LIGHT GRADE REPAIR

This instruction is authorised for use by command of the Chief of Army. It provides direction, mandatory controls and procedures for the operation, maintenance and support of equipment. Personnel are to carry out any action required by this instruction in accordance with EMEI General A 001.

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INTRODUCTION

General

1. This EMEI details all Light Grade Repair procedures for the Launch and Recovery Vehicle (LRV). For convenience, the LRV sub-frame and its constituent assemblies have been categorised into three groups for Light Grade Repair operations. These are:
   a. the hydraulic and lift frame system,
   b. the electrical system, and
   c. the mechanical system.

NOTE

This Light Grade Repair EMEI does not repeat information applicable to the Mack 8-Tonne cab/chassis, contained in EMEI Vehicle G 703, Truck, Cargo, Heavy, W/Winch, MC3, Mack, Light Grade Repair.

Associated Publications

2. Reference may be necessary to the latest issue of the following documents:
   c. EMEI Engr Equip H 008, RAE Bridging Equipment, Inspection Instruction;
   d. EMEI Engr Equip H 008-1, RAE Bridging Equipment, Non-technical Inspection Instruction;
   e. EMEI Vehicle G 700-1, Truck, Cargo, Heavy, W/Winch, MC3, Mack, Data Summary;
   f. EMEI Vehicle G 702, Truck, Cargo, Heavy, W/Winch, MC3, Mack, Technical Description;
   g. EMEI Vehicle G 703, Truck, Cargo, Heavy, W/Winch MC3, Mack, Light Grade Repair;
   h. EMEI Vehicle G 704, Truck, Cargo, Heavy, W/Winch, MC3, Mack, Medium Grade Repair;
   i. EMEI Vehicle G 704-1, Truck, Cargo, Heavy, W/Winch, MC3, Mack, Heavy Grade Repair;
   j. EMEI Vehicle G 709, Truck, Heavy, MC3, Mack, Servicing (All Types);
   k. EMEI Vehicle G 780, Truck, Transporter, Floating Bridge, MC3, W/Winch, Mack, Launch and Recovery Vehicle (LRV), Data Summary;
   l. EMEI Vehicle G 782, Truck, Transporter, Floating Bridge, MC3, W/Winch, Mack, Launch and Recovery Vehicle (LRV), Technical Description;
   m. EMEI Vehicle G 784, Truck, Transporter, Floating Bridge, MC3, W/Winch, Mack, Launch and Recovery Vehicle (LRV), Medium and Heavy Grade Repair;
   n. EMEI Vehicle G 785, Truck, Transporter, Floating Bridge, MC3, W/Winch, Mack, Launch and Recovery Vehicle (LRV), Preservation and Storage Procedures;
   o. EMEI Vehicle G 788, Truck, Transporter, Floating Bridge, MC3, W/Winch, Mack, Launch and Recovery Vehicle (LRV), Equipment Inspection and Examination Data;
   p. EMEI Workshop D 700, Painting of Army Equipment;
   q. Complete Equipment Schedule, SCES 17821, Kit Construction, Floating Support Bridge;
   r. Complete Equipment Schedule, SCES 10652, Tool Kit, Special Tools, Floating Support Bridge;
   s. Complete Equipment Schedule, SCES 10653, Repair and Maintenance Kit, Floating Support Bridge;
   t. Complete Equipment Schedule, SCES 12113, Truck Transporter, Floating Support Bridge, MC3 W/Winch, Mack, Launch and Recovery Vehicle (LRV); and
   u. Repair Parts Scale RPS 02216, Launch and Recovery Vehicle.
Safety Precautions

**CAUTION**

Do not use adhesive tapes to seal fuel or oil openings. The adhesive tape is soluble in fuel or oil and can cause contamination. Remove temporary covers before assembly.

3. Prevent dirt and foreign objects from entering any component by placing clean temporary coverings over all exposed openings, including hoses, tubes and lines.

**CAUTION**

Before removing any electrical system components, disconnect the battery leads.

4. When disconnecting electrical connectors, hoses and fittings, remove clamps as required to gain slack and avoid damage to connectors and fittings.

5. Discard all used gaskets, seals, cotter pins, tab washers, lock pins, key washers and lock washers. Discard all contaminated fuel and lubricants drained from the truck.

6. Use only those fuels and lubricants specified in the Servicing Instruction, EMEI Vehicle G 709, and the User Handbook when replenishing fuel or lubricants.

7. Any fastenings or fittings being tightened to prescribed torques are to have dry, clean threads unless otherwise specified. When specified, thread sealants are to be applied to dry, clean, oil-free threads.

**Special Tools and Gauges**

8. The following special tools and gauges, as listed in Tool Kit, Special Tools, Floating Support Bridge SCES 10652, are required to perform the following tasks:
   a. Hydraulic Pressure Test................................................................. Test Kit, Hydraulic, Caterpillar
   b. Fitting Test Gauges ................................................................. Test Gauge Adaptors

**DETAIL**

**Pre and Post Repair Inspection**

9. As part of any repair procedure to the lifting frame (undertaken at first to fourth line), a full dimensional check of the LRV frame and mounting system is to be undertaken, both before and after repair. The measurements are to be recorded in accordance with the procedures detailed in EMEI Vehicle G 788.

10. If the dimensions of the lifting frame are outside the limits specified in EMEI Vehicle G 788, repair action is to be initiated.

**HYDRAULIC AND LIFT FRAME SYSTEM**

**CAUTION**

When disconnecting any hydraulic line, open the line slowly. Protect the face and eyes as hydraulic oil may spray out due to residual pressure in the system.

**NOTE**

For a description of the operation of the LRV hydraulic system, refer to EMEI Vehicle G 782 LRV Technical Description.
General

11. The lift frame assembly components are operated by hydraulic pressure from a pump powered by the PTO from the vehicle transmission assembly. The PTO is engaged and disengaged by a pneumatic servo mechanism operated by an electric toggle switch mounted in the cabin.

12. Hydraulic power is provided to the following sub-assemblies:
   a. the hook arm,
   b. the lift frame,
   c. the module lock,
   d. the forward telescoping rollers,
   e. the rear telescoping rollers, and
   f. the lift winch.

Test for Faulty Directional Control Valve Relief

13. Test the directional control valve as follows:
   a. Connect the Test Kit, Hydraulic to the control valve test connector.
   b. Stall a recovery function (the hook arm).
   c. Check that the hydraulic pressure is controlled at 21 MPa.

14. If required, adjust the relief valve as follows (Figure 1):
   a. Locate the relief valve at the left-hand control panel.
   b. Remove the dome nut.
   c. Loosen the locknut.
   d. Adjust the screw as follows:
      
      (1) Turn the screw clockwise to increase the pressure setting.
      (2) If the pressure cannot be adjusted, replace the faulty valve.

HOOK ARM SYSTEM

General

15. The hook arm fabrication is mounted onto, and pivots about the front lift frame. It has an internally mounted cylinder providing the pivoting force (Figure 2).

16. The pivotal movement is used to locate the bridge module for engagement of the locking pin. The fixed hook component is used when loading the cargo pallet tray.
Hook Arm – Faulty Performance

17. **General.** If the hook arm is not functioning correctly, carry out the following:
   a. Inspect all the hydraulic pipelines and hoses for evidence of external damage (Figure 3).
   b. Replace any pipelines that are dented, ruptured, pinched or crimped.
   c. Check for binding pivot pins. Remove and clean any binding pivot pins.

18. **Test for Faulty Cylinder.** Test the cylinder as follows:
   a. Connect the test unit or the appropriate gauge to the cylinder test connector.
   b. Disconnect the supply pipeline from the rod end of the cylinder and plug the pipe.
c. Momentarily position the directional control valve to RAISE. If oil flows from the open port and the cylinder moves, check the related flow control valve and the motion control valve.

d. If the oil flows from the open ports and the cylinder does not move, the cylinder is faulty.

e. If no oil flows and the pressure is 21 MPa, the cylinder is faulty.

f. If no oil flows and no pressure is shown on the gauge, check the directional control valve as described in Para 19.

g. If the directional control valve is functioning correctly, test the motion control valve as described in Para 20.

h. If the motion control valve is functioning correctly, test the flow control valve as described in Para 21.

i. Remove the plug and reconnect the pipeline to the rod end of the cylinder.

j. Remove the pipeline from the cap end of the cylinder and plug the pipe.

k. Momentarily position the directional control valve to LOWER and repeat the operations detailed in Para 18.d. to i.

19. **Test for Faulty Directional Control Valve.** Test the directional control valve as follows:

   a. Disconnect the control valve hoses from the motion control valve.

   b. Momentarily operate the control lever in both directions. If no oil flows, the valve is faulty and must be replaced.

