## ELECTRICAL AND MECHANICAL VEHICLE D 324-1

**ENGINEERING INSTRUCTIONS**

**Issue 2, Jun 07**

### Table of Torque Requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Torque</th>
<th>Item</th>
<th>Description</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sequence valve</td>
<td>60 to 65 N.m</td>
<td>8</td>
<td>Pilot controlled PRV</td>
<td>45 to 50 N.m</td>
</tr>
<tr>
<td>2</td>
<td>Pressure sensor – PG1</td>
<td>50 N.m (max)</td>
<td>9</td>
<td>Electrically controlled PRV</td>
<td>35 to 40 N.m</td>
</tr>
<tr>
<td>3</td>
<td>Pressure sensor – PG2</td>
<td>50 N.m (max)</td>
<td>10a</td>
<td>Counterbalance (overcentre) valve (winch out)</td>
<td>60 to 65 N.m</td>
</tr>
<tr>
<td>4</td>
<td>Test point (M16 thread)</td>
<td>-</td>
<td>10b</td>
<td>Counterbalance (overcentre) valve (winch in)</td>
<td>60 to 65 N.m</td>
</tr>
<tr>
<td>5</td>
<td>Plug ¼ in</td>
<td>60 N.m</td>
<td>11</td>
<td>Plug ⅜ in</td>
<td>90 N.m</td>
</tr>
<tr>
<td>6</td>
<td>Shuttle valve</td>
<td>35 to 40 N.m</td>
<td>12</td>
<td>Check valve</td>
<td>45 to 50 N.m</td>
</tr>
<tr>
<td>7</td>
<td>Ball valve (manual)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 36 – Winch Hydraulic Valve Block**

**Figure 37 – Constant Pulling Device (Left Winch Shown)**
b. Remove the bolt securing the arm to the torsion block shaft.

c. Remove the two cap screws securing the lower guide block to the winch housing and slide the assembly off the shaft.

111. Disassembly. Disassemble the constant pulling device in accordance with Figure 37.

112. Cleaning and Inspection. To clean and inspect the constant pulling device, proceed as follows:

a. Clean and dry all components.

b. Inspect components for bending, damage and wear, repair or replace as required.

113. Assembly. Assemble the constant pulling device in reverse order to disassembly.

114. Installation. Install the constant pulling device in reverse order to disassembly and adjust the mechanical flag in accordance with Para 115.

**NOTE**

There is no requirement to conduct a full Winch Set-Up and Constant Pull System Check/Adjustment for maintenance to the constant pull device.

115. Mechanical Flag Adjustment. After repair or replacement of constant pull system components, the mechanical flag is to be adjusted in accordance with Winch Set-Up and Constant Pull System Check procedures. Refer to EMEI Vehicle D 329.

WINCH HYDRAULIC VALVE ADJUSTMENT

116. The following details the procedures for adjusting the winch pilot control pressure reducing valve, counterbalance valves and sequence valve.

117. Adjustment of the hydraulic valves must be carried out for any of the following:

a. replacement of a winch assembly complete,

b. replacement of a hydraulic block complete,

c. replacement of a hydraulic valve.

118. Table 6 lists the valve pressure settings and provides an overview of the valve adjustment method.

119. Once any of the above items has been adjusted, the winching system must be tested in accordance with the Winch Set-Up and Constant Pull System Check, Refer to EMEI Vehicle D 329.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Torsion block shaft</td>
</tr>
<tr>
<td>2.</td>
<td>Insert</td>
</tr>
<tr>
<td>3.</td>
<td>Torsion blocks</td>
</tr>
<tr>
<td>4.</td>
<td>Torsion block clips</td>
</tr>
<tr>
<td>5.</td>
<td>Pressure plate</td>
</tr>
</tbody>
</table>

Figure 38 – Winch Pressure Plate
Table 6 – Winch Valve Adjustment

<table>
<thead>
<tr>
<th>Valve No</th>
<th>Description</th>
<th>Pressure Setting</th>
<th>Adjustment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sequence valve</td>
<td>100 bar</td>
<td>Adjust this valve in accordance with Para 123.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turn the setting screw clockwise to increase opening pressure. Five complete turns covers the whole pressure range.</td>
</tr>
<tr>
<td>6</td>
<td>Shuttle valve</td>
<td>30 bar</td>
<td>Non adjustable.</td>
</tr>
<tr>
<td>8</td>
<td>Pilot controlled pressure reducing valve</td>
<td>136 bar</td>
<td>Adjust this valve in accordance with Para 120.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turn the setting screw clockwise to increase opening pressure. Five complete turns covers the whole pressure range.</td>
</tr>
<tr>
<td>9</td>
<td>Electrically controlled pressure reducing valve</td>
<td>N/A</td>
<td>Non adjustable.</td>
</tr>
<tr>
<td>10a</td>
<td>Counterbalance (overcentre) valve (winch out)</td>
<td>70 bar</td>
<td>Adjust this valve in accordance with Para 121.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turn the setting screw clockwise to reduce the pressure. Three complete turns covers the whole range.</td>
</tr>
<tr>
<td>10b</td>
<td>Counterbalance (overcentre) valve (winch in)</td>
<td>60 bar</td>
<td>Adjust this valve in accordance with Para 121.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turn the setting screw clockwise to reduce the pressure. Three complete turns covers the whole range.</td>
</tr>
<tr>
<td>12</td>
<td>Check valve</td>
<td>7 bar</td>
<td>Non adjustable.</td>
</tr>
</tbody>
</table>

**WARNING**

ENSURE CLEAR COMMUNICATION IS MAINTAINED BETWEEN THE VEHICLE MECHANIC ADJUSTING THE HYDRAULIC VALVE AND THE WINCH OPERATOR DURING THE VALVE ADJUSTMENT PROCEDURE. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

**NOTE**

The high idle switch must be activated when conducting pressure testing. Engine rpm is to be checked to ensure 1500 rpm is maintained.

To ensure consistent results, the recovery system hydraulic oil must be at its normal operating temperature. Refer to EMEI Vehicle D 329 for Bleed and Warm Up procedure. If at any time the vehicle is shut down, the operator must exercise the system to bring the hydraulic oil temperature back to its operating temperature before recommencing any system checks and adjustments.

To minimise damage to the protective caps during removal, grasp the cap as close to its outer edge using multi grips, using a twisting action remove the cap.

To minimise damage to the protective caps during refitment, Use a soft faced hammer to seat the cap.

**Adjustment of the Pilot Controlled Pressure Reducing Valve**

**120.** The pilot controlled Pressure Reducing Valve controls the maximum achievable winching load in manual mode. If necessary, adjust the PRV to achieve a maximum pull of between 11.50 to 13.25 tonne at Layer 1. The procedure is as follows:

**a.** Prepare the test vehicle in accordance with the Vehicle Preparation procedures, refer to EMEI Vehicle D 329.

**b.** Connect the rope/s to the anchor point.

**c.** Disengage the free spool cylinder/s on the winch/es and disengage the sheave tensioner/s.

**d.** Drive HRV being tested at low speed (under 2 km/h in low range, 1st gear) free spooling out the rope/s. An observer is to be stationed on the catwalk above the winches and within the line of sight of the driver, to monitor the payout of the rope and to advise the driver to stop when the winch rope is positioned in the middle of the winch drum on Layer 1.

