TRUCK, CARGO, HEAVY, MC3 – MACK
INCLUDING TRUCK, CARGO, WINCH, HEAVY, MC3 – MACK
MEDIUM 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

1. This EMEI contains procedures for removing, dismantling, repairing, assembling and installing various components of the Truck, Cargo, Heavy, MC3 Mack, including winch models, and should be read in conjunction with EMEI Vehicle G 703 and other associated publications. Where applicable, instructions for the adjustment, lubrication and minor servicing of these items are included.

Action Required

2. Actions detailed in this instruction are to be performed by technical maintenance organisations authorised to carry out Light, Medium or Heavy Grade Repairs. Inspection and repairs are to be performed by the following qualified tradespeople:
   a. Vehicle Mechanic – ECN 229;
   b. Technician Electrical – ECN 418-2; or
   c. tri-Service/civilian equivalent.

Associated Publications

3. Reference may be necessary to the latest issue of the following documents for maintenance and repair procedures:
   b. EMEI Vehicle A 429-1 – Brake Systems – Brake Shoe Reline Policy;
   c. EMEI Vehicle G 700 – Truck, Cargo, Heavy, MC3- Mack – Data Summary;
   d. EMEI Vehicle G 700-1 – Truck, Cargo, Winch, Heavy, MC3- Mack – Data Summary;
   e. EMEI Vehicle G 702 – Truck, Cargo, Heavy, MC3- Mack – Technical Description;
   f. EMEI Vehicle G 703 – Truck, Cargo, Heavy, MC3- Mack – Light Grade Repair;
   g. EMEI Vehicle G 709 – Truck, Cargo, Heavy, MC3- Mack – Servicing Instruction;
   h. EMEI Electrical P 41 Decade – Generator, Engine Accessory, 28VDC, 100 amp;
   i. EMEI Vehicle A 291-1 – Tyres and Tubes – Care and Maintenance of B Vehicles;
   k. EMEI Workshop D 701 – Painting of Army Equipment;
   l. EMEI Workshop D 180 – Flaw Detection, Non Destructive Safety Precautions; and
   m. Electronic Supply Chain Manual (ESCM).

4. Reference may be required to the current issue of the following publications to ensure safety of personnel and to prevent damage to equipment:
   a. EMEI Workshop E Series – Occupational Health and Safety;
   b. Defence Safety Manual (SAFETYMAN); and
   c. Material Safety Data Sheets (MSDS).

5. This EMEI supersedes the following EMEI:
   a. EMEI Vehicle G 704-2 – Air Spring Suspension System (SA441W) – Field and Base Repair;

Safety Precautions

6. All industrial safety work practices and equipment operating and maintenance instructions pertaining to this EMEI are to be adhered to.
Compressed air receivers are pressure vessels. Under no instances are they to be heated, brazed or welded. A damaged air receiver can explode when pressurised, resulting in lethal injuries.

Ensure the safety requirements for use of compressed air are strictly adhered to. Inadvertent use of compressed air equipment may result in injury to personnel.

7. Before removing any pneumatic components from the vehicle, ensure that the relevant compressed air receivers are exhausted through their respective drain cocks/valves.

**WARNING**

The handling, storage and use of chemical substances is to be in accordance with SAFETYMAN, MSDS and EMEI Workshop series requirements.

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

9. The engine cooling system contains Ethylene Glycol at a concentration of 28% to 33% total volume in addition to the additives from the coolant conditioner cartridge. The mixture SG is approximately 1.043. When there is a need to drain the cooling system, use a suitable receptacle to collect the coolant mixture being drained. This will facilitate its reuse later and also eliminates the need to renew the conditioner cartridge out of the scheduled service period. Before reusing the coolant mixture, check and if necessary, adjust the mixture concentration in accordance with the manufacturer’s instructions.

**WARNING**

Do not work on the vehicle, when raised, without the use of a safety stand beneath the axle. Place the safety stand as close to the raised wheel as possible. This procedure is required for all repairs and maintenance activities involving positioning of body parts in potential crush zones of the vehicle. Failure to comply may result in serious injury or death.

**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 assembling.

10. 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 systems components, disconnect the battery leads.