20. **Test for Faulty Motion Control Valve.** Each motion control valve consists of a differential relief, a pilot valve and a check valve. With the directional control valve set to RAISE, oil flows freely through the check valve to the flow control valve and into the cylinder. The check valve locks the load when the directional control valve is in the central position. The pilot valve pressure assists the relief valve to bypass the check valve when the load is lowered. Test the valve as follows:

   a. Disconnect the supply hose between the motion control valve and the flow control valve.

   b. Plug the hose.

   c. Momentarily set the directional control valve to RAISE and check that the oil flows from the motion control valve. If no oil flows, the motion control valve is faulty.

   d. If oil flows, measure the rate of flow, using the Test Kit, Hydraulic. If the rate is less than $1.3 \pm 0.2$ L/s the valve is faulty.

   e. Unplug the supply hose and reconnect the hose to the flow control valve.

   f. Repeat the operation detailed in sub-paragraphs a. to e. with the directional control valve momentarily set to LOWER and with the return hose disconnected from the flow control valve.

21. **Test for Faulty Flow Control Valve.** Each flow control consists of a check valve and a spring-loaded poppet valve. The check valve provides for free flow of oil when the directional control valve is set to RAISE. The poppet valve acts as a throttling device during the lowering of the load. The valve is adjustable and the normal setting of the spring adjusting screw is three turns anticlockwise from the fully compressed condition of the spring. Check the position of the adjusting screw as follows:

   a. Turn the spring adjusting screw three turns clockwise.

   b. Check that the spring is fully compressed.

   c. If the spring is not fully compressed, continue to adjust the screw clockwise until the spring is fully compressed.

   d. Turn the spring adjusting screw three turns anticlockwise.

22. Test the flow control valve as follows:

   a. Disconnect the flow control valve from the cylinder.

   b. Plug the hose.
Momentarily set the directional control valve to RAISE and check that oil flows from the flow control valve. If no oil flows, the flow control valve is faulty.

If oil flows, unplug the supply hose and reconnect the valve to the cylinder.

Disconnect the hose in the lowering line between the flow control valve and the motion control valve.

Momentarily set the directional control to RAISE and check that oil flows from the flow control valve.

If oil flows, reconnect the flow control valve to the motion control valve.

Repeat the operations detailed in Para 22.a. to g. with the directional control valve momentarily set to LOWER and with the return hose disconnected from the cylinder.

If the cylinder cycle time of the hook arm is outside the limits specified in EMEI Vehicle G 788, attempt to improve the performance by adjusting the setting of the flow control valve.

**Hook Arm Removal.** Remove the hook arm assembly as follows:

**NOTE**

Prior to removing the hook arm, it is recommended that the winch assembly and hook guide arm be removed (Para 74 and 76).

a. Raise the lift frame to gain access to the pivot pins. Securely chock the lift frame in position.

b. Position the arm forward to the end limit.
c. Disconnect the cylinder hoses from the hydraulic lines mounted on the front lift frame.
d. Plug the open ports and hoses. Mark them for later reassembly.
e. Remove the lower cylinder pivot pin by undoing the fastening screws and withdrawing the pin.
f. Support the hook arm with a suitable lifting mechanism.
g. Remove the hook arm pivot pin by undoing the fastening screw and withdrawing the pin.
h. Lift the hook arm, containing the cylinder, from the lift frame.
i. Undo the pivot fastening screws and withdraw the upper cylinder pivot pin.
j. Remove the hook arm cylinder and hoses from within the hook arm.

24. **Cleaning, Inspection and Repair.** Clean, inspect and repair all components as follows:
   a. Clean all components with an approved solvent.
   b. Inspect the fabrication for damage or wear.
   c. Inspect all welds for cracking.
   d. Repair all minor damage or wear to the hook arm by welding or machining.
   e. Inspect all bushes and pins for wear.
   f. Smooth out any imperfections on pins and in bores.
   g. Replace all components showing excessive wear or damage.

25. **Hook Arm Installation.** Install the components in the reverse order described in Para 23.

26. **Cylinder Overhaul and Repair.** Cylinder overhaul and repair is a Heavy Grade Repair task (Ref EMEI Vehicle G 784).

**LIFT FRAME SYSTEM**

**General**

27. The lift frame system consists of a front lift frame and a rear lift frame which are connected by a lockable pivot. Attached to either side and connected to the sub-frame are the two hydraulic lift cylinders. The cylinders provide the lift forces required for a controlled launch or recovery of a bridge module or a Bridge Erection and Propulsion Boat (BEPB).

28. The rear lift frame is connected to the sub-frame at the rear pivot. Attached at the rear of the frame within a trestle box are the telescoping rollers.

29. The rollers are located in position by two moveable location stops.

30. The rear lift frame is fitted with an electrical interlock to restrict movement and prevent mechanical damage by being raised too far.

31. Attached to the rear of the frame, are the rear tail light assemblies and rear bumper stops.

**Lift Frame – Faulty Performance**

32. **General.** If the lift frame is not functioning correctly, carry out the following:
   a. Inspect all the hydraulic pipelines and hoses for evidence of external damage (Figure 4).
   b. Replace any pipelines that are dented, ruptured, pinched or crimped.
   c. Check for binding pivot pins. Remove and clean any binding pivot pins.

33. **Test for Faulty Cylinder.** Each cylinder is tested as follows:
   a. Connect the test unit or the appropriate gauge to the cylinder test connector.
   b. Disconnect the supply hose from the rod end of each cylinder and plug the pipe end.
   c. Momentarily position the directional control to RAISE.
If oil flows from the open port and the cylinder moves, check the related flow control valve and the motion control valve.

If oil flows from the open port and the cylinder does not move, the cylinder is faulty.

If no oil flows and the pressure is 21 MPa, the cylinder is faulty.

If no oil flows and no pressure is shown on the gauge, check the directional control valve (Para 19).

If the directional control valve is functioning correctly, check the motion control valve (Para 20).

If the motion control valve is functioning correctly, check the flow control valve (Para 21).

Remove the pipe and reconnect the supply pipe to the rod end of the cylinder; remove the return pipe from the cap end of the cylinder and plug the pipe.

Momentarily position the directional control valve to LOWER and repeat the operation detailed in Para 33.d. to i.
Front Lift Frame

34. Front Lift Frame Removal. Remove the front lift frame as follows (Figure 5):
   a. Raise the locked lift frame to allow access to the lift frame pivot pin over the top of the sub frame.
   b. Securely chock the rear frame in this position.
   c. Lower and support the front lift frame to release the load on the frame lock mechanism.
   d. Remove the lift cylinders (Para 37).
   e. Disconnect the flexible hydraulic lines at the pivot joint (two off winch motor, one off winch drain, two off hook arm cylinder and two off hook guide arm cylinder).
   f. Cap the open ports and hose-ends. Mark the hose-ends for later reassembly.
   g. Remove the frame lock assembly (Para 39).
   h. Undo the fastening screws and withdraw the lift frame pivot pin.
   i. Remove the front lift frame.

35. Cleaning, Inspection and Repair. Clean, inspect and repair all components as follows:
   a. Clean all components with an approved solvent.
   b. Inspect the fabrication for damage or wear.
   c. Inspect all welds for cracking.
   d. Repair all minor damage or wear to the hook arm by welding or machining.
   e. Inspect all bushes and pins for wear.
   f. Smooth out any imperfections on pins and in bores.
   g. Replace all components showing excessive wear or damage.

Figure 5   Front Lift Frame
36. **Front Lift Frame Installation.** Install the components in the reverse order described in Para 34.

**Front Lift Frame Lift Cylinders**

37. **Front Lift Frame Lift Cylinder Removal.** Remove the lift frame lift cylinders as follows:

   a. The front lift frame must be raised and chocked to allow access to the lift cylinder pivot pin (Figure 5).
   b. Disconnect the flexible hydraulic hoses at the lift cylinder pivot. Mark hoses for later reassembly.
   c. Support the lift cylinder from the lift frame.
   d. Undo the fastening screws and remove the lift cylinder pivot pin.
   e. Repeat the procedure for the removal of the upper cylinder pivot pin.
   f. Remove the cylinder.

38. **Cylinder Overhaul and Repair.** Cylinder overhaul and repair is a heavy grade repair task (Ref EMEI Vehicle G 784).

**Frame Lock Assembly**

39. **Frame Lock Assembly Removal.** Remove the frame lock assembly as follows (Figure 6):

   a. Remove the circlips (Item 3) from the pivot pin (Item 2).
   b. Remove the spring (Item 4).
   c. Withdraw the pivot pin (Item 2) and remove the lock (Item 9).
   d. Remove the catch plate (Item 7) by undoing the screws (Items 5 and 6), together with the shims (Item 8).
   e. Undo the bolt (Item 11) and remove the control cable clevis (Item 1) from the detent lock lever (Item 10).
   f. Remove the turnbuckle (Item 20).
   g. Remove the upper crank lever (Item 21) by undoing the bolt (Item 24) together with the screw (Item 22).
   h. Undo the set screw (Item 19) from the shaft end-plate (Item 18).
   i. Undo the bolt (Item 12) and remove the release lever (Item 13) and the detent lock lever (Item 10) together with the shaft (Item 14).
   j. Lower the crank lever (Item 16) and the shaft end-plates (Item 18).
   k. Remove the rod lock (Item 9).

