfunction, and potential reproductive effects. Chronic inhalation of sulfuric acid mist may increase the risk of lung cancer.

**MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:** Respiratory and skin diseases may predispose one to acute and chronic effects of sulfuric acid and/or lead. Children and pregnant women must be protected from lead exposure. Persons with kidney disease may be at increased risk of kidney failure.

Additional Information
No health effects are expected related to normal use of this product as sold.

**SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS**

<table>
<thead>
<tr>
<th>INGREDIENTS (Chemical/Common Names)</th>
<th>CAS No.:</th>
<th>% by Wt:</th>
<th>EC No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead, inorganic</td>
<td>7439-92-1</td>
<td>43-70 (average: 65)</td>
<td>231-100-4</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>7664-93-9</td>
<td>20-44 (average: 25)</td>
<td>231-639-5</td>
</tr>
<tr>
<td>Antimony</td>
<td>7440-36-0</td>
<td>0-4 (average: 1)</td>
<td>231-146-5</td>
</tr>
<tr>
<td>Arsenic</td>
<td>7440-38-2</td>
<td>&lt;0.01</td>
<td>231-148-6</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>9003-07-0</td>
<td>5-10 (average: 8)</td>
<td>NA</td>
</tr>
</tbody>
</table>

Additional Information
These ingredients reflect components of the finished product related to performance of the product as distributed into commerce.

**SECTION 4: FIRST AID MEASURES**

**EYE CONTACT:** Flush eyes with large amounts of water for at least 15 minutes. Seek immediate medical attention if eyes have been exposed directly to acid.

**SKIN CONTACT:** Flush affected area(s) with large amounts of water using deluge emergency shower, if available, shower for at least 15 minutes. Remove contaminated clothing. If symptoms persist, seek medical attention.

**INGESTION:** If swallowed, give large amounts of water. Do NOT induce vomiting or aspiration into the lungs may occur and can cause permanent injury or death.

**INHALATION:** If breathing difficulties develop, remove person to fresh air. If symptoms persist, seek medical attention.

**SECTION 5: FIRE-FIGHTING MEASURES**

**SUITSABLE/UNSUITABLE EXTINGUISHING MEDIA:**
MATERIAL SAFETY DATA SHEET
LEAD ACID BATTERY WET, FILLED WITH ACID
(US, CN, EU Version for International Trade)

Dry chemical, carbon dioxide, water, foam. Do not use water on live electrical circuits.

SPECIAL FIRE FIGHTING PROCEDURES & PROTECTIVE EQUIPMENT:
Use appropriate media for surrounding fire. Do not use carbon dioxide directly on cells. Avoid breathing vapors. Use full protective equipment (bunker gear) and self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Batteries evolve flammable hydrogen gas during charging and may increase fire risk in poorly ventilated areas near sparks, excessive heat or open flames.

SPECIFIC HAZARDS IN CASE OF FIRE:
Thermal shock may cause battery case to crack open. Containers may explode when heated.

Additional Information
Firefighting water runoff and dilution water may be toxic and corrosive and may cause adverse environmental impacts.

SECTION 6: ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS:
Avoid Contact with Skin. Neutralize any spilled electrolyte with neutralizing agents, such as soda ash, sodium bicarbonate, or very dilute sodium hydroxide solutions.

ENVIRONMENTAL PRECAUTIONS:
Prevent spilled material from entering sewers and waterways.

SPILL CONTAINMENT & CLEANUP METHODS/MATERIALS:
Add neutralizer/absorbent to spill area. Sweep or shovel spilled material and absorbent and place in approved container. Dispose of any non-recyclable materials in accordance with local, state, provincial or federal regulations.

Additional Information
Lead acid batteries and their plastic cases are recyclable. Contact your East Penn representative for recycling information.

SECTION 7: HANDLING AND STORAGE

PRECAUTIONS FOR SAFE HANDLING AND STORAGE:
• Keep containers tightly closed when not in use.
• If battery case is broken, avoid contact with internal components.
• Do not handle near heat, sparks, or open flames.
• Protect containers from physical damage to avoid leaks and spills.
• Place cardboard between layers of stacked batteries to avoid damage and short circuits.
• Do not allow conductive material to touch the battery terminals. A dangerous short-circuit may occur and cause battery failure and fire.