11. When disconnecting electrical connectors, hoses and fittings, remove clamps as required to gain slack and avoiding damage to connectors, hoses and fittings. Refit the clamps after reconnecting the electrical connectors, hoses and fittings.

12. 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.
13. 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

14. Many of the procedures described in this EMEI require the use of special tools, jigs or fixtures. The special tools required are listed in Table Error! Reference source not found. and illustrated in Figures 1 to 4.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Part No</th>
<th>Use</th>
<th>Tool</th>
</tr>
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<td>J-26861</td>
<td>Removing water pump impeller</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MAC PP 522</td>
<td>Removing water pump front hub and pulley assembly</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Peg spanner A (to be fabricated)</td>
<td>Removing the power steering top adjusting nut</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Peg spanner B (to be fabricated)</td>
<td>Removing the power steering bearing cap assembly</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Sheppard pitman arm puller 3591842K</td>
<td>Removing the steering gear pitman arm</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Front axle yoke puller</td>
<td>Removing the front axle outer yoke</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Front axle yoke seal installer</td>
<td>Installing the front axle outer yoke seal</td>
<td></td>
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</table>
Figure 1  Peg Spanner A

Figure 2  Peg Spanner B
Location of Major Unit Assemblies (MUA) Identification

15. Table Error! Reference source not found. identifies the location of identification numbers for the major unit assemblies.

Table 2 Location of Identification Numbers (Major Unit Assemblies)

<table>
<thead>
<tr>
<th>Serial</th>
<th>Major Unit Assembly</th>
<th>Identification Number Location</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Chassis No</td>
<td>Right-hand rear frame, above intermediate axle</td>
</tr>
<tr>
<td>2</td>
<td>Chassis nameplate</td>
<td>Left-hand door inside cab</td>
</tr>
<tr>
<td>3</td>
<td>Engine No</td>
<td>Right-hand top of timing gear housing</td>
</tr>
<tr>
<td>4</td>
<td>Front axle No</td>
<td>Left rear of axle housing</td>
</tr>
<tr>
<td>5</td>
<td>Transmission No</td>
<td>Left-hand side</td>
</tr>
<tr>
<td>6</td>
<td>Transfer case</td>
<td>Right-hand rear</td>
</tr>
<tr>
<td>7</td>
<td>Intermediate axle No</td>
<td>Right-hand front of carrier housing</td>
</tr>
<tr>
<td>8</td>
<td>Rear axle No</td>
<td>Right-hand front of carrier housing</td>
</tr>
<tr>
<td>9</td>
<td>Injection pump identification</td>
<td>Side of the pump</td>
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</table>
Lubrication

16. Table Error! Reference source not found. lists lubricant type and capacities for assemblies.

### Table 3  Lubricants

<table>
<thead>
<tr>
<th>Serial</th>
<th>Equipment</th>
<th>Lubricant</th>
<th>Capacity (Litres)</th>
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<tr>
<td>1</td>
<td>Engine (including filters)</td>
<td>SAE Grade 40</td>
<td>55.3</td>
</tr>
<tr>
<td>2</td>
<td>Transmission</td>
<td>OEP-220</td>
<td>10.4</td>
</tr>
<tr>
<td>3</td>
<td>Transfer case</td>
<td>OEP-220</td>
<td>9.5</td>
</tr>
<tr>
<td>4</td>
<td>Transfer case (fitted with cooler / filtration system)</td>
<td>OEP-220</td>
<td>11.0</td>
</tr>
<tr>
<td>5</td>
<td>Intermediate axle</td>
<td>OEP-220</td>
<td>12.0</td>
</tr>
<tr>
<td>6</td>
<td>Rear axle</td>
<td>OEP-220</td>
<td>11.2</td>
</tr>
<tr>
<td>7</td>
<td>Front axle</td>
<td>OEP-220</td>
<td>11.4</td>
</tr>
<tr>
<td>8</td>
<td>Spring U-bolts</td>
<td>XG-276</td>
<td>As required</td>
</tr>
<tr>
<td>9</td>
<td>Power steering</td>
<td>SAE Grade 40</td>
<td>7.75</td>
</tr>
<tr>
<td>10</td>
<td>Front wheel bearings</td>
<td>OEP-220</td>
<td>Fill to level fill plug</td>
</tr>
<tr>
<td>11</td>
<td>Chassis lubrication</td>
<td>XG-276</td>
<td>As required</td>
</tr>
<tr>
<td>12</td>
<td>Winch gearbox</td>
<td>OEP-220</td>
<td>2.5</td>
</tr>
</tbody>
</table>

POL Suitability

**CAUTION**

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

17. Use only those fuels and lubricants specified in the Servicing Instruction EMEI VEH G 709, the User Handbook and this instruction manual when replenishing fuel or lubricants.