40. **Cleaning, Inspection and Repair.** Clean, inspect and repair all components as follows:

   a. Clean all components with an approved solvent.
   b. Inspect the rod lock (Figure 6 Item 9) and the stop plate (Figure 6 Item 27) for wear or evidence of damage.
   c. Inspect all welds for cracking.
   d. Repair minor damage on the lock or catch plate by welding or machining.
   e. Inspect all bushes and pins for wear.
   f. Smooth out any imperfections on pins and in bores.
   g. Replace all components showing excessive wear or damage.

41. **Frame Lock Assembly Installation.** Install the components in the reverse order to that described in Para 39.
Figure 6  Frame Lock Assembly
Rear Lift Frame

42. **Rear Lift Frame Removal.** Remove the rear lift frame as follows (Figure 7):

- **a.** Disconnect the flexible hydraulic lines at the pivot, (two off the winch motor, one off the winch drain, two off the hook arm cylinder, two off the hook guide arm cylinder, and two off the pontoon lock cylinder). Mark the lines for later reassembly.

- **b.** If the vehicle winch cable is positioned through the rear mounting fairlead rollers, disengage it and position it clear of the frame.

- **c.** Remove the rear tail light assemblies (Item 11) from the rear lift frame by removing electrical leads from cable clamps and undoing fastenings holding assembly frames.

- **d.** Remove the circlips (Item 13) and the lock screw (Item 12).

- **e.** Withdraw the pivot pin (Item 15).

- **f.** Remove the rear lift frame (Item 1) from the sub-frame.

- **g.** Remove the rear roller assembly (Para 141).

- **h.** Remove the electrical limit switch.

![Figure 7 Rear Lift Frame](image-url)
43. **Cleaning, Inspection and Repair.** Clean, inspect and repair all components as follows:
   a. Clean all components with an approved solvent.
   b. Inspect the fabrication for damage or wear.
   c. Inspect all welds for cracking.
   d. Repair any minor damage and wear to the lift frame by welding or machining.
   e. Inspect all bushes and pins for wear.
   f. Smooth out minor surface imperfections on pins and in bushes.
   g. Inspect the electrical switch for damage and correct operation.
   h. Replace all components showing excessive wear or damage.

44. **Rear Lift Frame Installation.** Install the components in the reverse order described in Para 42.

**Guide Pads**

45. Inspect the guide pads (Figure 7 Item 17) for damage or wear. If worn or damaged, replace by undoing the fastening screw (Figure 7 Item 16).

**Location Stops**

46. **Location Stops Removal.** Remove the location stops as follows (Figure 7):
   a. Remove the circlips (Items 2 and 7) from the pivot pins (Item 4) and (Item 6).
   b. Remove the pivot pins, the location stop (Item 3) and the link (Item 5).

47. **Cleaning, Inspection and Repair.** Clean, inspect and repair all components as follows:
   a. Inspect the pivot pin for damage or wear.
   b. Inspect the pivot bracket welds for cracking.
   c. Inspect the stops for damage on the stop face.
   d. Repair any minor damage to the stop face by welding or machining.
   e. Repair any cracked welds.
   f. Replace any components showing excessive wear or damage.

48. **Location Stops Installation.** Install the components in the reverse order described in Para 46.

**Rear Bumper Stops**

49. If the rear bumper stops (Figure 7 Item 8) are damaged or worn, undo the bolts, (Figure 7 Item 9) and replace the stops.

**MODULE LOCK SYSTEM**

**Module Lock Inoperative**

50. **General.** If the module lock is not functioning correctly, carry out the following:
   a. Inspect all the hydraulic pipelines and hoses for evidence of external damage.
   b. Replace any pipelines that are dented, ruptured, pinched or crimped.
   c. Inspect the lock pin and linkage lever for evidence of binding or damage. Replace the damaged components.

51. **Test for Faulty Cylinder.** Test the cylinder for internal damage as follows:
   a. Disconnect the rod end hose.
   b. Momentarily position the directional control valve to LOCK, and check for oil flow from the cylinder.
c. If oil flows and the rod moves, the cylinder is functioning correctly.
d. If no oil flows, reconnect the rod end hose and disconnect the cap end hose.
e. Momentarily position the control valve to LOCK, and check for oil flow from the hose.
f. If oil flows, the cylinder is faulty.
g. If no oil flows, the directional control valve is faulty.
h. Repeat the operations detailed in Para 51.a. to g. with the directional control valve momentarily set to UNLOCK.

52. **Module Lock Removal.** Remove the module lock as follows (Figure 8):

a. Disconnect the hydraulic hoses from the cylinder.
b. Plug the open ports and hoses and mark them for later reassembly.
c. Remove the circlips (Item 3) and the pivot pins (Item 4) from both ends of the cylinder (Item 5).
d. Remove the cylinder (Item 5).
e. Remove the circlip (Item 1) and the pivot pin (Item 2).
f. Remove the circlip (Item 7) and pivot pin (Item 9).
g. Remove the lever (Item 6).
h. Remove the locking pin (Item 8).

![Figure 8 Module Lock Assembly](image-url)
53. **Cleaning, Inspection and Repair.** Clean, inspect and repair all components as follows:
   a. Clean all components with an approved solvent.
   b. Inspect all the pivot pins for wear and damage.
   c. Inspect the lever locking pin for wear and damage.
   d. Repair any minor damage or wear by welding or machining.
   e. Smooth out minor surface imperfections on pins and in bores.
   f. Replace all components showing excessive wear or damage.

54. **Module Lock Installation.** Install the components in the reverse order described in Para 52.

55. **Cylinder Overhaul and Repair.** Cylinder overhaul and repair is a Heavy Grade Repair task (Ref EMEI Vehicle G 784).

**FRONT AND REAR ROLLERS**

**Front and Rear Roller Extension / Retraction – Faulty Performance**

56. **General.** If the front or rear rollers are not functioning correctly, carry out the following:
   a. Inspect each hydraulic pipeline and hose for evidence of external damage.
   b. Replace the pipelines or hoses that are dented, ruptured, pinched or crimped.

57. **Test for Faulty Cylinder.** Test each cylinder for internal damage as follows:
   a. Connect the hydraulic test unit or the appropriate gauge to the directional control valve test connector.
   b. Disconnect the hose from the rod end of the cylinder and plug the hose end.
   c. Momentarily position the directional control valve to EXTEND.
   d. If oil flows from the open port and the cylinder moves, check the pilot-operated check valve and the flow control valve.
   e. If oil flows from the open port and the cylinder does not move, the cylinder is faulty. Replace the cylinder.
   f. If no oil flows and the pressure is 21 MPa, the cylinder is faulty. Replace the cylinder.
   g. If no oil flows and no pressure is shown on the gauge, check the directional control valve (Para 19).
   h. If the directional control valve is functioning correctly, check the pilot-operated check valve (Para 58).
   i. If the pilot-operated check valve is functioning correctly, check the flow control valve in accordance with Para 21. The basic setting of the flow control valve adjusting screw is one half-turn anticlockwise from the fully compressed condition of the spring.
   j. Remove the plug and reconnect the hose to the rod end of the cylinder; remove the hose from the cap end of the cylinder and plug the hose.
   k. Momentarily position the directional control valve to RETRACT and repeat the operations detailed in Para 57.d. to i.

58. **Test for Faulty Pilot-Operated Check Valve.** Each pilot-operated check valve is a double-locking valve and operates in support of its related flow control valve. The flow control valves in the forward and rear roller systems are simple flow restriction devices and do not incorporate a check valve. Test the pilot-operated check valve as follows:
   a. Disconnect the line from the valve port C1.
   b. Momentarily position the directional control valve to EXTEND and check that oil flows from the valve.
   c. If no oil flows, the check valve is faulty. Replace the check valve.
   d. Reconnect the line to the valve port C1 and disconnect the valve return line.
   e. Momentarily set the directional control valve to RETRACT and check for oil flow from the valve port.
   f. If no oil flows, the valve is faulty and must be replaced.
59. **Roller Assemblies Repair.** Removal and repair of the roller assemblies, including the hydraulic cylinders is detailed in Para 136 to 145.

**LIFT WINCH**

**General**

60. The hydraulically driven winch is mounted onto the back of the hook arm. The cable assembly consists of an eye hook, clevis and 20 metres of cable and passes up the hook arm, over a sheave to the hook guide.

61. The hook guide and sheave can pivot about the hook arm to allow for the cargo pallet tray to be fitted.

62. A mesh guard is bolted onto the hook arm body to protect the operator from the winch rope (Figure 9).

![Lift Winch Assembly](image)

**Figure 9** Lift Winch Assembly
Winch Rope

63. **Winch Rope Removal.** Remove the winch rope as follows (Figure 10):
   
   a. The winch rope can only be removed when the winch is operable.
   
   b. Operate the winch and pay out the rope until the drum anchor (Item 11) is exposed. Remove the rope end from the cable anchor.

64. **Lift Winch Rope Disassembly.** Disassemble the winch rope as follows (Figure 10):

   **NOTE**

   Disassembly is only required if the winch rope is to be replaced or shortened.

   a. Undo the fastening pin (Item 10) and remove the eye-hook (Item 9) from the clevis (Item 8).