OTHER PRECAUTIONS (e.g.; Incompatibilities):
Keep away from combustible materials, organic chemicals, reducing substances, metals, strong oxidizers and water.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS/SYSTEM DESIGN INFORMATION:
Charge in areas with adequate ventilation.

VENTILATION:
General dilution ventilation is acceptable.

RESPIRATORY PROTECTION:
Not required for normal conditions of use. See also special firefighting procedures (Section 5).

EYE PROTECTION:
Wear protective glasses with side shields or goggles.

SKIN PROTECTION:
Wear chemical resistant gloves as a standard procedure to prevent skin contact.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT: Chemically-impervious apron and face shield recommended when adding water or electrolyte to batteries.

Wash Hands after handling.

EXPOSURE GUIDELINES & LIMITS:

East Penn Manufacturing Co., Inc.
EXPOSURE GUIDELINES & LIMITS:

<table>
<thead>
<tr>
<th>Organization</th>
<th>Exposure Limit</th>
<th>Lead, inorganic (as Pb)</th>
<th>Sulfuric acid</th>
<th>Antimony</th>
<th>Arsenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA</td>
<td>Permissible Exposure Limit (PEL/TWA)</td>
<td>0.05 mg/m³</td>
<td>1 mg/m³</td>
<td>0.5 mg/m³</td>
<td>0.01 mg/m³</td>
</tr>
<tr>
<td>ACGIH</td>
<td>2007 Threshold Limit Value (TLV)</td>
<td>0.05 mg/m³</td>
<td>0.2 mg/m³</td>
<td>0.5 mg/m³</td>
<td>0.01 mg/m³</td>
</tr>
<tr>
<td>Quebec</td>
<td>Permissible Exposure Value (PEV)</td>
<td>0.15 mg/m³</td>
<td>1 mg/m³</td>
<td>0.5 mg/m³</td>
<td>0.01 mg/m³</td>
</tr>
<tr>
<td>Ontario</td>
<td>Occupational Exposure Level (OEL)</td>
<td>0.10 mg/m³</td>
<td>1 mg/m³ TWA</td>
<td>0.5 mg/m³ STEL</td>
<td>0.01 mg/m³</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Maximaal Aanvaarde Concentratie (MAC)</td>
<td>0.15 mg/m³</td>
<td>1 mg/m³</td>
<td>0.5 mg/m³</td>
<td>0.01 mg/m³</td>
</tr>
<tr>
<td>Germany</td>
<td>Maximale Arbeitsplatzkonzentrationen (MAK)</td>
<td>0.1 mg/m³</td>
<td>1 mg/m³ TWA</td>
<td>2 mg/m³ STEL</td>
<td>0.5 mg/m³</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Occupational Exposure Standard (OES)</td>
<td>0.15 mg/m³</td>
<td>0.5 mg/m³</td>
<td>0.1 mg/m³</td>
<td></td>
</tr>
</tbody>
</table>

Additional Information

- Batteries are housed in polypropylene cases which are regulated as total dust or respirable dust only when they are ground up during recycling. The OSHA PEL for dust is 15 mg/m³ as total dust or 5 mg/m³ as respirable dust.
- May be required to meet Domestic Requirements for a Specific Destination(s).

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Industrial/commercial lead acid battery
ODOR: Odorless
ODOR THRESHOLD: NA
PHYSICAL STATE: Sulfuric Acid: Liquid; Lead: solid
pH: <1
BOILING POINT: 235-240° F (as sulfuric acid)
MELTING POINT: NA
FREEZING POINT: NA
VAPOR PRESSURE: 10 mmHg
VAPOR DENSITY (AIR = 1): > 1
SPECIFIC GRAVITY (H2O = 1): 1.27–1.33
EVAPORATION RATE (n-BuAc=1): < 1
SOLUBILITY IN WATER: 100% (as sulfuric acid)
FLASH POINT: Below room temperature (as hydrogen gas)
AUTO-IGNITION TEMPERATURE: NA
LOWER EXPLOSIVE LIMIT (LEL): 4% (as hydrogen gas)
UPPER EXPLOSIVE LIMIT (UEL): 74% (as hydrogen gas)
PARTITION COEFFICIENT: NA
VISCOSITY (poise @ 25° C): Not Available
MATERIAL SAFETY DATA SHEET
LEAD ACID BATTERY WET, FILLED WITH ACID
(US, CN, EU Version for International Trade)