18. The manufacturer’s original recommendation was to use Mack COG gear oil in driveline components. This has since been superseded to Mack GO-J. All OEP-220 gear oil that is currently in service is equivalent to Mack GO-J. If OEP-220 is unavailable, the commercial oils listed in Table Error! Reference source not found. are to be used.

### Table 4  OEP-220 Commercial Equivalents

<table>
<thead>
<tr>
<th>Serial</th>
<th>Manufacturer</th>
<th>Part Number</th>
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<tr>
<td>1</td>
<td>Ampol</td>
<td>Gearlube AP 80W/90</td>
</tr>
<tr>
<td>2</td>
<td>Castrol</td>
<td>GO-H90</td>
</tr>
<tr>
<td>3</td>
<td>B.P</td>
<td>Multi Gear 80W/90</td>
</tr>
<tr>
<td>4</td>
<td>Mobil</td>
<td>Mobile Lube HD80W/90</td>
</tr>
<tr>
<td>5</td>
<td>Shell</td>
<td>Spirax HD 80W/90 EP</td>
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</table>
ITEMS PREVIOUSLY KNOWN TO HAVE CONTAINED ASBESTOS

Asbestos is a hazardous material and a carcinogen. Airborne asbestos fibre poses a serious danger to personnel and can lead to acute health concerns and eventual death.

The Mack Family of Vehicles (FOV) was originally fitted with a number of components suspected as Asbestos Containing Materiel (ACM).

Since 2003, all genuine OEM supplied gaskets, seals and washers are asbestos free. If it is unknown as to whether the material contains asbestos, such items are to be removed, handled and disposed of in accordance with EMEI Workshop E 410.

19. The following table provides a list of all identified, in-situ suspected Asbestos Containing Materiel (ACM) If an item in table 5 is to be replaced, the GM 120, part 4 should be reviewed.

20. If the item in question has been replaced after 2009 and notated in the GM 120 at part 4, the item can safely be considered as being asbestos free.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Item</th>
<th>ACM NIIN</th>
<th>Non-ACM NIIN</th>
<th>Can remain in-situ</th>
<th>Procedure in this EMEI</th>
<th>Enter GM 120 Part 4</th>
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<tbody>
<tr>
<td>1</td>
<td>Gasket – Air Compressor</td>
<td>00-291-8977</td>
<td>01-467-7736</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>2</td>
<td>Brake Assy, Clutch, Brake Assy, Clutch, Transmission Input Drive.</td>
<td>66-122-6215</td>
<td>66-135-0343</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>3</td>
<td>Gasket PTO</td>
<td>66-123-0972</td>
<td>NIL</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>4</td>
<td>Brake Shoe,</td>
<td>01-065-1828</td>
<td>66-118-6717</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>5</td>
<td>Gasket Timing Cover</td>
<td>01-121-8351</td>
<td>66-160-8341</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
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</table>

DETAIL

ENGINE

Cylinder Heads

21. **Removal.** Remove the cylinder heads as follows:

   a. Remove the bonnet assembly in accordance with EMEI Vehicle G 703.
   b. Remove the radiator cross stays.
   c. Drain the cooling system by opening the drain cocks located at the bottom of the radiator and at the right-hand rear of the cylinder block.
   d. Remove the air cleaner-to-turbocharger air intake duct, and the air cleaner-to-tip turbine fan air duct.
   e. Disconnect the air inlet, oil inlet and outlet lines, exhaust pipe, and crossover tube at the turbocharger. Remove the retaining nuts and remove the turbocharger from the exhaust manifold (Figure 5).
f. Disconnect and remove the overboard breather and breather manifold from the cylinder head covers and remove the interconnecting wire from the Dynatard brake solenoids (Figure 6).

g. Remove the top radiator hose.

h. Disconnect the water inlet and outlet pipes from the intercooler housing (Figure 7).
i. Disconnect the tip turbine fan air-bleed line from the crossover tube (Figure 8).

j. Remove the header plate and the crossover tube from the intercooler housing (Figure 9).
k. Remove the water-to-air core and air-to-air core from the intercooler housing (Figure 10).