---

**Figure 10  Hook and Rope Assembly**
Care should be taken when dismantling the socket bodies as the wire rope may spring open.

b. Dismantle the socket body (Figure 11) using a 10mm Allen Key. The socket bodies and wedge must be inspected for excessive wear or damage at the point the wire rope is jammed into the socket.

Figure 11 Removing the Rope From the Socket

65. Cleaning and Inspection. Clean and inspect the winch rope as follows:
   a. Clean the clevis and pin in approved solvent.

   CAUTION

   DO NOT use solvents or ZX 8 to clean or lubricate the winch rope.
   b. Clean the rope by wire brushing and wiping down with rags and Rocol wirerope lube.
   c. Inspect the cable for broken strands and fraying.
   d. Inspect the clevis for evidence of damage, cracking, pitting or corrosion.
   e. Inspect the eye hook for evidence of damage or wear.

66. Repair or Replacement of the Winch Rope. Repair or replace the winch rope as follows:
   a. Replace all components that are worn, cracked, pitted or damaged.
   b. Replace the cable if any strands are broken.

67. Socket Reassembly. Reassemble the socket as follows:
   a. Re-assemble the socket body by tightening the socket head cup screws to 150 N.m prior to re-reeving the wire rope.
   b. Reeve the rope through the socket, install the wedge and pull the rope tight (Figure 12).
   c. Leave approx 200mm of the rope end protruding from the socket (Figure 13), so that any slippage will be evident.

Figure 12 Reeving the Rope Through the Socket
DO NOT place the rope grip across both the live rope and the dead end as it will lead to severe damage to the wire rope.

d. Apply a wire rope grip to the tail (only) of the rope below the socket to prevent dislodgment of the wedge (Figure 14).

![Figure 13 Protrusion of Dead End](image)

![Figure 14 Wire Rope Grip to Tail](image)

**Wire Rope Installation.** Install the wire rope as follows (Figure 10):

a. Thread the bare cable end over the hook guide sheave to the winch drum.
b. Insert the cable into the drum cable anchor with the locking wedge.

**NOTE**

Ensure that the cable anchor location allows for the lifting load to be applied to the winch drum when in a clockwise rotation viewed from the hydraulic motor end of the winch. Braking action of the winch will only function when the cable is anchored this way.

c. Operate the winch and slowly winch in under tension until the clevis just contacts the hook guide.

**Hydraulic Lift Winch - Faulty Performance**

**NOTE**

Before removing the hydraulic winch for disassembly and internal examination, check the hydraulic system for correct operation. If the winch has been mounted to an uneven surface, the application of a load can result in a decrease in drum rpm or failure of the winch to operate.

**Hydraulic System - Rate of Flow.** The rate of flow in the hydraulic system is directly proportional to the cable speed and the drum rpm of the winch. The rated cable speeds and the rated drum speed are as follows:

a. bare drum, at the first layer of cable on the drum – 0.5 m/s (1.7 ft/s);
b. mean drum diameter – 0.7 m/s (2.3 ft/s);
c. full drum diameter – 0.9 m/s (2.9 ft/s); and
d. bare drum speed – 48 rpm.

**Rate of Flow - Check.** To achieve the rated performance the winch motor must receive hydraulic oil flowing at the rate of 3.2 L/s at the pressure port. Check the rate of flow, with the engine running and the PTO engaged as follows (Figure 15):
a. Fit a flow meter to the inlet P1 port. Fully open the winch control valve and check that the required rate of flow is delivered.

b. If the check indicates a loss or reduction in the rate of flow, check the hydraulic pump performance (Para 83).

c. Check the operation of the cross-line pressure relief valve, using a pressure gauge connected into the inlet P1 port. The pressure should be 15 MPa (2200 psi).

d. Check the operation of the winch control valve as follows:
   (1) Disengage the PTO and stop the engine.
   (2) Disconnect the hose from the motor port P1.
   (3) Momentarily position the control lever to the cable IN position and check for oil flow from the hose.
   (4) If there is no oil flow, the control valve is faulty and must be replaced.
   (5) If oil flows, set the control valve lever to NEUTRAL and reconnect the hose to the motor port P1.
   (6) Disconnect the hose from the motor port P2.
   (7) Momentarily set the control valve lever to cable OUT and check that oil flows from the hose.
   (8) If there is no oil flow the control valve is faulty and must be replaced.
   (9) If oil flows, set the control valve lever to NEUTRAL and reconnect the hose to the motor port P2.
   (10) Start the vehicle engine and engage the PTO.
71. Hydraulic System – Oil Pressure. The hydraulic pressure is directly proportional to the lifting or pulling capacity of the winch. The lifting performances are as follows:
   a. bare drum, ie, one layer of cable on the drum – 5443 kg (12 000 lb);
   b. mean drum diameter – 4090 kg (9000 lb); and
   c. full drum diameter – 3182 kg (7000 lb).

72. Oil Pressure - Check. The operating pressure required by the winch to meet the performance values given in Para 79 is 15 Mpa (2200 psi). Check the operating pressure as follows:
   a. Disengage the PTO and fit a pressure gauge into the line leading to motor port P1, ie, the hoisting port.
   b. Engage the PTO and stall the winch.
   c. Open the control valve and record the hydraulic pressure.
   d. If the pressure is below 15 Mpa (2200 psi), check the following:
      (1) the hydraulic system pressure relief valve, using an external pressure gauge at the test connection;
      (2) the hydraulic pump (Para 83); and/or
      (3) The control valve unless previously checked.
   e. Adjust the cross-line relief valve; remove and replace it if the required pressure is not achieved.

73. Lift Winch Assembly Fault Diagnosis. If the functional checks on the hydraulic system are satisfactory, carry out fault diagnosis of the winch in accordance with Table 1.

74. Lift Winch Assembly Removal. Remove the lift winch as follows (Figure 10):

   NOTE
   If disassembly of the winch is required, the winch cable should be removed prior to the removal of the winch.

   a. Operate and raise the lift frame to its end limit.
   b. Operate the hook arm forward to its end limit; this will position the winch off the back end of the LRV.
   c. Remove the mesh guard from the hook arm.
   d. Remove the spacer plate from between the flanges of the hook guide (Item 5).
   e. Remove the circlips (Item 1) from the roller pin (Item 2).
   f. Remove the roller (Item 4) to allow the hook clevis (Item 8) and the cable (Item 7) to be removed from the hook guide.
   g. Undo the hydraulic hoses from the winch motor (Item 12).
   h. Plug the open ports and the open hose ends; mark for later reassembly.
   i. Support the winch body and undo the bolts (Item 13).
   j. Remove the winch and the cable from the hook arm.

75. Lift Winch Assembly Installation. Install the lift winch in the reverse order described in Para 74. After winch repairs, test the winch by operating in both directions without load prior to use.

Hook Guide Arm

76. Hook Guide Arm Removal. Remove the hook guide arm as follows (Figure 10):

   a. Remove the hook guide arm cylinder.
   b. Unbolt the rod end housing plate.
   c. Remove the circlips (Item 1) from roller pin (Item 2).
   d. Remove the roller (Item 4) to allow the hook clevis (Item 8) and cable (Item 7) to be removed from the hook guide arm (Item 5).
   e. Remove the circlips (Item 6).
f. Support the weight of the hook guide arm (Item 5) and remove the retaining pin (Item 15) and pivot pin (Item 14).

g. Remove the hook guide arm from the hook arm.

h. Undo the fastening bolts (Item 16) and remove the sheave pivot pin (10 Item 17) and sheave (Item 3).

77. **Cleaning and Inspection.** Clean and inspect the hook guide arm as follows:

a. Clean all components with approved solvent.

b. Inspect the hook guide arm fabrication (Item 5) for wear and damage.

c. Inspect the sheave (Item 3) and pivot pin (Item 14) for wear or damage.

d. Inspect the auxiliary cable clevis link and pin (Item 15) for wear or damage.

e. Inspect all welds for evidence of cracking.

78. **Repair or Replacement.** Repair or replace the hook guide arm items as follows:

a. Repair minor damage or wear to the hook guide arm by welding and machining.

b. Smooth out minor surface imperfections on pins, bores and sheave cable grooves.

c. Replace all components showing excessive wear or damage.

79. **Cylinder Overhaul and Repair.** Cylinder overhaul and repair is a heavy grade repair task (Ref EMEI Vehicle G 784).

80. **Hook Guide Arm Installation.** Install the hook guide arm in the reverse order described in Para 76.

**POWER TAKE-OFF ASSEMBLY**

**General**

81. The pump for the hydraulic system is directly coupled to a power take-off (PTO) unit attached to the right-hand side of the truck transmission gearbox. Control of the PTO is achieved through a pneumatic switch, which controls the airshift assembly and is positioned in the cabin to the left-hand side of the driver’s seat.