DECOMPOSITION TEMPERATURE: Not Available

FLAMMABILITY/HMIS HAZARD CLASSIFICATIONS (US/CN/EU): As sulfuric acid
HEALTH: 3 FLAMMABILITY: 0 REACTIVITY: 2

SECTION 10: STABILITY AND REACTIVITY

STABILITY: This product is stable under normal conditions at ambient temperature.
INCOMPATIBILITY (MATERIAL TO AVOID): Strong bases, combustible organic materials, reducing agents, finely divided metals, strong oxidizers, and water.
HAZARDOUS DECOMPOSITION BY-PRODUCTS: Thermal decomposition will produce sulfur dioxide, sulfur trioxide, carbon monoxide, sulfuric acid mist, and hydrogen.
HAZARDOUS POLYMERIZATION: Will not occur
CONDITIONS TO AVOID: Overcharging, sources of ignition

SECTION 11: TOXICOLOGICAL INFORMATION

ACUTE TOXICITY (Test Results Basis and Comments):
Sulfuric acid: LD₅₀, Rat: 2140 mg/kg
LC₅₀, Guinea pig: 510 mg/m³
Lead: No data available for elemental lead

SUBCHRONIC/CHRONIC TOXICITY (Test Results and Comments):
Repeated exposure to lead and lead compounds in the workplace may result in nervous system toxicity. Some toxicologists report that abnormal conduction velocities in person with blood lead levels of 50 µg/100 ml or higher. Heavy lead exposure may result in central nervous system damage, encephalopathy and damage to the blood-forming (hematopoietic) tissues.

Additional Information
- Very little chronic toxicity data available for elemental lead.
- Lead is listed by IARC as a 2B carcinogen: possible carcinogen in humans. Arsenic is listed by IARC, ACGIH, and NTP as a carcinogen, based on studies with high doses over long periods of time. The other ingredients in this product, present at equal to or greater than 0.1% of the product, are not listed by OSHA, NTP, or IARC as suspect carcinogens.
- The 19th Amendment to EC Directive 67/548/EEC classified lead compounds, but not lead in metal form, as possibly toxic to reproduction. Risk phrase 61: May cause harm to the unborn child, applies to lead compounds, especially soluble forms.

SECTION 12: ECOLOGICAL INFORMATION

PERSISTENCE & DEGRADABILITY:
Lead is very persistent in soils and sediments. No data available on biodegradation.

BIO-ACCUMULATIVE POTENTIAL (Including Mobility):
Mobility of metallic lead between ecological compartments is low. Bioaccumulation of lead occurs in aquatic and terrestrial animals and plants, but very little bioaccumulation occurs through the food chain. Most studies have included lead compounds, not solid inorganic lead.

AQUATIC TOXICITY (Test Results & Comments):
Sulfuric acid: 24-hour LC₅₀, fresh water fish (Brachydania rerio): 82 mg/l
96-hour LOEC, fresh water fish (Cyprinus carpio): 22 mg/l (lowest observable effect concentration)
Lead (metal): No data available

Additional Information
- No known effects on stratospheric ozone depletion.
- Volatile organic compounds: 0% (by Volume)
- Water Endearing Class (WGK): NA

SECTION 13: DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Follow local, State/Provincial, and Federal/National regulations applicable to as-used, end-of-life characteristics to be determined by end-user.

PAGE 5 OF 8

East Penn Manufacturing Co., Inc.
MATERIAL SAFETY DATA SHEET
LEAD ACID BATTERY WET, FILLED WITH ACID
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HAZARDOUS WASTE CLASS/CODE:
US - Not applicable to finished product as manufactured for distribution into commerce.
CN – Not applicable to finished product as manufactured for distribution into commerce.
EWC – Not applicable to finished product as manufactured for distribution into commerce.