![Intercooler Assembly](image)

Figure 10 Intercooler Assembly

l. Remove the puff limiter-to-reversing relay line (Figure 11).

![Puff Limiter/Reversing Relay Line](image)

Figure 11 Puff Limiter/Reversing Relay Line

m. Remove the coolant conditioner line and coolant conditioner (Figure 12).

![Removing Conditioner Line](image)

Figure 12 Removing Conditioner Line

n. Remove the coolant conditioner adaptor housing (Figure 13).
Loosen the water outlet sleeve clamps, remove the two remaining bolts in the thermostat housing and remove the thermostat housing (Figure 14).

Remove the intercooler housing mounting bracket (Figure 15).
q. Remove the rear half of the air inlet manifold and the rear half of the water outlet manifold (Figure 16).

![Figure 16 Air Inlet and Water Outlet Manifolds](image)

r. Straighten the lock tabs on the exhaust manifold, remove the retaining nuts, and remove the exhaust manifold (Figure 17).

![Figure 17 Exhaust Manifold](image)

s. Remove the cylinder head cover retaining bolts and remove the cylinder head covers.

t. Disconnect and remove the high pressure fuel lines from the injection pump, injection nozzles and holders, then remove the high pressure fuel lines as an assembly.

u. Remove the fuel return lines and remove the injection nozzle and holder assemblies.

v. Remove the rocker arm bracket retaining bolts, remove the rocker arm and shaft assemblies then remove the valve push rods.

w. Remove the cylinder head bolts and then remove the cylinder heads (Figure 18).

**NOTE**

Clean up the cylinder head surfaces and remove all gasket material prior to checking for flatness.
22. **Checking Cylinder Heads.** Check the cylinder head surface for scratches, gouges, cracks and flatness. The cylinder head surface should be flat within 0.050 mm (0.002 in) (Figure 19).

23. **Installation.** Install the cylinder heads as follows:

   a. Place the new cylinder head gaskets in position on the cylinder block, then carefully fit a new ‘fire-ring’ over the circular bead on each cylinder sleeve flange (Figure 20).

   **NOTE**

   Do not use sealing compound on the head gaskets as they are pre-coated.
b. Install the charge air cooling manifold housing and gasket onto the cylinder head. Tighten the short bolts to 46 N.m (34 lbf.ft) and the long bolts to 42 N.m (31 lbf.ft). Position the cylinder head assembly over the cylinder block. Align the guide pins in the block with the guide holes in the cylinder head (Figure 21).

![Figure 21 Installing Cylinder Heads](image)

**NOTE**

After run-in procedure, back off each cylinder head bolt individually in sequence until free, lubricate, then tighten the same bolt to 300 N.m (220 lbf.ft).

c. Oil the cylinder head bolt bosses, threads and washers with engine oil prior to assembly. Install the bolts and tighten them in the sequence shown in Figure 22, in the following three steps:

1. **Step One.** Tighten them to 68 N.m (50 lbf.ft).
2. **Step Two.** Tighten them to 170 N.m (125 lbf.ft).
3. **Step Three.** Tighten them to 270 N.m (200 lbf.ft).

![Figure 22 Cylinder Head Tightening Sequence](image)

d. Before installing the push-rods, check that they are not bent, worn or have loose ends. Replace any defective push rod. Apply a light coat of engine oil to the spherical ends and install the push rods in the valve lifters (Figure 23).

![Figure 23 Installing Push Rods](image)
e. Inspect the rocker arm assemblies, before installation, for the following (Figure 24):
   (1) Check for wear and ensure that all oil ports and passages are open.
   (2) Check the rocker arms for contact surface wear; reface or replace as required.