**e.** Apply sheave tensioner/s and make the rope/s dead.

**f.** Set the tackle layout for a straight pull on Layer 1 with the winch rope connected to the load cell and the load cell connected to the anchor point.
g. Bring the hydraulic system to operating temperature in accordance with the Bleed and Warm Up procedure detailed in EMEI Vehicle D 329.

h. Disengage the PTO and shut down the engine.

i. Remove the protective coverplate from the top of the hydraulic block.

j. Carefully remove the anti-tamper cap without damaging it from the pilot controlled PRV (item 8, Figure 36).

k. Confirm the winch/es are set to manual mode by moving the lever on the hydraulic block to the horizontal position.

l. Start the truck, engage the winch PTO and activate the PLC/s.

m. Engage the free spool cylinder.

n. Actuate the engine throttle switch to increase the engine speed.

o. Disengage the sheave tensioner.

p. Conduct at least three (3) maximum pull tests. To minimise load spikes the operator is to winch the rope in until the rope is taut, then feather and hold the control lever until the maximum pull has stabilised.

q. If the maximum pulls are outside the range of 11.50 to 13.25 tonnes, proceed with the valve adjustment.

r. Loosen the locknut on the PRV and turn the set screw one turn counter clockwise to reduce the maximum pull.

**NOTE**

Turning the set screw by 1/8 of a turn will change the maximum manual pull by approximately 0.5 tonne.

s. While applying maximum pull, adjust the set screw until the load cell reads between 12.50 to 13.00 tonne.

t. Once the adjustment has been made, tighten the locknut and conduct at least three (3) maximum pull tests.

u. If the maximum pulls are outside the range of 11.50 to 13.25 tonnes, repeat steps p to q.

v. Carefully refit the anti-tamper cap without damaging it to the PRV (item 8, Figure 36).

w. Refit the protective coverplate to the top of the hydraulic block.

**Adjustment of the Counterbalance Valves**

121. The counterbalance (overcentre) valves control the load holding ability of the winch for both winching in and out.

**WARNING**

DISENGAGE BOTH WINCH FREE SPOOL CYLINDERS PRIOR TO CONDUCTING ADJUSTMENT PROCEDURES. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

**WARNING**

TO PREVENT ACCIDENTAL ACTIVATION OF A WINCH THE WINCH REMOTE CONTROL IS TO BE ISOLATED AT ALL TIMES WHEN NOT BEING OPERATED FOR TESTING. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

122. Procedures for adjusting the counterbalance valves are as follows:

a. Remove the protective covers from the counterbalance valves (item 10a & 10b, Figure 36). Whilst holding the set screw with an allen key, release each valves locknut.

b. Connect a hydraulic pressure gauge with a range of 0 to 250 bar (refer to Para 5d) to the test point (item 4, Figure 36).

c. Start the truck and engage the recovery PTO.

**WARNING**

DISENGAGE BOTH WINCHES PRIOR TO CONTINUING WITH THE ADJUSTMENT PROCEDURE.

d. Fit the remote control pendant and ensure that both winches freespool cylinders are disengaged.

**WARNING**

TO ENSURE CLEAR COMMUNICATION IS MAINTAINED BETWEEN THE VEHICLE MECHANIC ADJUSTING THE HYDRAULIC VALVES AND THE WINCH OPERATOR, THE OPERATOR WITH REMOTE IS TO BE POSITIONED ON THE CATWALK FACING THE VEHICLE MECHANIC DURING THE
VALVE ADJUSTMENT PROCEDURE. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

ENSURE 10 METRES OF ROPE IS FREE SPOOLED FROM EACH WINCH TO REDUCE THE RISK OF DAMAGE TO THE SHEAVE HEAD ASSEMBLIES THROUGH ACCIDENTAL INCORRECT OPERATION OF WINCH CONTROLS.

e. Bring the hydraulic system to operating temperature in accordance with the Bleed and Warm Up procedure detailed in EMEI Vehicle D 329.

f. Counterbalance-In Valve (item 10b). Start winching in by depressing the appropriate winch in button on the remote pendant. Turn the setting screw on the valve clockwise until end stop is reached.

g. Continue winching in, adjust the set screw on the counterbalance-in valve until the pressure gauge reads 60 bar. Tighten the locknut and recheck.

h. Counterbalance-Out Valve (item 10a). Start winching out by depressing the appropriate winch out button. Turn the setting screw on the valve clockwise until end stop is reached.

i. Continue winching out, adjust the set screw on the counterbalance-out valve until the pressure gauge reads 70 bar. Tighten the locknut and recheck.

j. Lightly grease the protective valve covers and replace using a soft-faced hammer.

Adjustment of the Sequence Valve (item 1, Figure 36)

123. The sequence valve controls the dual speed function by distributing oil to either one or all three motors. The winches will transition from high speed low torque (single motor) to low speed high torque (three motors) when the sequence valve opens at a load of approximately 3 tonne.

WARNING

TO PREVENT ACCIDENTAL ACTIVATION OF A WINCH THE WINCH REMOTE CONTROL IS TO BE ISOLATED AT ALL TIMES WHEN NOT BEING OPERATED FOR TESTING. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

124. Procedures for adjusting the sequence valve are as follows:

a. Remove the protective cover from the sequence valve and, whilst holding the set screw with an allen key, release the lock nut.

b. Connect a hydraulic pressure gauge with a range of 0 to 250 bar (refer to Para 5d) to the test point (item 4, Figure 36).

c. Start the truck and engage the recovery PTO.

WARNING

DISENGAGE BOTH WINCHES PRIOR TO CONTINUING WITH THE ADJUSTMENT PROCEDURE.

d. Fit the remote control pendant and ensure that both winches freespool cylinders are disengaged.

WARNING

TO ENSURE CLEAR COMMUNICATION IS MAINTAINED BETWEEN THE VEHICLE MECHANIC ADJUSTING THE HYDRAULIC VALVES AND THE WINCH OPERATOR, THE OPERATOR WITH REMOTE IS TO BE POSITIONED ON THE CATWALK FACING THE VEHICLE MECHANIC DURING THE VALVE ADJUSTMENT PROCEDURE. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

CAUTION

ENSURE 10 METRES OF ROPE IS FREE SPOOLED FROM EACH WINCH TO REDUCE THE RISK OF DAMAGE TO THE SHEAVE HEAD ASSEMBLIES THROUGH ACCIDENTAL INCORRECT OPERATION OF WINCH CONTROLS.
e. Bring the hydraulic system to operating temperature in accordance with the Bleed and Warm Up procedure detailed in EMEI Vehicle D 329.

f. Start winching in by depressing the appropriate winch in button. Adjust the set screw on the sequence valve until the pressure reaches its peak (at this point you should hear that the winch is changing to a higher speed). In order to accurately determine the peak valve adjustment point, the valve must be exercised by repeating the above procedure at least two more times. Note the final position of the allen key and then turn the key a further ¾ of a turn clockwise and tighten the lock nut.

g. Lightly grease the protective valve covers and replace using a soft-faced hammer.