Additional Information
Not Included – Recycle or dispose as allowed by local jurisdiction for the end-of-life characteristics as-disposed.

SECTION 14: TRANSPORT INFORMATION

GROUND – US-DOT/CAN-TDG/EU-ADR/APEC-ADR:
Proper Shipping Name: Batteries, Wet, Filled with Acid
Hazard Class: 8
Packing Group: III
ID Number: UN2794
Labels: Corrosive

AIRCRAFT – ICAO-IATA:
Proper Shipping Name: Batteries, Wet, Filled with Acid
Hazard Class: 8
Packing Group: III
ID Number: UN2794
Labels: Corrosive
Reference IATA packing instructions 870

VESSEL – IMO-IMDG:
Proper Shipping Name: Batteries, Wet, Filled with Acid
Hazard Class: 8
Packing Group: III
ID Number: UN2794
Labels: Corrosive
Reference IMDG packing instructions P801

Additional Information
Transport requires proper packaging and paperwork, including the Nature and Quantity of goods, per applicable origin/destination/customs points as-shipped.

SECTION 15: REGULATORY INFORMATION

INVENTORY STATUS:
All components are listed on the TSCA; EINECS/ELINCS; and DSL, unless noted otherwise below.

U.S. FEDERAL REGULATIONS:
TSCA Section 8b – Inventory Status: All chemicals comprising this product are either exempt or listed on the TSCA Inventory.
TSCA Section 12b – Export Notification: If the finished product contains chemicals subject to TSCA Section 12b export notification, they are listed below:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS #</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>NA</td>
</tr>
</tbody>
</table>

CERCLA (COMPREHENSIVE RESPONSE COMPENSATION, AND LIABILITY ACT)
Chemicals present in the product which could require reporting under the statute:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>7439-92-1</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>7664-93-9</td>
</tr>
</tbody>
</table>

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)
The finished product contains chemicals subject to the reporting requirements of Section 313 of SARA Title III.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS #</th>
<th>% wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>7439-92-1</td>
<td>65</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>7664-93-9</td>
<td>25</td>
</tr>
</tbody>
</table>

CERCLA SECTION 311/312 HAZARD CATEGORIES: Note that the finished product is exempt from these regulations, but lead and sulfuric acid above the thresholds are reportable on Tier II reports.

- Fire Hazard: No
- Pressure Hazard: No
- Reactivity Hazard: No
MATERIAL SAFETY DATA SHEET
LEAD ACID BATTERY WET, FILLED WITH ACID
(US, CN, EU Version for International Trade)

Immediate Hazard: Yes (Sulfuric acid is Corrosive)
Delayed Hazard: No

Note: Sulfuric acid is listed as an Extremely Hazardous Substance.

STATE REGULATIONS (US):

California Proposition 65
The following chemicals identified to exist in the finished product as distributed into commerce are known to the State of California to cause cancer, birth defects, or other reproductive harm:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS #</th>
<th>% Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (as arsenic oxides)</td>
<td>7440-38-2</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Strong inorganic acid mists including sulfuric acid</td>
<td>NA</td>
<td>25</td>
</tr>
<tr>
<td>Lead</td>
<td>7439-92-1</td>
<td>65</td>
</tr>
</tbody>
</table>

California Consumer Product Volatile Organic Compound Emissions
This Product is not regulated as a Consumer Product for purposes of CARB/OTC VOC Regulations, as-sold for the intended purpose and into the industrial/Commercial supply chain.

INTERNATIONAL REGULATIONS (Non-US):

Canadian Domestic Substance List (DSL)
All ingredients remaining in the finished product as distributed into commerce are included on the Domestic Substances List.

WHMIS Classifications
Class E: Corrosive materials present at greater than 1%
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the Controlled Products Regulations.

NPRI and Ontario Regulation 127/01
This product contains the following chemicals subject to the reporting requirements of Canada NPRI +/or Ont. Reg. 127/01:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS #</th>
<th>% Wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>7439-92-1</td>
<td>65</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>7664-93-9</td>
<td>25</td>
</tr>
</tbody>
</table>

European Inventory of Existing Commercial Chemical Substances (EINECS)
All ingredients remaining in the finished product as distributed into commerce are exempt from, or included on, the European Inventory of Existing Commercial Chemical Substances.