82. A warning lamp mounted onto the PTO control switch bracket indicates engagement of the PTO.

83. **Hydraulic Pump Inoperative or Noisy.** Check the hydraulic pump as follows:

a. Disengage the PTO.

b. Check the level of the oil in the hydraulic tank; fill if necessary. Check the delivery and return hoses for obvious signs of damage. Replace any hose that is ruptured, pinched or crimped.

c. Check for a loose or damaged PTO or pump assembly.

d. Replace any damaged component as detailed later in this section.
### Table 1  Winch Assembly Fault Diagnosis

<table>
<thead>
<tr>
<th>Serial</th>
<th>Fault</th>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Winch will not lift or pull its maximum rated load:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bare drum – 5433 kg</td>
<td>Winch mounted to uneven surface</td>
<td>Shim below the mounting pads as required to eliminate any spaces</td>
</tr>
<tr>
<td></td>
<td>Mean drum – 4090 kg</td>
<td>Cable sheave or the roller, operated with the winch, are not turning freely.</td>
<td>Service or remove and replace the cable sheave and roller</td>
</tr>
<tr>
<td></td>
<td>Full drum – 3182 kg</td>
<td>Relief valve set too low, ie, below 15 MPa (2200 psi)</td>
<td>Reset the pressure relief valve as required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excessive back pressure in the hydraulic system</td>
<td>Check the setting of the pressure relief valve; check for restrictions, internal damage or obstructions in the winch return line to the hydraulic tank. Rectify accordingly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Damage or wear to the winch motor</td>
<td>Inspect the motor, remove and replace if necessary</td>
</tr>
<tr>
<td>2</td>
<td>Winch does not produce its rated line speed or drum rpm</td>
<td>The winch is mounted on an uneven surface</td>
<td>Shim below the mounting pads as required to eliminate any spaces</td>
</tr>
<tr>
<td></td>
<td>Bare drum – 0.5 m/s</td>
<td>The cable sheave and, or, the roller is not turning freely</td>
<td>Examine the sheaves and the roller for signs of obvious damage or distortion. Repair, lubricate or replace as necessary</td>
</tr>
<tr>
<td></td>
<td>Mean drum - .07 m/s</td>
<td>Excessive back pressure in the hydraulic system</td>
<td>Check the relief valve setting and adjust if required. Check the winch hydraulic oil return hose to the hydraulic tank and remove any obstruction found. Check the hydraulic tank filter and vent for cleanliness</td>
</tr>
<tr>
<td></td>
<td>Full drum – 0.9 m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drum speed – 48 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Winch will not reverse, ie will not lower a load</td>
<td>The winch is mounted to an uneven surface</td>
<td>Shim below the mounting pads as required to eliminate any spaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic pressure in the lower line is below 5.5 MPa (800 psi), which is the brake release pressure</td>
<td>Test the hydraulic system in the lowering line, adjust or replace any defective component</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faulty ‘O’ ring seals on the brake system</td>
<td>Remove and replace the winch assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oil leakage between the motor adaptor and the brake housing</td>
<td>Remove and replace the winch assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic pressure is not reaching the brake piston</td>
<td>Remove and replace the winch assembly</td>
</tr>
<tr>
<td>4</td>
<td>The brake will not hold</td>
<td>The winch cable is secured to the incorrect cable anchor</td>
<td>Run out the winch cable, check that the position of the cable anchor is such that the load is applied to the winch drum only when the drum rotates in a clockwise direction, when viewed from the motor-end of the winch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Back pressure in the return line exceeds 344 kPa (50 psi)</td>
<td>Check the relief valve setting and adjust if required. Check the winch hydraulic oil return hose to the hydraulic tank and remove any obstruction found. Check the hydraulic tank, valve and vent for cleanliness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brake piston is seized in the brake housing</td>
<td>Check the hydraulic oil for cleanliness and contamination. Empty, purge and replenish the system with clean hydraulic oil as necessary. Remove and replace the winch assembly if required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brake plates or divider plates contaminated by hydraulic oil</td>
<td>Remove and replace the winch assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brake plates or divider plates damaged by lack of oil circulation in the brake housing.</td>
<td>Check the hydraulic system for correct operation. Remove and replace the assembly as necessary.</td>
</tr>
</tbody>
</table>
### Table 1 Winch Assembly Fault Diagnosis (Continued)

<table>
<thead>
<tr>
<th>Serial</th>
<th>Fault</th>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Brake vibrates when lowering the load, ie, chattering</td>
<td>Low or insufficient rate of flow</td>
<td>Check the flow rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The brake is running hot; insufficient oil circulation</td>
<td>Select REVERSE and check the rate of oil flow from the winch hydraulic return line; it must be a minimum of 0.3 L/s (0.067 gal/s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The winch control valve has poor metering characteristics</td>
<td>Check the control valve lever for feel, ie freedom of movement throughout the range from NEUTRAL to FORWARD and from NEUTRAL to REVERSE. Check that the control valve spring loading centralises the valve in the ‘spooling’ or neutral position. Change the control valve if the problem persists</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air in the hydraulic system indicated by frothy oil</td>
<td>Check the system for signs of leakage(s); check the hydraulic tank oil level and check that the overflow baffle is not damaged</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Damaged brake plates or divider plates</td>
<td>Replace the winch and return the defective unit for disassembly and replacement of the brake and/or divider plates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A damaged over-running clutch</td>
<td>Replace the winch</td>
</tr>
<tr>
<td>6</td>
<td>Oil leaks</td>
<td>Leakage at the motor flange</td>
<td>Check the cap-screws securing the motor for tightness, remove and replace the ‘O’ ring seal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leakage between the cable drum flanges and the housing</td>
<td>Check the pressure in the hydraulic system return line, it must not exceed 344.5 kPa (50 psi). Check the hydraulic tank vent for cleanliness, remove and replace the winch assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oil leak from the breather relief valve on the drum end cover</td>
<td>Check the pressure in the hydraulic system return line, it must not exceed 344.5 kPa (50 psi). Check the hydraulic tank vent for cleanliness, remove and replace the winch assembly. Check that the system is filled with oil to the correct specification; remove and replace as required</td>
</tr>
</tbody>
</table>

#### 84. Check Oil Supply to the Pump.
Check oil supply to the hydraulic pump as follows:

a. Close the valve in the supply line from the hydraulic tank and shut off the oil supply to the pump.

b. Disconnect the oil supply hose from the pump.

c. Momentarily open the manual valve at the tank and check that the oil flows freely from the supply hose.

d. If the oil flow is restricted, check the supply line and hose for blockage(s); remove any blockage and repeat the flow test.

e. If the oil flow is still restricted, remove and check the oil return line filter and air vent in the top of the hydraulic tank for cleanliness. Clean the filter and vent in an approved solvent as necessary. Replace any damaged components. Repeat the oil flow test.

f. Run the vehicle engine and check the hydraulic pump operation as follows:

   (1) Remove the rear control panel and connect a pressure gauge to the test connector.

   (2) Engage the PTO and check that a system pressure of 21 MPa (3048 psi) is achieved.

   (3) If the test is satisfactory, disengage the PTO, disconnect the pressure gauge and replace the rear control panel.

g. If the hydraulic pump is still inoperative or noisy during operation, check the PTO.
85. **Check the PTO for Correct Operation.** Disengage the PTO, stop the vehicle engine and check the PTO as follows:

   a. Remove the hydraulic pump from the PTO as follows:
      (1) Ensure that the oil supply is turned off.
      (2) Place a clean container below the pump, disconnect the pump oil supply hose and drain the oil from the inlet side of the pump.
      (3) Disconnect the pump oil delivery hose and drain the oil from the outlet side of the pump.
      (4) Remove the four bolts securing the pump to the PTO.
      (5) Remove the pump from the PTO.

   b. Start the vehicle engine, engage the PTO and check that the PTO output shaft rotates freely and quietly. Satisfactory operation of the PTO indicates that the hydraulic pump is defective. Overhaul the pump as detailed in Para 86. If the PTO is noisy or does not rotate correctly, carry out the procedure detailed in Para 87 and 90.

   c. The most common problem associated with the PTO unit is noisy operation. The noise can range from a rattle to a whine. Noise is generally the result of incorrect backlash in the PTO gears.

86. **Hydraulic Pump Overhaul.** Disassemble and overhaul the hydraulic pump (Figure 16) as follows:

   a. Undo and remove the three cap-screws from the mount adaptor.
   b. Separate the mount adaptor, the cover plate and the flange from the gear plate.
   c. Remove the drive gear, the idler gear and the 'O' rings and seals.
   d. Clean all components with an approved solvent.
   e. Inspect all components, particularly the gears, for signs of wear or damage. Replace defective components as necessary.
   f. Replace all 'O' rings and seals and thoroughly lubricate all components with graphite grease prior to assembly.
   g. Reassemble the pump in the reverse order to disassembly.