   ![Figure 24 Checking Rocker Arms for Wear](image1)

f. Install new O rings on the rocker arm assemblies and mount the assemblies on the heads. Tighten the mounting bolts to 47 N.m (35 lbf.ft).

g. Adjust the valve clearances when each piston is at TDC on the compression stroke. Start with No 1 cylinder and follow the firing order 1-5-3-6-2-4 in succession. Set the inlet valves to 0.41 mm (0.016 in) and the exhaust valves to 0.61 mm (0.024 in) (Figure 25).

   **NOTE**
   Be sure to exert pressure onto the top of the exhaust valve adjusting nut while checking the valve clearance.

   ![Inlet Valve Adjustment and Exhaust Valve Adjustment](image2)

   ![Figure 25 Valve Clearance Adjustment](image3)

h. After adjusting the valve clearances, install the cylinder head cover gaskets. Apply contact cement to both the gasket and the cover; let stand for several minutes, then assemble the adhesive side of the gasket to the cover and assemble the covers to the engine.

i. Fit new gaskets to the cover retaining bolts. Tighten the cover retaining bolts to 21 N.m (16 lbf.ft) (Figure 26).
j. Install the injector nozzle and holder assemblies, and refit the fuel return lines.

k. Refit the high pressure fuel line assembly to the injection nozzles, holders and to the injection pump.

l. Inspect the exhaust manifold for restrictions, cracks or wear. Install the manifold using new gaskets and nut locking tabs. Tighten the nuts to 48 N.m (35 lbf.ft) then bend the locking tabs to secure the nut (Figure 27).

m. Refit the charge air cooling manifold housing and both the rear water outlet manifold and air inlet manifold and tighten bolts as follows (Figure 28):

   (1) charge air cooler housing short bolts to 46 N.m (34 lbf.ft);
   (2) charge air cooler housing long bolts to 42 N.m (31 lbf.ft);
   (3) water outlet manifold bolts to 31 N.m (23 lbf.ft); and
   (4) rear outlet manifold bolts to 48–62 N.m (35–46 lbf.ft).
n. Refit the charge air cooling housing mounting bracket bolts. Tighten the bolts to 54 N.m (40 lbf.ft) (Figure 29).

Figure 29 Refitting Mounting Bracket Bolts

o. Install the thermostat housing (Figure 30).

Figure 30 Installing Thermostat Housing

p. Install the coolant conditioner adaptor housing (Figure 31).

Figure 31 Thermostat and Conditioner Adaptor Housings
q. Tighten the water outlet sleeve clamps (Figure 32).

![Figure 32 Sleeve Clamp Location – Thermostat Housing](image)

r. Install the coolant conditioner and refit the coolant conditioner inlet line (Figure 33).

![Figure 33 Refitting Conditioner Inlet Line](image)

s. Tighten the water outlet and air inlet manifold clamps (Figure 34).

![Figure 34 Clamp Location – Inlet Manifold](image)

t. Reconnect the puff limiter reversing relay line (Figure 35).
u. Install the tip turbine fan on the charge air cooler housing. Tighten the retaining clamp screws to 13 N.m (10 lbf.ft) (Figure 36).

v. Install the air-to-air core and water-to-air core in the charge air cooler housing (Figure 37).

**NOTE**

Before installing the cores, check the condition of the seals. Replace all defective seals.

w. Replace the seals in accordance with EMEI Vehicle G 703.
x. Refit the charge air cooling header plate and crossover tube. Tighten the header plate bolts to 31 N.m (23 lbf.ft).

y. Reconnect the tip turbine bleed air line (Figure 38).

z. Reconnect the water inlet and outlet pipes to the air cooler core (Figure 39).

aa. Refit the overboard breather pipe and connecting manifold using new gaskets and reconnect the Dynatard brake solenoid interconnecting wire.

bb. Fit a new gasket on the exhaust flange studs then install the turbocharger. Tighten the turbocharger retaining nuts to 47 N.m (35 lbf.ft) (Figure 40).
cc. Reconnect the turbocharger inlet and exhaust pipe, oil inlet and outlet lines and crossover tube (Figure 41). Tighten the oil inlet and outlet line retaining bolts to 31 N.m (23 lbf.ft).