Adjustment of Constant Pull System Default Settings

125. All adjustments of the Parameters for the constant pull system are done via the winch displays in the left hand control box. Below the display screen, there are 4 keys explained from left to right as follows:

a. Key F1, labelled ‘NEXT’ is used to advance to the next menu.

b. Key F2, labelled ‘PREV’ is used to return to the previous menu.

c. Key F3, labelled ‘←’ is used to reduce the adjustable value displayed in the current menu.

d. Key F4, labelled ‘→’ is used to increase the adjustable displayed value in the current menu.

e. Keys F5 and F6, marked ‘CLR’ and ‘↵’ are not used.

126. All menus are shown below in the correct order. To browse through eg from menu 1 to menu 2, the first key, marked ‘NEXT’ is pushed once. To return, the key marked ‘PREV’ is pushed once. Through repeated pushing of the ‘NEXT’ key, all active menus are skimmed through. If you continue pushing ‘NEXT’, the screen will read ‘SCREEN NOT DEFINED’. To return to the menus, ‘PREV’ is used. Alternatively, you can disconnect and reconnect power to the relevant PLC by switching the power off then back on at the PLC ISOLATION switch to return to menu 1.

127. This paragraph explains all menus applicable to the winches and their functions as follows:

da. Menu 1. Load. (Information Menu). This menu displays the approximate current load on the rope, the actual rope layer on the drum. No adjustment can be made using this menu. When the power is first turned on and or the load is under 6 tonnes, the display will read ‘UNDER RANGE’.

NOTE
The mm reading on the display is an internal value for the PLC and does not correspond with the actual sensor distance.

Load: 12,0 tonnes
Level: 1 1mm

b. Menu 2. Pressure Gauge 1. (Information Menu). This menu displays the inlet pressure measured by pressure transmitter 1 (PG1) connected to port MP3. No adjustment can be made using this menu.

Pressure Gauge 1
0 bar

NOTE
A pressure reading may be displayed without the hydraulic system operating due to residual pressure locked inside the hydraulic block. This also applies to Para 127c.

c. Menu 3. Pressure Gauge 2. (Information Menu). This menu displays the outlet pressure measured by pressure transmitter 2 (PG2) connected to port MP4. No adjustment can be made using this menu.

Pressure Gauge 2
0 bar

d. Menu 4. Max Pressure. (Information and Setting Menu). This menu is used to set the required hydraulic pressure to achieve the correct pulling force with 4 layers of rope on the drum. The value is adjusted by pushing keys F3 or F4 until the required pressure is shown.

Max. Pressure 0-200
173 bar

e. Menu 5. Min. Pressure. (Information and Setting Menu). This menu is used to set the required hydraulic pressure to achieve the correct pulling force with one layer of rope on the drum. The value is adjusted by pushing keys F3 or F4 until the required pressure is shown.

Min. pressure 0-200
124 bar
f. **Menu 6. Maximum Radius. (Information Menu).** This menu is used to enter the radius of the drum fitted with four layers of wire rope. The radius is measured from the centre of the drum to the centre of the rope on the 4th layer. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

| Max radius 0-500 | 206mm |

---

g. **Menu 7. Minimum Radius. (Information Menu).** This menu is used to enter the radius of the drum fitted with one layer of wire rope. The radius is measured from the centre of the drum to the centre of the rope on the 1st layer. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

| Min radius 0-500 | 156mm |

---
h. **Menu 8. Maximum Distance. (Information Menu).** This menu is used to input and display the distance between the mechanical flag and the sensor with four layers of rope on the drum. The value is adjusted by pushing key F3 or F4 until the correct measurement is displayed.

**NOTE**
The displayed value will be 51 mm.

| Max dist 10-50mm | 51mm |

---
i. **Menu 9. Min. Distance. (Information Menu).** This menu is used to input and display the measured distance between the mechanical flag and the sensor with one layer of rope on the drum. The value is adjusted by pushing key F3 or F4 until the correct measurement is displayed.

| Min dist 10-20mm | 10mm |

---
j. **Menu 10. Constant 1. (Information / Setting Menu).** This menu is not used.

| Constant 1 | Not Used |

---
k. **Menu 11. Constant 2. (Information / Setting Menu).** This is the calibrating constant for the display set to a factory default of 38. Adjust the value by pressing keys F3 or F4 until the desired force is displayed.

| Constant 2 | 38 |

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**NOTE**
Adjusting Constant 2 does not affect the actual pulling force, only the displayed pulling force at Menu 1.
The safety relay is activated by the PLC at the value displayed at Menu 1, eg 14 tonnes.

---
l. **Menu 12. Displacement 1. (Information / Setting Menu).** This menu displays the total displacement for the two motors connected at ports M3 and M5 which is 400 cc. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

| Displacements 1 | 400cc |

---
m. **Menu 13. Displacement 2. (Information / Setting Menu).** This menu displays the displacement for the motor connected at port M1 which is 250 cc. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

| Displacement 2 | 250cc |

---
n. **Menu 14. Filter Distance. (Information Menu).** This menu is not adjustable.

| Filterdist. 0-20 | 1mm |

---
o. **Menu 15. Alarm Sensor. (Information Menu).** An alarm indicating an error with the distance sensor.

| Alarm | Sensor fault |

---
p. **Menu 16. Alarm Pressure Guard 1. (Information Menu).** An alarm indicating an error with the pressure transmitter PG1.

| Alarm | Pressguard 1 |

---

**q. Menu 17. Alarm Pressure Guard 2. (Information Menu).** An alarm indicating an error with the pressure transmitter PG2.

| Alarm | Pressguard 2 |

---
r. **Menu 18. Level 1. (Information Menu / Setting Menu).** The nominal distance for the first rope layer. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.
s. Menu 19. Level 2. (Information Menu / Setting Menu). The nominal distance for the second rope layer. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

```
Level 2
10mm
```


t. Menu 20. Level 3. (Information Menu / Setting Menu). The nominal distance for the third rope layer. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

```
Level 3
25mm
```

u. Menu 21. Level 4. (Information Menu / Setting Menu). The nominal distance for the fourth rope layer. This value is set by pushing keys F3 or F4 until the correct measurement is displayed.

```
Level 4
37mm
```

v. Menu 22. Under Range. (Information Menu). This information is displayed when the load is under 6 tonnes. Non-adjustable.

```
Load: Under range
Level: 1 10mm
```

w. Menu 23. Working Hours Over 150 Bar. (Information Menu). This menu displays recorded working hours and minutes of the winch with a recorded pressure of 150 bar or higher. The pressure for this menu is measured at PG1. Non-adjustable.

```
Working hours
> 150 bar 00,00
```

x. Menu 24. Working Hours Over 30 Bar. (Information Menu). This menu displays recorded complete working hours of the winch with a recorded pressure of 30 bar or higher. The pressure for this menu is measured at PG1. Non-adjustable.

```
Working hours
> 30 bar 0000
```