87. **Fault Diagnosis.** Table 2 contains a list of PTO fault diagnostics.
<table>
<thead>
<tr>
<th>Serial</th>
<th>Fault</th>
<th>Probable Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Noisy Rattles or whines</td>
<td>Backlash outside of limits. Backlash in PTO gears should be 0.15 mm (0.006 in) to 0.3 mm (0.12 in)</td>
<td>Measure backlash Rattle – remove gasket(s) Whine – add gasket(s) One Chelsea 0.25 mm (0.010 in) thick gasket will change backlash by about 0.15 mm (0.006 in) and a Chelsea 0.50 mm (0.020 in) thick gasket will change backlash by about 0.30 mm (0.012 in)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clicking</td>
<td>Worn, nicked or burred gear</td>
<td>Worn or nicked gears must be replaced. Burrs can be removed with a hand grinder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Heating</td>
<td>PTO installed with insufficient backlash Add gaskets to obtain 0.15 mm (0.006 in) to 0.3 mm (0.12 in) backlash (refer to serial 1)</td>
<td>Install a new bearing. Clean inside of the PTO thoroughly and change the transmission oil. Use an arbour press and appropriate diameter tube; press the inner race over the shaft and the outer race into the housing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low transmission oil level</td>
<td>Fill the transmission to the correct oil level</td>
</tr>
<tr>
<td>3</td>
<td>Vibration</td>
<td>PTO loose on transmission</td>
<td>Torque the six PTO retaining bolts to 41 N.m (30 lbf.ft) to 47.5 N.m (35 lbf.ft)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>External oil leak</td>
<td>Faulty shaft seal</td>
<td>Replace shaft seal ensuring that the shaft and the housing are free from nicks and burrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Porous or cracked PTO housing</td>
<td>Replace the PTO housing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor mating surface with the transmission</td>
<td>Torque the PTO as detailed in serial 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broken or worn gasket</td>
<td>Replace the gasket. A gasket should be fitted between all mating surfaces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faulty or missing copper washers under the nuts or bolts retaining the PTO</td>
<td>Install copper washers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faulty ‘O’ ring on the shifter post</td>
<td>Replace the ‘O’ ring. The shifter cover hole must be free from dirt and burrs. If the shifter handle is replaced onto the shifter cover, care is to be taken that the shifter post is not pushed in, as the ‘O’ ring will be damaged when the shifter post is pulled back out to the normal position</td>
</tr>
<tr>
<td>5</td>
<td>Jumping out of gear</td>
<td>Excessive torque on the PTO gears</td>
<td>Install a PTO with adequate torque capability or reduce the load on the PTO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A worn gear due to shifting out under load</td>
<td>Replace the gear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A broken shifter poppet spring or the poppet hole is elongated</td>
<td>Replace the spring, if broken, or the housing if the hole is elongated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A worn shift rail poppet notch</td>
<td>Replace the shift rail. Inspect the poppet and spring and replace as necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The shift fork is sprung or loose</td>
<td>Replace a sprung shift fork or tighten a loose fork on the rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low pneumatic pressure (the air shift requires 482 kPa (70 psi) to 965 kPa (140 psi) for a complete shift)</td>
<td>Install a pressure protection valve to limit shifting unless a minimum pressure of 413 kPa (60 psi) to 482 kPa (70 psi) is available. If the valve is installed, check for an air leak. Repair the leak or change the defective part</td>
</tr>
</tbody>
</table>
88. **Removal of the PTO.** Remove the PTO as follows:
   a. Place a suitable clean container below the transmission drain and remove the drain plug.
   b. When draining is completed, replace the drain plug and remove the container.
   c. Clean the PTO-to-transmission interface with an approved solvent and allow the surfaces to dry.
   d. Disconnect the air line from the PTO shifter housing.
   e. Disconnect the electrical lead from the engagement sensor switch.
   f. Remove the PTO retaining cap-screws and remove the PTO from the transmission.
   g. Remove the PTO gear adapter and the gaskets from the transmission.
   h. Cover the transmission opening to keep dirt out.
   i. Remove all traces of gasket residue from the transmission mounting surface.

89. **Disassembly, Repair or Replacement.** To disassemble, repair or replace components in the PTO proceed as follows (Figure 17):
   a. Undo the bolts and remove the covers from the PTO housing.
   b. Remove the main shaft and gear.
   c. Remove the set screw from the body, the idler shaft and the cluster gear input.
   d. Remove and disassemble the air shift assembly (Figure 18).
   e. Clean all components with an approved solvent and inspect the components for wear or damage.
   f. Reassemble in the reverse order of disassembly.
   g. Prior to replacing the covers, check the gear backlash to ensure that it is within the range of 0.15 to 0.30 mm.
   h. Replace the covers and tighten the securing bolts to 21 N.m torque.

90. **Fitting a PTO.** Fit a **Fully Functional** PTO as follows:
   a. Ensure that the vehicle engine is stopped.
   b. Rock the PTO driver gear in the gear box and the driven gear in the PTO by hand. This operation indicates the inherent backlash in the gear box and the PTO.
   c. Check that the correct torque loading has been applied to each PTO retaining stud, 23 to 26 N.m (17 to 19 lbf.ft).
   d. Fit the appropriate number of gaskets over the studs (usually one 0.50 mm (0.020 in) thick gasket is adequate to meet the backlash requirements).
   e. Fit gaskets between all mounting surfaces and fit copper gaskets under each retaining cap-screw.
   f. Secure the PTO to the gear box adapter and tighten each cap-screw to 41 to 47.5 N.m (30 to 35 lbf.ft).
   g. Connect the electrical lead from the engagement sensor switch.
   h. Connect the air line from the shifter housing.
   i. Remove the filler plug, fill the gear box with the appropriate transmission oil to the prescribed level and refit the filler plug.
   j. Run the vehicle engine and engage and run the PTO for about 10 minutes. Check for oil leaks and noise (Table 2).
   k. Check the engagement sensor switch for correct operation of the indicator lamp.

   **NOTE**
   Ensure that the lamp is extinguished when the PTO is disengaged.
   l. Disengage the PTO and stop the vehicle engine.
Figure 17  Power Take Off (PTO) Assembly

Figure 18  PTO Airshift Assembly
91. **Fitting the Hydraulic Pump.** Fit the hydraulic pump to the PTO as follows:
   a. Position the pump on the PTO and secure the pump with the four bolts.
   b. Connect the oil delivery hose to the outlet side of the pump.
   c. Connect the oil supply hose from the tank to the inlet side of the pump.
   d. Open the oil supply valve from the tank.
   e. Start the vehicle engine and engage the PTO.
   f. Allow time for the hydraulic system to reach operating pressure (approximately two minutes).
   g. Check the hydraulic pump for correct operation as described in Para 83.
   h. Check the pump connections for leaks.
   i. Disengage the PTO and stop the vehicle engine.

**PTO Pneumatic Control Switch**

92. **Removal.** Remove the pneumatic control switch as follows (Figure 19):
   a. Drain the air from the brake tank, which supplies air to the PTO control, by opening the air cock.
   b. Mark and disconnect the two air lines from the switch body.
   c. Undo the four screws securing the nameplate and remove the nameplate.
   d. Undo the two screws securing the switch body and remove the switch body.

![Figure 19 PTO Pneumatic Control Switch, Lines and Fittings](image)
93. **Installation.** To install the pneumatic control switch proceed as follows:

a. Reassemble the switch in the reverse order.

b. Close the air cock at the brake tank.

c. Start the vehicle motor and build up the air pressure. Check that the pressure relief valve operates between 410 to 480 kPa (60 to 70 psi).

d. Check all connections for air leaks.

e. Check for correct operation including the smooth engagement of the PTO, the functioning of the air shift assembly sensor switch and the engagement indicator lamp.

**HYDRAULIC TANK**

**General**

94. The hydraulic tank is mounted on the operator control platform sub-frame on the opposite side of the vehicle to the operator. Mounted on its left-hand side is a sight gauge giving a visual indication of oil level and temperature (Figure 20).

95. Oil filtration is provided by a return line filter mounted into the top surface. Also mounted into this surface is a filler cap/strainer unit.

96. The capacity of the hydraulic tank is 80 L (17.5 gal).
The hydraulic tank is heavy. Use a suitable lifting device.

97. **Removal.** Remove the hydraulic tank as follows:
   a. Remove the protective cage over the hydraulic oil cooler.
   b. Place a suitable container under the hydraulic pump supply line.
   c. Close the supply line cock at the tank.
   d. Disconnect the supply line from the hydraulic pump and place it into the container.
   e. Open the supply line cock and drain the tank.
   f. Disconnect the supply line, oil return line and the winch drain line from the tank.
   g. Support the tool box which is secured by common fasteners with the hydraulic tank.
   h. Undo the hydraulic tank fasteners.
   i. Attach the lifting device and remove the tank assembly complete with the oil cooler and stand.

98. **Disassembly.** Disassemble the hydraulic tank as follows:
   a. Drain the residual oil from the tank through the bottom drain plug.
   b. Remove the oil return line filter by undoing the screws. Disassemble, clean and inspect as detailed in Para 102 to 106.
   c. Remove the oil level gauge by undoing the fastening screws (Para 107). Clean and inspect as detailed in Para 108.
   d. Remove the filler cap/strainer unit by undoing the securing screws. Clean and inspect as detailed in Para 111.

   **NOTE**
   Captive nuts are welded to the inside of the tank.

99. **Cleaning and Inspection.** Clean and inspect the hydraulic tank as follows:
   a. Clean the tank inside and out with an approved solvent and dry it thoroughly.
   b. Inspect threaded connections for damage.
   c. Inspect all welds for cracking.
   d. Inspect for structural damage.
   e. Inspect all sealing gaskets for damage.