European Communities (EC) Hazard Classification according to directives 67/548/EEC and 1999/45/EC.

R-Phrases
35, 36, 38

S-Phrases
1/2, 26, 30, 45

Additional Information
This product may be subject to Restriction of Hazardous Substances (RoHS) regulations in Europe and China, or may be regulated under additional regulations and laws not identified above, such as for uses other than described or as-designed/as-intended by the manufacturer, or for distribution into specific domestic destinations.

SECTION 16: OTHER INFORMATION

OTHER INFORMATION:
Distribution into Quebec to follow Canadian Controlled Product Regulations (CPR) 24(1) and 24(2).
Distribution into the EU to follow applicable Directives to the Use, Import/Export of the product as-sold.

SOURCES OF INFORMATION:
Ontario Ministry of Labour Regulation 654/86. Regulations Respecting Exposure to Chemical or Biological Agents.
RTECS – Registry of Toxic Effects of Chemical Substances, National institute for Occupational Safety and Health.

MSDS/SDS PREPARATION INFORMATION:
DATE OF ISSUE: 15 December 2011
SUPERCEDES: 3 May 2011

DISCLAIMER:
This Material Safety Data Sheet is based upon information and sources available at the time of preparation or revision date.

East Penn Manufacturing Co., Inc.
Information in the MSDS was obtained from sources which we believe are reliable, but are beyond our direct supervision or control. We make no Warranty of Merchantability, Fitness for any particular purpose or any other Warranty, Expressed or Implied, with respect to such information and we assume no liability resulting from its use. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of the product. It is the obligation of each user of this product to determine the suitability of this product and comply with the requirements of all applicable laws regarding use and disposal of this product. For additional information concerning East Penn Manufacturing Co., Inc. products or questions concerning the content of this MSDS please contact your East Penn representative.

END
**APPENDIX G**

<table>
<thead>
<tr>
<th>Labeled</th>
<th>Function</th>
<th>Preset Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Fan Speed</td>
<td>3.3 GPM</td>
</tr>
<tr>
<td>5</td>
<td>Dump</td>
<td>1,000 psi</td>
</tr>
<tr>
<td>8</td>
<td>Relief</td>
<td>2,500 psi</td>
</tr>
</tbody>
</table>

**NOTES:**
1. SYSTEM PRESSURE "P1": 1000 PSI
2. SYSTEM FLOW "P1": 40 GPM or 20 GPM
3. SYSTEM PRESSURE "P2": 2420 PSI
4. SYSTEM FLOW "P2": 40 GPM
E-M Series
Combined Manual and Automatic Engine Overspeed Shut Down Valves

A range of easily installed diesel engine air intake valves which automatically close on engine overspeed and also incorporate a manual shut down feature for additional safety.
Application

The E-M Series of Wyndham Page combined manual and automatic overspeed air intake shut down valves are designed for situations where flammable gas or vapour may enter the atmosphere in an area in which a diesel engine is operating.

Should such flammable material be drawn into the engine intake this may result in uncontrolled engine overspeed and a situation in which shut down of the normal diesel fuel supply may fail to stop the engine.

Under these circumstances a rapid shut down of the engine is required by immediate closure of the engine air intake thereby reducing the potential for major damage and possible ignition of the flammable material in the surrounding atmosphere.

The E-M range of Wyndham Page automatic engine air intake shut down valves are suitable for installation in the intakes of either naturally aspirated or turbocharged engines.

Once installed and set, the repeatability of the actual engine automatic shut down speed has a greater scatter in the case of turbocharged engines than for naturally aspirated types. However, unless there is a special requirement for a very precise shut down speed, adequate protection from excessive engine overspeed is achieved.

Principle of Operation [Automatic Overspeed Shutdown]

The actuation force to close the valve is derived from the engine intake air flow passing through the valve. As the air flow increases this actuation force also increases. This force is resisted by an internal valve spring, the pre-load of which is adjusted via the “Trip Adjuster Screw”.