y. Menu 25. Max Pressure. (Information Menu). This menu displays the maximum pressure recorded at PG1. Non-adjustable.

```
Max Pressure
0000 bar
```

z. Menu 26. Back Pressure. (Information Menu Not Used). This menu is not used.

```
Back Pressure
Not used
```

aa. Menu 27. Automatic Control. (Information Menu). When the power to the PLC is switched on and the selector valve is in ‘AUTO MODE’ this information is displayed for 10 seconds, indicating that the system is in automatic mode and constant force will be achieved. Non-adjustable.

```
Automatic Control
```

bb. Menu 28. Manual Control. (Information Menu). This indicates that the selector valve is in ‘MAN MODE’ and constant force cannot be achieved. Non-adjustable.

```
Manual Control
```

c. Menu 29. System Blocked. (Information Menu). If the displayed load at menu 1 exceeds 14 tonnes, the safety relay will activate, blocking the system. The display will read as indicated below. To reset the system, power to the PLC must be switched off then back on. The reason for the safety relay activation should be ascertained and the winch rope inspected in accordance with EMEI Vehicle D 108. Non-adjustable.

```
System blocked
Safety relay ON
```

d. Menu 30 to 256. Not In Use.

```
Screen not Defined
```

### Fault Finding

128. Table 7 provides fault finding and problem solving procedures for the winches.
### Table 7 – Winch Fault Finding

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPERATIONAL FAULTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Winch will not operate</td>
<td>a. PTO has not been engaged</td>
<td>Engage the recovery PTO.</td>
</tr>
<tr>
<td></td>
<td>b. PLC isolation switch is turned off</td>
<td>Set PLC isolation switch to ON position.</td>
</tr>
<tr>
<td></td>
<td>c. Emergency stop button on remote pendant is pressed</td>
<td>Reset emergency stop on the remote pendant.</td>
</tr>
<tr>
<td></td>
<td>d. AUTOMATIC/MANUAL selector valve incorrectly set</td>
<td>Ensure the lever on the hydraulic valve block is in either the AUTOMATIC or MANUAL position. Move the lever in the required direction until it stops.</td>
</tr>
<tr>
<td></td>
<td>e. No oil flow to winch</td>
<td>Check hydraulic oil level.</td>
</tr>
<tr>
<td></td>
<td>f. Electric defect</td>
<td>Inspect and repair electrical system.</td>
</tr>
<tr>
<td></td>
<td>g. Defective hydraulic pump</td>
<td>Inspect hydraulic pump. Replace defective hydraulic pump, refer to Para 66.</td>
</tr>
<tr>
<td></td>
<td>h. Defective hydraulic motors</td>
<td>Inspect hydraulic motors. Replace defective hydraulic motor/s, refer to EMEI Vehicle D 323 and Para 99.</td>
</tr>
<tr>
<td>2. Winch drum does not turn</td>
<td>a. The pin of the disengaging cylinder (free spool cylinder) is disengaged</td>
<td>Ensure that ALL winch ENGAGE/DISENGAGE switches are in the ENGAGE position and check that the pin locks into the clutch gear wheel. Check the electrical circuit and solenoid bank for correct operation (refer to EMEI Vehicle D 323). Ensure that the disengaging device is correctly adjusted (refer to EMEI Vehicle D 323). Replace shuttle valve.</td>
</tr>
<tr>
<td></td>
<td>b. Pressure displayed on gauges on the control panel, no pressure at test point, shuttle valve faulty</td>
<td></td>
</tr>
<tr>
<td>3. Winch drum pneumatic disengaging cylinder (free spool device) is under load</td>
<td>a. Winch is under load</td>
<td>Pay out rope to unload winch.</td>
</tr>
<tr>
<td></td>
<td>b. The pin of the disengaging cylinder will not disengage from the clutch gear wheel</td>
<td>Check the air supply to the lower port of the disengaging cylinder. Check for restrictions in the breather tube from the upper port. Check the electrical circuit and solenoid bank for correct operation (refer to EMEI Vehicle D 323). Replace spring (refer EMEI Vehicle D 323).</td>
</tr>
<tr>
<td></td>
<td>c. Disengaging (free spoolling) cylinder piston return spring broken or collapsed</td>
<td>Inspect and repair.</td>
</tr>
<tr>
<td></td>
<td>d. Disengaging (free spoolling) cylinder piston jammed in cylinder</td>
<td>Replace pneumatic disengaging cylinder (refer EMEI Vehicle D 323).</td>
</tr>
<tr>
<td>4. Winch creeps under load</td>
<td>a. Pressure on counterbalance valves too low</td>
<td>Adjust counterbalance valves, refer to Para 121.</td>
</tr>
<tr>
<td></td>
<td>b. Hydraulic brake clutch pack slipping</td>
<td>Replace the hydraulic brake assembly.</td>
</tr>
</tbody>
</table>
### Table 7 – Winch Fault Finding (Cont.)