100. **Repair.** Repair the hydraulic tank as follows:
   a. Repair threads using suitable thread chasers.

   **WARNING**
   Ensure the tank is vapour free prior to commencing any welding.
   
   b. Repair cracks by welding.
   c. Repaint the tank exterior when necessary.

101. **Installation.** Reassemble and install in the reverse sequence to the removal operations.

**Oil Return Line Filter**

102. **Removal.** Remove the oil return line filter as follows:
a. Disconnect the oil return line from the filter body.
b. Undo the screws fastening the filter body to the top of the tank.
c. Remove the filter body and sealing gasket from the tank.

103. **Disassembly.** Disassemble the oil return line filter as follows:
   a. Undo the top-cap sealing screws.
b. Remove the top-cap and seal.
c. Remove the filter element and contamination container.

104. **Cleaning and Inspection.** Clean and inspect the oil return line filter as follows:
   a. Discard the filter element and clean the contamination container with an approved solvent.
b. Clean the filter body and cap with an approved solvent.
c. Inspect the cap seal and body sealing gaskets for wear and damage.
d. Inspect the connection port threads for wear or damage.
e. Inspect the clogging indicator for correct operation.
f. Inspect the body components for cracks or damage.

105. **Repair or Replace.** Repair or replace the oil return line filter components as follows:
   a. worn or damaged seals,
b. cracked or damaged body components, and
c. the filter element.

106. **Reassembly.** Reassemble the oil return line filter in the reverse sequence to the disassembly.

**Oil Level Gauge**

107. **Removal.** Remove the oil level gauge as follows:
   a. Undo the securing screws.

   **NOTE**
   Captive nuts are welded to the inside of the tank.

   b. Remove the gauge body and sealing washers.

108. **Cleaning and Inspection.** Clean and inspect the oil level gauge as follows:
   a. Visually check the body and the ‘O’ ring seal for any obvious signs of damage. Replace the ‘O’ ring seal if necessary.
b. If the glass is dirty, flush the gauge with an approved solvent.

109. **Installation.** Reassemble and install in the reverse sequence to the removal operations.

**Filler/Strainer Cap**

110. **Removal.** Remove the filler/strainer cap as follows:
   a. Unscrew the air filter cap from the body.
b. Undo the screws fastening the filler body to the tank top.
c. Remove the filler body and sealing gaskets from the tank.
d. Remove the filter cap from the body by disconnecting the link chain.

111. **Cleaning and Inspection.** Clean and inspect the filler/strainer cap as follows:
   a. Clean the strainer element in an approved solvent and blow dry with low pressure compressed air.
b. Clean the air filter cap in an approved solvent.
c. Inspect all components for wear or damage.
112. Repair. Repair by replacement any worn or damaged components.

113. Installation. Reassemble and install in the reverse sequence to the removal operations.

Oil Cooler

114. Removal. Remove the oil cooler as follows:
   a. Remove the four screws retaining the oil cooler protection grille and fan mounting plate and remove the grille and mounting plate.
   b. Disconnect the electrical cable to the fan motor.
   c. Undo the input and output hydraulic lines from the cooler.
   d. Cap the hydraulic lines.
   e. Remove the four mounting bolts retaining the oil cooler core and remove the core.

115. Cleaning and Inspection. Clean and inspect the oil cooler as follows:
   a. Clean the oil cooler core by blowing it with compressed air.
   b. Inspect all components for wear, damage or leaks.

116. Repair. Repair by replacement any worn, damaged or leaking components.

117. Installation. Reassemble and install in the reverse sequence to the removal operations.

ELECTRICAL SYSTEM

General

118. The LRV electrical system consists of the original vehicle electrical system plus four additional systems for:
   a. blackout and work lights,
   b. side clearance lamps,
   c. the PTO warning lamp, and
   d. the hook arm position indicator box.

Blackout-lights

119. Removal. Remove the blackout lights as follows:
   a. Position the blackout light switch on the control console to the OFF position.
   b. Disconnect electrical leads from the connectors at the rear of the blackout light assembly.
   c. Remove the nuts and washers securing the blackout light assembly to the mounting bracket and remove the assembly.

120. Disassembly. Disassemble the blackout light as follows (Figure 21):
   a. Remove the lens assembly from the body by undoing the fastening screws and disconnecting the lead from the lamp body.
   b. Remove the globe from the lamp housing.

Figure 21 Blackout Light Assembly
121. **Cleaning.** Clean, inspect and replace any faulty components as follows:
   a. Clean the components using an approved solvent.
   b. Inspect all components for damage.
   c. Inspect all wiring for continuity.
   d. Replace defective or damaged components.
   e. Test the lamp for correct operation.

122. **Reassembly.** Reassemble the blackout light in the reverse sequence to the disassembly.

123. **Installation.** Install the blackout light as follows:
   a. Reassemble the blackout light to the mounting bracket, ensuring correct positioning of the washers and fasteners.
   b. Reconnect the electrical leads to the blackout light assembly.
   c. Test for correct operation.

**Side Clearance Lamp**

124. **Replacement.** The side clearance lamps are sealed units which are repaired by replacement as follows (Figure 22):

   ![Side Clearance Light](image)

   **Figure 22 Side Clearance Light**

   a. Remove the two lamp retaining nuts from the rear of the deflector base.
   b. Remove the lamp from the deflector base.
   c. Withdraw the electrical cable from the extension arm (approx. 2.5 metres of cable).
   d. Disconnect the electrical connector and discard the lamp.
   e. Connect the electrical connector of a new lamp and replace the cable into the extension arm.
   f. Fit the new lamp to the deflector base.
   g. Secure the lamp with the two retaining nuts at the rear of the deflector base.

**PTO Warning Lamp**

125. **Removal.** Remove the PTO warning lamp as follows (Figure 23):

   a. Ensure that the vehicle ignition is switched off.
   b. Undo the fastening nut from the lamp and remove the lamp.
   c. Disconnect the electrical leads.
   d. Unscrew the lens.
   e. Remove the globe from the lamp body.
126. **Installation.** Reassemble and install in the reverse sequence to the removal operations and test for correct operation.

**Hook Arm Position Indicator (HAPI) Box**

127. The Hook Arm Position Indicator (HAPI) Box indicates the correct position of the hook arm, for recovery operations, by a green light. Incorrect position is indicated by a red light. The HAPI box is located at eye level on the operator’s stand.

128. The system consists of a proximity switch changeover and an actuator magnet, which are attached to the lift frame and hook arm respectively.

129. Repairs to the system mainly consist of changing defective globes in the HAPI box. After some use the actuator magnet may require adjustment. The magnet is equipped with slotted grooves for this purpose. Adjust the magnet position until the green light is ON when the hook arm is correctly positioned. (The correct position is when the yellow line on the side of the hook arm is aligned with the front lift frame).

**MECHANICAL REPAIRS**

**Operator Control Platform**

130. **General.** The control platform provides the support for the hydraulic controls by which an operator launches or recovers a bridge module or a BEPB. The platform flooring is fabricated from grid mesh (Figure 24).
131. **Support Frame.** Inspect and repair the support frame as follows:
   a. Inspect for cracks or damage.
   b. Repair the frame using approved welding techniques.
   c. Repaint the repaired area.

132. **Cover Panels.** Inspect and repair the cover panels as follows:
   a. Inspect for missing fastening screws.
   b. Make good any fastening screw deficiencies.
   c. Inspect for structural damage.
   d. Repair or replace as required.

**Spare Wheel Carrier**

133. **General.** The spare wheel carrier consists of a wheel support plate attached by a chain to a winch box. The winch box is bolted to the chassis, rearward of the battery box (Figure 25).

134. **Winch Box.** Inspect and repair the winch box as follows:
   a. **Removal.** Remove the winch box as follows:
      1. Undo and remove the wheel nuts holding the wheel support plate to the chassis.
      2. Lower the spare wheel to the ground.
      3. Remove the spare wheel.
      4. Undo and remove the winch box from the chassis.

![Spare Wheel Carrier](image)

**Figure 25**  Spare Wheel Carrier
b. **Inspect and Repair.** Inspect and repair the winch box as follows:
   1. Remove the cover from the winch box.
   2. Inspect the mechanism for worn or damaged components.
   3. Replace the assembly or components as necessary.
   4. Reassemble the winch box.

c. **Installation.** Install the winch box in the reverse order of removal and test for correct operation.

135. **Wheel Support Plate.** Inspect and repair the wheel support plate as follows:

a. **Removal.** Remove the wheel support plate as follows:
   1. Undo and remove the wheel nuts holding the wheel support plate to the chassis.
   2. Lower the spare wheel to the ground.
   3. Remove the spare wheel.
   4. Undo the wheel support plate from the chain and remove it.

b. **Inspect and Repair.** Inspect and repair the wheel support plate as follows:
   1. Inspect the holding studs and wheel nuts for wear or thread damage.
   2. Replace where necessary.

c. **Installation.** Install the wheel support plate in the reverse order to removal.