Once the actuation force exceeds the resisting force of the valve spring, the valve rapidly moves to the closed position. Once closed the E-M valve remains shut until the engine has fully stopped. The valve then resets to the open position after a delay of some seconds.

Enhanced Protection [Manual Shutdown]

The Wyndham Page E-M series of automatic overspeed intake shut down valve kits include a manual actuator connected to the valve via a mechanical cable to enable manual emergency valve closure.

Description & Main Dimensions

A typical E-M Series valve is shown below. The overall dimensions for this range of valves are given on page 4.

The valve is supplied complete with hose adaptors selected in consultation with the customer from a range typical for the rating of the engine to be protected and as tabulated on page 4. The standard stocked lengths from which the manual shut down cable may be selected are also given on page 4. Alternative cable lengths may be available on application.
Valve Selection

To enable Wyndham Page to select the most suitable shut down valve for a given application the following data is required:

- Engine type and model.
- Engine rating and / or application details.
- The internal bore of the intake system hose at the position the valve is to be fitted.
- The cable length for the manual shut down.
- The option of a marine grade cable.
- The option of a lever actuator.

Order Coding

EXXM - XXX - XXX - RXX - X - SXXX

Option: M = Marine Cable or L = Lever

Manual shutdown cable length: RXX see table below

Outlet adaptor code

Inlet adaptor code

Valve size (model code in table)

Use metric value for adaptor code, add zero to make 3 digit code e.g. 25 = 025
Combine inlet and outlet adaptor codes if the same.

Special features by arrangement with Wyndham Page.

Power values marked* may be increased under certain restricted circumstances.
Contact Wyndham Page or your Wyndham Page supplier for details. Data subject to change.
Valve Installation

Wyndham Page E-M valves are supplied complete with the manual shut down pull handle and the selected length of shut down cable fitted and adjusted. It is recommended that the pull handle and cable are not separated from the valve when installing.

Subject to the comments below generally install the Wyndham Page E-M Series valve as close to the engine intake manifold as practical. Always ensure following installation:

[a]. Adjustment and locking of the setting screw is possible.
[b]. A suitable run for the manual shut down cable is accommodated.

In the case of turbocharged engines fit the valve upstream [air cleaner side] of the turbocharger. If an intercooler [charge cooler] is also fitted, site the valve down stream of the intercooler or, if this is not possible, fit upstream of the turbocharger. Never fit between turbocharger and intercooler.

In all cases where an intake flametrap is also fitted, the Wyndham Page valve must be installed upstream of the flametrap.

When fitting always ensure the direction of air flow is in compliance with the arrow marked on the body of the valve. The valve may be fitted in any attitude from vertical to horizontal.

The hose into which the valve is fitted should be adequate to fully support the valve whilst not permitting excessive vibration of the valve. For the heavier valves in the range a support bracket for the valve may be necessary.

Generally ensure that there is sufficient flexibility in the finalised intake system installation to allow for the relative movement between the system components over the full range of engine operating conditions thereby avoiding excessive mechanical stresses.

In the case of an engine with multiple intake systems requiring the fitting of more than one Wyndham Page E-M valve, a suitable balance pipe must be installed between the intake system pipes downstream [engine side] of the valves to give simultaneous shut down of the fitted valves. Typically such a balance pipe should be 30% to 40% of the intake pipe diameter.

Any engine crankcase breather arrangement venting directly into the intake ports or into the air intake system downstream of the Wyndham Page E-M valve must be sealed and replaced by an external breather system connected to the intake system upstream of the E-M valve or [if permitted at the operating site] vented to atmosphere.

A pull “T” handle is supplied as standard for manual emergency valve closure. Valve types E50M to E90M have the option of a lever operated manual shut down actuator. Both types are shown over on page 8. Always install the manual shut down actuator in a convenient position such that it can be easily accessed during an emergency situation. The “T” handle type can be located in a suitable bulkhead or mounting bracket by providing a 18mm diameter hole. To fit the pull handle assembly release the handle locknut and remove the handle. Remove the body locknut and washer at the handle end and push the handle body through the 18mm hole. Refit body washer and locknut adjusting both body locknuts as required. Refit handle locknut and handle and tighten. In the case of the optional lever type actuator two 7mm diameter holes are provided through the body for fixing.