<table>
<thead>
<tr>
<th>Symptom Description</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Winch jerks or is noisy during operation</td>
<td>a. Defective hydraulic pump</td>
<td>Inspect hydraulic pump</td>
</tr>
<tr>
<td></td>
<td>b. Defective hydraulic motors</td>
<td>Replace defective hydraulic motors. Refer to Para 66.</td>
</tr>
<tr>
<td></td>
<td>c. Low hydraulic oil flow, engine speed below 1500 rpm</td>
<td>Adjust engine throttle valve, refer to EMEI Vehicle D 323.</td>
</tr>
<tr>
<td></td>
<td>d. Hydraulic oil filters dirty</td>
<td>Replace filters.</td>
</tr>
<tr>
<td></td>
<td>e. Brake not functioning correctly</td>
<td>Inspect brake operation (brake should release at approximately 30 bar which may be checked at the test point, item 5, Figure 36). If necessary, replace brake assembly (refer Para 101).</td>
</tr>
<tr>
<td></td>
<td>f. Counterbalance Valve-in out of adjustment / faulty</td>
<td>Check pressure setting of valve, refer to Para 121.</td>
</tr>
<tr>
<td>6. Winch will not achieve required rope speed</td>
<td>a. Engine rpm below 1500 rpm</td>
<td>Adjust engine throttle valve, refer to EMEI Vehicle D 323.</td>
</tr>
<tr>
<td></td>
<td>b. Hydraulic oil filters are dirty</td>
<td>Replace filters.</td>
</tr>
<tr>
<td></td>
<td>c. Hydraulic oil too hot</td>
<td>Refer to Serial 7.</td>
</tr>
<tr>
<td></td>
<td>d. Control valve defect</td>
<td>Inspect and repair control valve. Refer to Para 80.</td>
</tr>
<tr>
<td></td>
<td>e. Defective hydraulic pump</td>
<td>Inspect and repair hydraulic pump. Refer to Para 66.</td>
</tr>
<tr>
<td></td>
<td>g. Faulty sequence valve</td>
<td>Check sequence valve adjustment, refer to Para 123.</td>
</tr>
<tr>
<td></td>
<td>h. Faulty check valve</td>
<td>Sequence valve adjustment does not rectify the fault, replace the check valve (item 7, Figure 36).</td>
</tr>
<tr>
<td>7. Hydraulic oil too hot (&gt;70° C)</td>
<td>a. Blocked or defective oil cooler or fan</td>
<td>Inspect and repair oil cooler assembly.</td>
</tr>
<tr>
<td></td>
<td>b. Control valve defect</td>
<td>Inspect and repair control valve. Refer to Para 80.</td>
</tr>
<tr>
<td>8. Maximum pull on layer one (Manual Mode) is outside the range of 11.50 to 13.25 tonne</td>
<td>a. Pilot controlled PRV out of adjustment</td>
<td>Adjust pilot controlled PRV, refer to Para 120.</td>
</tr>
<tr>
<td>10. Both winches will not achieve maximum pull on one or more layers</td>
<td>a. Low hydraulic oil flow, engine speed below 1500 rpm</td>
<td>Adjust engine throttle valve, refer to EMEI Vehicle D 323.</td>
</tr>
<tr>
<td></td>
<td>b. Hydraulic system pressure low</td>
<td>Check hydraulic pressure on both winch hydraulic blocks whilst conducting a maximum pull test (Auto Mode) in accordance with EMEI Vehicle D 329. If the maximum pressure is below 173 bar at layer 4, and maximum pressure reading on both winches are approximately the same. Replace the PTO (after contacting Mack Trucks Defence Business Unit in Brisbane).</td>
</tr>
<tr>
<td>11. Maximum pull is less than 11.50 tonne on one or more layers (Auto Mode)</td>
<td>a. Selector valve in manual position</td>
<td>Place the lever on the hydraulic block in the AUTOMATIC position.</td>
</tr>
</tbody>
</table>
### Table 7 – Winch Fault Finding (Cont.)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>b. Fault with inductive sensor on the hydraulic valve block (not sensing that the lever is in the AUTOMATIC position)</td>
<td>Check that the sensor is in place, is in good condition and that the wiring between the sensor and the PLC is in good condition.</td>
<td></td>
</tr>
<tr>
<td>c. Insufficient hydraulic oil pressure, main relief valve in the hydraulic control valve block allowing oil pressure to bypass</td>
<td>Replace the applicable relief valve.</td>
<td></td>
</tr>
<tr>
<td>12. Maximum pull is outside the range of 11.50 to 13.25 tonne on one or more layers (Auto Mode)</td>
<td>a. PLC default settings incorrect</td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td>b. Mechanical flag adjustment, seized, damaged or worn pressure plate or linkages</td>
<td>Inspect the condition of all distance sensor components and repair as necessary.</td>
</tr>
<tr>
<td></td>
<td>c. Layer sensor faulty</td>
<td>Check that the mechanical flag is adjusted in accordance with EMEI Vehicle D 329 – Mechanical Flag Check.</td>
</tr>
<tr>
<td></td>
<td>d. Pressure sensor PG 1 (0-250 bar) faulty – PLC displays Alarm Pressure Guard 1 (menu 16). An alarm indicating an error with the pressure transmitter PG1</td>
<td>Refer to test procedures detailed in EMEI Vehicle D 323.</td>
</tr>
<tr>
<td></td>
<td>e. Pressure sensor PG 1 (0-250 bar) faulty – No PLC alarm</td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td>f. Pressure sensor PG 2 (0-60 bar) faulty – PLC displays Alarm Pressure Guard 2 (menu 17). An alarm indicating an error with the pressure transmitter PG2</td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td>g. Pressure sensor PG 2 (0-60 bar) faulty – No PLC alarm</td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td>h. Electrically controlled pressure reducing valve malfunction</td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td>i. Winch PLC assembly</td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recheck PLC default settings, refer to Para 125.</td>
</tr>
</tbody>
</table>

- a. PLC default settings incorrect
- b. Mechanical flag adjustment, seized, damaged or worn pressure plate or linkages
- c. Layer sensor faulty
- d. Pressure sensor PG 1 (0-250 bar) faulty – PLC displays Alarm Pressure Guard 1 (menu 16). An alarm indicating an error with the pressure transmitter PG1
- e. Pressure sensor PG 1 (0-250 bar) faulty – No PLC alarm
- f. Pressure sensor PG 2 (0-60 bar) faulty – PLC displays Alarm Pressure Guard 2 (menu 17). An alarm indicating an error with the pressure transmitter PG2
- g. Pressure sensor PG 2 (0-60 bar) faulty – No PLC alarm
- h. Electrically controlled pressure reducing valve malfunction
- i. Winch PLC assembly
### Table 7 – Winch Fault Finding (Cont.)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC DISPLAY FAULTS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 13. The PLC display will not operate | a. No power to PLC | Ensure that the PTO is engaged.
Ensure that the PLC isolation switch is in the ON (down) position.
Check the power supply and main recovery circuit breaker.
Check the fuses in the PLC (refer to Para 91).
Check all wiring and connections between the PLC and Display. |
| | b. Broken connection between PLC and display box | |
| 14. The PLC display does not display the correct winch mode | a. Fault with inductive sensor on the hydraulic valve block (not sensing the lever position) | Check that the sensor is in place, is in good condition and that the wiring between the sensor and the PLC is in good condition. |
| | b. Sensor fault | |
| 15. The PLC display shows incorrect Level for the current winch rope layer | a. Mechanical flag adjustment seized, damaged or worn pressure plate or linkages | Inspect the condition of all distance sensor components and repair as necessary. Check that the mechanical flag is adjusted in accordance with EMEI Vehicle D 329 – Mechanical Flag Check. Refer to symptom 16b. |
| | b. Sensor fault | |
| 16. PLC display showing Menu 15 (Alarm Sensor Fault) | a. Bad electrical connection between distance sensor and PLC | Inspect the wiring and connections between the sensor and the PLC. Test the output from the sensor at connection point 4 at Plinth X1 on the PLC circuit card (refer to Figure 33). Disconnect cable 4 and connect a multi-meter between the cable and connection point 4. Output signal should be between 4 and 20 mA depending on the position of the mechanical flag. The further the flag is moved away from the sensor, the higher the output signal. |
| | b. Sensor fault | |
| 17. Display showing Menu 16-17 (Alarm, Pressure guard 1 or 2) (Auto Mode) | a. Poor electrical connection between pressure guard and PLC | Inspect the wiring and connections between the pressure guard and the PLC. |

### PALFINGER CRANE PK-9501

Table 8 provides torque settings for fasteners used on the crane.