**Front Roller Assembly**

136. **General.** There are two front roller assemblies; namely, left and right. Each roller assembly is supported on an extending boom which is actuated by an internally mounted hydraulic cylinder. The boom is guided within a stabilising beam by brass wear pads. The positioning of the roller is determined by the cylinder stroke. Full extension provides the bridge module transport position and full retraction is the position for supporting the cargo pallet tray.

137. **Roller Assemblies.** To repair the roller assemblies, proceed as follows (Figure 26):

a. **Removal.** Remove each roller assembly as follows:
   1. Unfasten and remove the axle spigot bolt (Item 13).
   2. Remove the roller (Item 4) from the extending beam (Item 12).

b. **Inspect.** Inspect the roller as follows:
   1. Inspect the outside roller contact surface for wear, cracks or damage.
   2. Inspect the inner bearing bushes (Item 3) for wear or damage.
   3. Inspect the axle spigot (Item 2) for wear.
   4. Inspect the side thrust washers (Item 1) for wear.

c. **Repair or Replace.** Repair or replace each roller assembly as follows:
   1. Repair minor damage to the roller by welding and machining.
   2. Replace any component that is excessively worn.

d. **Installation.** Install in the reverse order of removal.
**Figure 138.** Front Roller Assembly

### 138. Cylinders.
To replace the cylinders, proceed as follows (Figure 26):

**a. Removal.** Remove each front roller cylinder as follows:

1. Remove the circlips (Item 10) and the pinion (Item 11) from the cylinder front end.
2. Remove the extending boom (Item 12).
3. Disconnect the hydraulic hoses from the pipelines on the main frame.
4. Remove the circlips (Item 7) and the pinion (Item 8) from the cylinder rear end.
5. Remove the cylinder (Item 6) complete with the hydraulic hoses.

**NOTE**
Disassembly and repair of the cylinder is a Heavy Grade Repair task (Ref EMEI Vehicle G 784).

**b. Installation.** Install in the reverse order of removal.

### 139. Wear Pads.
To repair the wear pads, proceed as follows (Figure 26):

**a. Removal.** Remove the wear pads as follows:

1. After removal of the extending boom, access is gained to the wear pads (Items 5 and 16) located at the front of the stabilizer arm and the rear of the extending boom respectively. The vertical wear pads (Item 14) are located at the front of the stabilizer arm.
2. Undo the six hex head bolts and two stainless steel cap-screws (Items 9 and 15), and remove the wear pads.

**b. Inspect.** Inspect each wear pad for wear and thickness. If the thickness of each pad is less than 12 mm (0.470 in), replace the pad.

**c. Installation.** Install in the reverse order of removal. Apply Duralac compound to the complete thread length and under the heads of the stainless steel cap-screws (Item 15).
Rear Roller Assembly

140. **General.** Each of the two rear roller assemblies functions as follows (Figure 27):

   a. The roller assembly is supported on an extending boom which is actuated by an internally mounted hydraulic cylinder. The boom is guided within a trestle box beam by brass wear pads.

   b. The module catch plate assembly is mounted on and pivoted about the outside of the roller assembly support frame.

   c. The roller and catch plate assembly has three positions. Full cylinder extension is the position used when recovering a module to the loader. Retracting the cylinder to a moveable mechanical stop is the position for locking the module to the loader and full retraction is the position for supporting the cargo pallet tray.

![Figure 27 Rear Roller Assembly](image)

141. **Roller Assemblies.** To repair the roller assemblies, proceed as follows (Figure 27):

   a. **Removal.** Remove each roller assembly as follows:
      
      (1) Remove the retaining pin (Item 20) and rotate the catch plate assembly to the down position.
      
      (2) Unfasten and remove the countersunk axle spigot bolt (Item 12).
      
      (3) Remove the roller (Item 4) from the extending beam.

   b. **Inspect.** Inspect the roller as follows:
      
      (1) Inspect the outside roller contact surface for wear, cracks or damage.
      
      (2) Inspect the inner bearing bushes (Item 3) for wear or damage.
      
      (3) Inspect the axle spigot (Item 2) for wear.
      
      (4) Inspect the side thrust washers (Item 1) for wear.

   c. **Repair or Replace.** Repair or replace each roller assembly as follows:
      
      (1) Repair any minor damage by welding and machining.
      
      (2) Replace any component that is excessively worn.

   d. **Installation.** Install in the reverse order of removal.
142. **Cylinders.** To replace the cylinders, proceed as follows (Figure 27):
   a. **Removal.** Remove each rear roller cylinder as follows:
      (1) Remove the circlips (Item 11) and the pinion (Item 13) from the cylinder front.
      (2) Remove the extending boom (Item 10).
      (3) Disconnect both of the hydraulic hoses.
      (4) Remove the circlips (Item 7) and the pinion (Item 8) from the rear of the cylinder.
      (5) Remove the cylinder (Item 6) with the hydraulic hoses.

   **NOTE**
   Disassembly and repair of the cylinder is a Heavy Grade Repair task (Ref EMEI Vehicle G 784).

143. **Wear Pads.** To repair the wear pads, proceed as follows (Figure 27):
   a. **Removal.** Remove the wear pads as follows:
      (1) After removal of the extending boom (Item 10), access is gained to the wear pads (Items 5 and 16) located at the front of the stabilizer arm and the rear of the extending boom respectively. The vertical wear pads (Item 14) are located at the front of the stabilizer arm.
      (2) Undo the six hex head bolts and two stainless steel cap-screws (Items 9 and 15), and remove the wear pads.
   b. **Inspect.** Inspect each wear pad for wear and thickness. If the thickness of each pad is less than 12 mm (0.470 in) replace the pad.
   c. **Installation.** Install in the reverse order of removal. Apply Duralac compound to the complete thread length and under the heads of the stainless steel cap-screws (Item 15).

**Inner Roller Assemblies**

144. **General.** The two inner roller assemblies consist of one set of contoured aluminium alloy rollers and one single roller which rotate about a shaft. Each assembly is supported by mounting brackets bolted to the front lift frame.

145. **Roller Assemblies.** Repair the roller assemblies as follows (Figure 28):
   a. **Removal.** Remove each roller assembly as follows:
      (1) Undo the fastening screws retaining the mounting bracket.
      (2) Remove the roller assembly from the frame.
      (3) Remove the circlip from the shaft.
      (4) Remove the mounting bracket and the rollers from the shaft.
   b. **Inspect.** Inspect the roller as follows:
      (1) Inspect the outside roller contact surface for wear, cracks or damage.
      (2) Inspect the inner bearing for wear or damage.
      (3) Inspect the shaft for wear or damage.
   c. **Repair or Replace.** Repair or replace each roller assembly as follows:
      (1) Repair any minor damage by welding and machining.
      (2) Replace any component that is excessively worn.
   d. **Installation.** Install in the reverse order of removal.
Catch Plate

146. General. The catch plate is mounted to and pivots about the rear roller extension box. The assembly has two positions. When rotated and pinned in the vertical position, it provides the means to capture and lock the bridge module or BEPB onto the LRV. When rotated 250° and pinned in this position the cargo pallet tray can be loaded and the modules can be launched.

147. Removal. Remove the catch plate as follows (Figure 29):
   a. Undo the pivot retaining bolt (Item 15) and remove it together with the spacer (Item 14).
   b. Remove the retaining pin (Item 20).
   c. Remove the catch plate assembly (Item 13) from the pivot.

148. Disassembly. Disassemble the catch plate as follows (Figure 29):
   a. Undo the screws (Item 9) and remove the stop bracket (Item 10).
   b. Remove the pin (Item 16) and the nut (Item 17) to remove the slide assembly (Item 3) and release the spring set (Item 21).
   c. Remove the circlip (Item 22) and the trunnion pivot pin (Item 23).
   d. Remove the roll pins (Item 5) from the slide assembly (Item 3).
   e. Remove the pivot pin (Item 4) and the locating hook (Item 1).
   f. Undo the screws (Item 11) and remove the trunnion pivot pins (Item 12).
   g. Remove the roll pin (29 Item 8) from the nut (Item 7).
   h. Undo the nut (Item 7) and remove the threaded rod (Item 6).

149. Cleaning and Inspection. Clean and inspect the catch plate as follows (Figure 29):
   a. Clean all the components in an approved solvent.
   b. Inspect the locating hook (Item 1) for worn or damaged surfaces and the bearing bushes (Item 2) for wear.
c. Inspect the trunnion (Item 19) for worn bushes (Item 18).

d. Inspect the slide (Item 3) and the threaded rod (Item 6) for worn or damaged threads.

e. Inspect all welds for cracking.

150. Repair or Replace. Repair or replace the catch plate as follows (Figure 29):

a. Repair minor damage or wear to the locating hook (Item 1) by welding and machining.

b. Smooth out minor surface imperfections on pins, bores or sliding surfaces.

c. Repair minor distortion of the components by straightening.

d. Replace all the components showing excessive wear or damage.

151. Installation. Install in the reverse order of removal.

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**Figure 29**  Catch Plate

END

Distribution List: VEH G 59.0 – Code 2 (Maint Level)
(Sponsor: ENG SPO Engr Equip)
(Authority: ECO EE 18/07)