Note. Towards the upper end of the relevant E-M size range for both types of manual actuator a significant force may be required to operate when the engine is not running. Once the engine is running the force required to carry out a manual emergency stop reduces as the engine speed increases.

Important Note. Always retain the standard fuel stop provided with the engine. The E-M valve manual stop should never be used as the normal way to stop an engine. It is intended for emergency operation only or when checking for correct functioning.
Valve Trip Speed Setting

The Wyndham Page E-M valve as supplied will normally be set to trip at a speed below that required. To adjust the trip speed use the trip adjuster screw and associated lock nut. See diagram below.
Rotating the adjuster screw clockwise increases the trip speed. Prior to attempting to set the trip speed check that the manual emergency stop pull handle is in the run condition. To set:

[1]. Check adjuster screw locknut is tight and that the intake system from air cleaner to intake manifold is fitted and secured and is leak free.

[2]. Start engine. Slowly increase speed until a shut down occurs. [Note; if no shut down occurs up to the maximum available engine speed with maximum throttle, remove air hose connection from the inlet end of the Wyndham Page valve as necessary to gain access to the setting screw and locknut. Release setting screw locknut and rotate the setting screw two turns anticlockwise. Tighten locknut, refit hose and recheck for shutdown].

[3]. Following initial shut down remove air hose at the inlet end of the shut down valve as necessary to gain access to the setting screw and lock nut.

[4]. Release setting screw locknut and rotate setting screw one turn clockwise.

[5]. Tighten locknut, refit hose as necessary, start engine and slowly increase speed up to the maximum available.

[6]. Repeat steps [3], [4] and [5] until the first time that no shut down occurs up to the highest speed available. Then adjust the setting screw a further one half turn clockwise and tighten the locknut. With the intake system fully fitted and the engine fully warmed up, slowly run up and down the engine speed range a number of times to check no further shut down occurs. If a further shut down occurs reset the adjuster screw one further half turn clockwise and check again until no shut down occurs.

[7]. Finally restart engine and run at about half maximum speed [or higher if this not possible]. Operate the manual emergency stop to ensure that the engine stops within a few seconds.

Notes:
In the case of turbocharged engines it is important that the final check above is carried out with the engine under load.

A more precise method to set the trip speed is achieved by monitoring and recording the engine speed during adjustment and by temporarily raising the engine high idle speed [if safe to do so] to enable the final trip setting speed to be measured. Once the trip speed is set, the high idle must be reset to its standard setting.

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**Maintenance**

The following maintenance schedule should be undertaken. Subject to experience of local operating conditions the frequency of the maintenance requirements may need to be varied.

**DAILY:**
- Run engine at mid range speed [or higher if this not possible]. Operate the manual emergency stop. The engine should stop within a few seconds.

**MONTHLY:**
- [1]. Check intake pipework between valve and engine to ensure all pipe fixings and any support brackets are properly fitted and secure and that the engine intake is leak free and shows no signs of significant damage.
- [2]. Check the shut down trip speed setting is correct by either:
  - [a] Carrying out the trip speed adjustment as outlined herein or;
  - [b] Temporarily raise the engine high idle and check trip speed using an engine tacho.

**3 MONTHLY:**
- [1]. Remove valve complete with manual stop handle and cable.
- [2]. Clean valve as necessary using a soft brush / air line plus white spirit or similar if necessary taking all normal precautions. Dry valve.
- [3]. Check that the valve moves smoothly over its complete operating stroke and that there are no signs of significant damage or excessive wear. Do not lubricate.
- [4]. Check the manual stop handle and cable for damage or wear. Check for freedom of operation.
- [5]. Refit valve and complete “daily and monthly” checks as above.

**NOTES:**
- [a]. Carry out the above maintenance whilst the engine is in a non-hazardous area.
- [b]. Where applicable ensure that the high idle speed of the engine is reset to the correct value.
- [c]. Any problems identified must be rectified before returning the equipment to a hazardous area.
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