### Table 8 – Crane Fastener Torque Settings

<table>
<thead>
<tr>
<th>Thread Diameter</th>
<th>Property Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8</td>
<td>10.9</td>
</tr>
<tr>
<td>M8</td>
<td>23 N.m</td>
</tr>
<tr>
<td>M10</td>
<td>46 N.m</td>
</tr>
<tr>
<td>M12</td>
<td>79 N.m</td>
</tr>
<tr>
<td>M14</td>
<td>125 N.m</td>
</tr>
<tr>
<td>M16</td>
<td>195 N.m</td>
</tr>
<tr>
<td>M18</td>
<td>280 N.m</td>
</tr>
<tr>
<td>M20</td>
<td>390 N.m</td>
</tr>
</tbody>
</table>

**Table 8 – Crane Fastener Torque Settings (Cont.)**

<table>
<thead>
<tr>
<th>Thread Diameter</th>
<th>Property Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 Cr Mo 4v</td>
<td>600 N.m</td>
</tr>
</tbody>
</table>

**NOTE**
An indication of sensor operation can be obtained by placing a metallic object between the mechanical flag and the sensor, the insertion and vertical movement of the item should register on the display. This test will not determine the accuracy of the sensor.
HYDRAULICS

WARNING

PRIOR TO COMMENCING REPAIRS TO THE HYDRAULIC SYSTEM RELIEVE HYDRAULIC PRESSURE BY VENTING THE RESERVOIR AND CYCLING ALL CONTROL VALVES WITH THE ENGINE SHUT DOWN. ENSURE HYDRAULIC FLUID HAS REACHED A SAFE HANDLING TEMPERATURE.

130. Figure 46 and Figure 47 show the cranes hydraulic circuits.

HYDRAULIC CYLINDERS

WARNING

BEFORE REMOVING ANY HYDRAULIC CYLINDER, ENSURE THAT THE HYDRAULIC FLUID IS SUFFICIENTLY COOL TO AVOID BURNS.

BEFORE COMMENCING REMOVAL OF HYDRAULIC COMPONENTS, PLACE A WARNING SIGN NOT TO OPERATE THE CRANE ON OR NEAR THE VEHICLE CONTROLS.

NOTE

Before commencing the removal of any hydraulic cylinder, clean the area around the cylinder, paying particular attention to the area around the pipe connections.

After removing pipework from hydraulic cylinders, always plug the pipes and fittings to prevent the ingress of dirt into the hydraulic system.

After installation, bleeding and testing of hydraulic cylinders, always check the level of fluid in the oil reservoir with crane in stowed position. If necessary, top up with AWH 68 hydraulic oil.

Inner Boom Cylinder

131. Removal. To remove the inner boom cylinder, proceed as follows:

a. Place the crane in the ‘h’ position (inner boom horizontal, outer boom vertical with the end resting on the ground) and suitably support the crane with chocks to prevent the booms moving due to the loss of fluid pressure.

b. Disconnect and free the overload protection wiring from the load holding valve pressure sensors (U230 and U231).

c. Crack loose the two flexible hose connections from the ports of the load holding valve and disconnect the fittings. Use a suitable container to catch any oil spillage. Tag the hoses to ensure correct re-connection.

d. Secure the outer boom cylinder in place using an appropriate strap to prevent it falling when the pin is withdrawn.

e. Suitably support the cylinder in a sling prior to the removal of the pivot pins.

f. Remove the circlip and pivot pin securing the cylinder to the crane column.

g. Remove the circlip and pivot pin securing the cylinder to the inner boom.

h. Lift the inner boom cylinder complete with load holding valve and pipework clear of the crane.

132. Installation. To install the inner boom cylinder, proceed as follows:

a. Position the inner boom cylinder in place and secure using the pivot pins and circlips. Ensure that the grease nipple on the rod end is facing out for access.

b. Remove the plastic plugs and connect the two flexible hoses to the appropriate ports of the load holding valve. Tighten securely.

c. Reconnect and secure the overload protection wiring to the load holding valve pressure sensors (U230 and U231).

d. Start the engine, engage the crane PTO and operate the crane to check the operation of the cylinder and to bleed the air from the system (see Para 70). Check for leaks and rectify as necessary.
Outer Boom Cylinder

133. **Removal.** To remove the outer boom cylinder, proceed as follows:
   
a. Place the crane in the ‘h’ position (inner boom horizontal, outer boom vertical with the end resting on the ground) and suitably support the crane with chocks to prevent the booms moving due to the loss of fluid pressure.

b. Tag then crack loose and remove the two flexible hose connections from the ports of the load holding valve. Use a suitable container to catch any oil spillage.

c. Secure the inner boom cylinder in place using an appropriate strap to prevent it falling when the pin is withdrawn.

d. Suitably support the cylinder in a sling prior to the removal of the pivot pins.

e. Remove the circlip and pivot pin securing the cylinder to the inner boom.

f. Remove the circlip and pivot pin securing the cylinder to the lever assembly linking the cylinder to the outer boom.

g. Lift the outer boom cylinder complete with load holding valve and pipework clear of the crane.

134. **Installation.** To install the outer boom cylinder, proceed as follows:

a. Position the outer boom cylinder in place and secure using the pivot pins and circlips. Ensure that the grease nipple on the rod end is facing out for access.

b. Remove the plastic plugs and connect the two flexible hoses to the appropriate ports of the load holding valve. Tighten securely.

c. Grease all pivot points at completion of assembly.

d. Start the engine, engage the crane PTO and operate the crane to check the operation of the cylinder and to bleed the air from the system in accordance with Para 70. Check for leaks and rectify as necessary.

Boom Extension Cylinder

135. **Removal.** To remove the boom extension cylinder, proceed as follows (refer to Figure 40):

a. Unfold the crane, extend the boom approximately 300 mm then lay the boom out straight with the end of the boom resting gently on a wooden block on the ground. Leave the crane running.

b. Remove the roll pin and clevis pin securing the cylinder to the boom extension. Operate the crane and retract cylinder.

c. Disengage the PTO, shut down the engine and relieve hydraulic pressure in accordance with Para 60.

d. Disconnect pipes relieving any residual pressure before removing.

e. Suitably support the cylinder in a sling prior to the removal of the mounting pins.

f. Remove the clip and block retaining the cylinder to the outer end of the outer boom.

g. Remove the retaining screws securing the cylinder to the inner end of the outer boom then lift the boom extension cylinder clear of the crane.

136. **Installation.** To install the boom extension cylinder, proceed as follows:

a. Position the boom extension cylinder in place and secure piston rod end using the clevis and roll pins.

b. Secure the cylinder barrel to the inner end of the outer boom with the retaining screws and fit the block and clip to retain the forward end of the cylinder in its mount at the outer end of the outer boom. Ensure correct alignment of the cylinder.

c. Reconnect the pipes to the cylinder and tighten the fittings.

d. Start the engine, engage the crane PTO and extend the cylinder to line up pin hole at the outer end of the extension boom. Coat the clevis pin with anti-seize compound, install the clevis pin and secure it with the roll pin.

e. Operate the crane to check the operation of the cylinder and to bleed the air from the system (refer to Para 70). Check for leaks and rectify as necessary.

f. Start the engine, engage the crane PTO and operate the crane to check the operation of the cylinder and to bleed the air from the system (refer to Para 70). Check for leaks and rectify as necessary.

Valves

**WARNING**

CRANE SERIAL NUMBER MUST BE SUPPLIED WHEN ORDERING ANY CRANE COMPONENTS TO ENSURE COMPATIBILITY AND SAFE CRANE OPERATION.
Load Holding Valves

137. **Removal.** To remove the load holding valves, proceed as follows:

**WARNING**

**DO NOT ATTEMPT TO REMOVE LOAD HOLDING VALVES WITH ANY LOAD ON THE CRANE COMPONENTS.**

a. All load holding valves may be removed with the crane in the stowed position.

b. Tag all hoses, lines and wiring and disconnect them from the valve. Remove the valve from the crane.

138. **Installation.** To install the load holding valves, proceed as follows:

a. Refit the load holding valve to the cylinder and reconnect pipes before tightening fittings.

b. Tighten fittings and reconnect sensor wiring.

c. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (refer to Para 70). Check that the crane operates smoothly and correctly and rectify any leaks as necessary.

Main Control Valve

139. **Removal.** To remove the main control valve, proceed as follows (refer to Figure 39):

a. Remove the operators console cover.

b. Tag and disconnect all wiring and hydraulic hoses from the control valve blocks.

**NOTE**

To remove the electrical plugs from the control modules, ease the locking cap away from the rear of the plug using a small screwdriver (refer to Figure 30).

c. Unbolt the control valve and remove it from the frame.

d. Cap all ports lines and fittings to prevent the ingress of dirt.

140. **Installation.** To install the main control valve, proceed as follows:

a. Position the valve back into its mounting position and tighten the fasteners.

b. Reconnect the hydraulic fittings and electrical connectors.

c. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (refer to Para 70). Check that the crane operates smoothly and correctly and rectify any leaks as necessary.

CRANE ASSEMBLY

141. **Removal.** To remove the crane assembly from the vehicle, proceed as follows:

a. To facilitate removal, the crane is best positioned in the stowed position.

b. Prepare a suitable stand that will accommodate the crane when it has been removed from the vehicle.

c. Remove stabiliser legs if necessary.

d. Crack loose and remove the supply hose connection at the pressure filter inlet. Use a suitable container to contain any oil spillage.

e. Crack loose and remove the return hose at the ‘T’ piece on top of the valve bank and disconnect the fitting. Use a suitable container to contain any oil spillage.

f. Cap all ports lines and fittings to prevent the ingress of dirt.

**NOTE**

Disconnect the air line from the crane PTO to prevent inadvertent operation while the crane is removed.

g. Disconnect the crane’s power connection, pull the wiring back to the crane and stow.

h. Fit the travel latch at the travel rest bracket for the inner boom. This will prevent movement in the crane boom system due to hydraulic creep.
i. Insert a lifting hook into the lifting point on the crane boom.

**WARNING**

ENSURE CRANE IS SECURED TO THE STAND OR OTHERWISE SAFELY SUPPORTED AS IT WILL NOT BALANCE ON ITS OWN.

j. Remove mounting bolts then carefully lift the crane clear of the vehicle. Lower the crane onto suitable safety stands.

142. **Cleaning and Inspection.** To clean and inspect the crane assembly, proceed as follows:

a. Check the condition of the crane mounting sub-frame.

b. Replace worn or damaged parts as necessary.

143. **Installation.** To install the crane assembly, proceed as follows:

**WARNING**

DO NOT RE-USE OLD TIE DOWN BOLTS OR NUTS WHEN RE-FITTING THE CRANE.

a. Using overhead lifting equipment, lift the crane from the safety stand and guide it into position over the truck chassis.

b. Guide the crane down into its position on the chassis ensuring all mounting holes are correctly aligned. Install and nip up all tie down bolts then check that the crane is sitting flat on all mounting points of the sub-frame. Tension the tie down bolts to 600 N.m.

c. Reconnect the supply and return hoses to their respective fittings as tagged.

d. Reconnect the power supply to the crane.

e. Remove travel lock and reconnect the PTO air line.

f. Refit the stabiliser legs if previously removed.

g. Bleed and test the crane systems.

h. Check the level of fluid in the oil reservoir. If necessary, top up with AWH 68.

**Boom Extension**

144. **Removal.** To remove the boom extension, proceed as follows (refer to Figure 40):

a. Prior to removing the boom extension, measure the clearance between the guide blocks and boom extension.

**NOTE**

Guide blocks are to be replaced if more than 4 mm clearance exists between the guide block and the extension boom. Guide blocks are manufactured in three thicknesses, 6, 8 and 10 mm.

b. Extend out 300 mm, remove the top keeper blocks then extend approximately 2/3rds the maximum distance and rest the boom on the ground. Remove the lower wear pads then fully extend the boom. Remove the roll pin and clevis pin to disconnect the piston rod from the end of the boom and retract the cylinder.

c. Raise the boom 300 mm off the ground to provide clearance to remove the extension.

d. Position lifting equipment above the extension and take the weight of the section with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly then withdraw the extension and lower to the ground.

145. **Cleaning and Inspection.** To clean and inspect the boom extension, proceed as follows:

a. Clean the boom extension thoroughly.

b. Inspect the following components for wear and damage, replace as required:

(1) interior of outer boom,

(2) boom extension, and

(3) guide blocks and retaining brackets.

c. Inspect the boom extension for twisting or bending.

d. Check the condition of the boom extension cylinder mounting hardware. Replace worn or damaged parts as necessary.

e. Check the condition of associated hoses and pipework. Repair or replace as necessary.

146. **Installation.** To install the boom extension, proceed as follows:

a. Lift the extension into position, ensuring that the sling is positioned to balance the weight evenly.
b. Engage the hollow section of the outer boom and push the extension in until it can support itself.

c. Install the guide blocks and retaining brackets into the outer boom.

NOTE
To install the top pad assembly, position the assembly on top of the extension using grease to hold it in place then slide the boom in until the screw holes line up. Apply Loctite 242 to the screws, install and tighten.

d. Remove the sling and overhead lifting equipment.

e. Push the boom extension completely into the outer boom.

f. Install the boom extension cylinder as detailed at Para 136.

Outer Boom and Extension

147. Removal. To remove the outer boom and extension, proceed as follows (refer to Figure 40):

To remove the outer boom and extension, proceed as follows (refer to Figure 40):

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Outer boom</td>
<td>6.</td>
<td>Wear pads</td>
</tr>
<tr>
<td>2.</td>
<td>Top pad assembly</td>
<td>7.</td>
<td>Distance washer</td>
</tr>
<tr>
<td>4.</td>
<td>Extension cylinder</td>
<td>9.</td>
<td>Pin</td>
</tr>
<tr>
<td>5.</td>
<td>Boom extension</td>
<td>10.</td>
<td>Lever assembly</td>
</tr>
</tbody>
</table>

WARNING
ENSURE THAT THE CRANE IS SECURELY SUPPORTED SO IT WILL NOT MOVE DURING THE FOLLOWING REPAIR PROCEDURE.

a. Position and support the crane in a suitable position to allow safe access to all areas of the outer boom.

b. Position lifting equipment above the outer boom and boom extension and take up the weight of the section with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

c. Crack loose the boom extension cylinder’s two flexible hose connections adjacent to the outer boom cylinder mounting and disconnect the fittings. Use a suitable container to catch any oil spillage. Tag the hoses to ensure correct connection during installation.
d. Remove the necessary cable ties, clamps and disconnect the wiring to the outer boom sensor.

e. Suitably support the outer boom cylinder then remove the pins securing the knuckle links to the outer boom.

f. Maneuvre the outer boom and extensions away from the inner boom mount and lower to the ground.

148. **Cleaning and Inspection.** To clean and inspect the outer boom and extension, proceed as follows:

a. Clean the outer boom and extension thoroughly.

b. Check the boom for twist, bend or excessive damage. Check for elongation of any of the mounting points. Repair or replace as necessary.

c. Check the condition of all bushes, pins and links associated with connecting the inner and outer booms. Replace worn or damaged parts as necessary.

d. Check the condition of the guide blocks and retaining brackets. Replace worn or damaged parts as necessary.

e. Check the condition of the outer boom cylinder mounting hardware. Replace worn or damaged parts as necessary.

f. Check the condition of associated hoses and pipework. Repair or replace as necessary.

149. **Installation.** To install the outer boom and extension, proceed as follows:

a. Lift the outer boom complete with extension into position, ensuring that the sling is positioned to balance the weight evenly.

b. Insert and secure the pivot pin to join the outer boom to the inner boom, taking care not to damage the bushes.

c. Re-attach the outer boom cylinder the knuckle assembly.

d. Reconnect the wiring to the outer boom sensor and secure the wiring.

e. Reconnect the two flexible hose connections to the boom extension cylinder valve block.

f. Start the engine, engage the crane PTO, then operate the crane to check the operation of the cylinder and to bleed the air from the system (refer to Para 70). Check for leaks and rectify as necessary.

---

**Inner Boom**

150. **Removal.** To remove the inner boom, proceed as follows (refer to Figure 41):

a. Remove the outer boom cylinder and outer boom complete with extension as detailed in Paras 133 and 147, leaving the inner boom cylinder disconnected from the inner boom.

b. Position lifting equipment above the inner boom and take up the weight with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

c. Remove the clamps securing the boom extension hoses and wiring to the inner boom and withdraw the harness from the inner boom ensuring that the wires are removed. The hoses can be left in boom during removal.

d. Remove the retaining screw and washer from the pivot pin securing the inner boom to crane column and remove the pin.

e. Lift the inner boom clear of the crane column and lower to the ground.

---

**Figure 41 – Column and Inner Boom**

151. **Cleaning and Inspection.** To clean and inspect the inner boom, proceed as follows:

a. Clean the inner boom thoroughly.

b. Check the boom for twist, bend, cracking or excessive damage. Check for elongation of any of the mounting points. Repair or replace as necessary.

c. Check the condition of the inner boom pivot pin and the associated bushes mounted in the crane body. Replace worn or damaged parts as necessary.

d. Check the condition of the inner boom cylinder mounting hardware. Replace worn or damaged parts as necessary.
e. Check the condition of the bushes in the piston rod end of the inner boom cylinder. Replace worn or damaged parts as necessary.

f. Check the condition of associated hoses and pipework. Repair or replace as necessary.

152. **Installation.** To install the inner boom, proceed as follows:

a. Lift the inner boom into position, ensuring that the sling is positioned to balance the weight evenly.

b. Carefully manoeuvre the inner boom onto its mounting point on the crane column, align the pivot pin holes and insert the pivot pin. Install the retaining washer and screw to secure the pivot pin in position.

c. Raise the inner boom cylinder and position it in its mount, align the pivot pin holes then insert the pivot pin and secure it in position with the circlip.

d. Install the outer boom complete with extension and the outer boom cylinder as detailed at Paras 134 and 149.

e. Grease all joints on completion of installation.

**CRANE ELECTRONICS**

**WARNING**

**THE CRANE SERIAL NUMBER MUST BE SUPPLIED WHEN ORDERING REPAIR PARTS FOR THE CRANE TO ENSURE COMPATIBILITY AND SAFE CRANE OPERATION.**

153. Figure 48 provides an overview of the cranes electrical circuit including the vehicle mounted remote control units.

154. All circuit boards used within the cranes electronic system are non-repairable and must be replaced with factory pre-programmed units upon failure. At medium level repair, the electronic boxes are to be replaced as complete assemblies.

155. Figure 48 to Figure 51 illustrate the crane electrical circuits. Refer to EMEI Vehicle D 323 for fault finding information.
INTENTIONALLY LEFT BLANK
Figure 42 – Recovery System Pneumatic Diagram
Figure 43 – Recovery System Hydraulic Circuit
Hydraulic reservoir is shared with recovery system
Volume = 150L

1. Reservoir
2. Hydraulic pump
3. High pressure filter
4. Control valve-crane
5. Control rod with emergency cut off
6. Test gauge connection
7. Control valve-stabilisers
8. Check Valve
9. Return filter

Figure 46 – Crane Spool Valve Hydraulic Circuits
1. Control valve - crane
2. Control rod with emergency cut-off
3. One way restrictor
4. Double acting load holding valve
5. Slewing gear
6. Load holding valve
7. Inner boom cylinder
8. Outer boom cylinder
9. Pressure transducer
10. Boom extension cylinder
11. Double acting load holding valve
12. Pilot controlled check valve
13. Stabiliser cylinder

Figure 47 – Crane Actuator Hydraulic Circuits
**Figure 48 – Crane Electrical Circuit Overview**

- **Legend Description**
  - B1: Level switch
  - H5: Horn – overload
  - H440: Hour – meter
  - S1: Selector switch – manual/radio/prop
  - U230: Pressure transmitter – crane piston-side
  - U231: Pressure transmitter – crane pole-side
  - Y0: Valve – emergency stop
  - Y32: Emergency – stop – prop
  - 1: Slew
  - 2: Main boom
  - 3: Outer boom
  - 4: Extension
  - 5, 6, 7: Not used

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**REMOTE CONTROL ANTENNA BOX**

- **REMOTE RECEIVER**
  - 1 2 3 4 5 6 7

- **EX CABLE**
  - TO CONTROL MODULES

- **PALTRONIC 50 CONNECTION BOX**

- **PALTRONIC 50 BASIC UNIT**

- **PALKHUNIC 50 DISPLAY UNIT**

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Figure 49 – Crane Remote Control Receiver Circuits

**Legend**

<table>
<thead>
<tr>
<th>S1</th>
<th>Selector switch – manual/radio/prop</th>
</tr>
</thead>
<tbody>
<tr>
<td>YO</td>
<td>Valve – emergency stop</td>
</tr>
<tr>
<td>Y32</td>
<td>Emergency – stop – prop</td>
</tr>
</tbody>
</table>

**Description**

- S1: Selector switch – manual/radio/prop
- YO: Valve – emergency stop
- Y32: Emergency – stop – prop
Figure 50 – Paltronic 50 Spool Position Sensor and Display Unit Circuits
Figure 51 – Paltronic 50 Basic Unit Circuits

Legend

<table>
<thead>
<tr>
<th>Legend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
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<td>H5</td>
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</tr>
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<td>Pressure transmitter – crane piston–side</td>
</tr>
<tr>
<td>U231</td>
<td>Pressure transmitter – crane pole–side</td>
</tr>
</tbody>
</table>

Distribution List: VEH D 30.0 – Code 4 (Maint Level)
(Sponsor: LV SPO, Hvy B Veh Sect)