![Image of turbocharger inlet and exhaust pipe connections](image1)

Figure 41  Reconnecting Turbocharger Inlet, Exhaust Pipe, Oil Inlet and Outlet Lines

dd. Refit the top radiator hose. Close off the drain cocks at the bottom of the radiator and the right hand side of the engine block towards the rear of the engine. Refill the cooling system with coolant.

NOTE

After run-in procedure, back off each cylinder head bolt individually in sequence until free, lubricate, then tighten the same bolt to 300 N.m (220 lbf.ft).

ee. Bleed the fuel injection high pressure lines as follows:

1. crack the fuel injection high pressure lines at the injectors,
2. crank the engine until fuel is forced from the lines, and
3. tighten the injector lines.

Flywheel and Ring Gear

24. Removal. Remove the flywheel and ring gear as follows:

Remove the transmission and clutch assemblies.

a. Remove the six bolts retaining the flywheel to the crankshaft and remove the flywheel.
b. Remove the ring gear from the flywheel using a hammer and suitable drift.
c. Fit the new ring gear by heating uniformly around the inside of the ring gear and then positioning it on the flywheel.

25. Installation. Install the flywheel and ring gear as follows:

a. Position the flywheel on the crankshaft.
b. Install the six retaining bolts and tighten them to 258 N.m (190 lbf.ft).
c. Install the clutch assembly.
d. Install the transmission.

Oil Pump

26. Removal. Remove the oil pump as follows:

a. Drain the engine oil.
b. Remove the retaining screws from around the mounting face of the engine sump, and remove the sump.
c. Remove the retaining bolt from the oil pump feed pipe support bracket and remove the feed pipe from the oil pump.
d. Remove the oil pump retaining bolts and withdraw the oil pump from the engine.

27. Disassembly. Disassemble the oil pump as follows:
a. Remove the oil pump housing cover. Inspect the cover surface for nicks and burrs. Repair or replace the cover as necessary.
b. Bend the oil pressure relief valve cap lock tab away from the valve cap then remove the valve cap and spring (Figure 42).

NOTE
Clean and inspect the oil pressure relief valve spring for breaks. Replace if broken.

Figure 42 Removing the Relief Valve Cap and Spring

c. Remove the oil pressure relief valve plunger (Figure 43).

NOTE
Clean and inspect the relief valve plunger seating surface for burrs or nicks. If the seal surface is burred or nicked it must be repaired. Apply lapping compound on the plunger seal and install the plunger in the relief valve housing then oscillate the plunger. After lapping, check the seating of the plunger-to-relief valve housing with ‘Prussian Blue’ paste. Clean off all traces of lapping compound.

Figure 43 Removing Relief Valve Plunger
d. Slide the oil pump idler gear off the shaft (Figure 44).

Figure 44 Removing Idler Gear
e. Position the pump housing vertically, grasping the driving gear in a soft-jawed vice, and remove the driving shaft nut (Figure 45).

NOTE
Discard the self-locking nut and hardened washer.

f. Remove the oil pump driving gear off the shaft and remove the driving gear key.

g. Remove the driven gear and shaft from the housing (Figure 46).

h. Remove the oil pump inlet flange cover and gasket from the oil pump housing cover.

28. Inspection. Inspect the oil pump as follows:

NOTE
After removing all parts from the oil pump housing, thoroughly clean and inspect the housing for wear or damage. If badly worn or damaged, the housing must be replaced.
a. Inspect the bushings in the oil pump housing for burrs, nicks or cracks (Figure 47).

![Inspecting Bushings](image)

**Figure 47** Inspecting Bushings

b. Inspect the idler gear for free play by spinning it on its shaft. If it is binding, check the housing bore for burrs or nicks and check the idler gear teeth edges for burrs. If the housing or idler gear are damaged, replace as required.

c. Insert the driven gear in the housing and check the free play by spinning. If it binds, check the housing for burrs or nicks. If the housing or driven gear are damaged, replace as required (Figure 48).

![Inspecting Driven Gear and Housing](image)

**Figure 48** Inspecting Driven Gear and Housing

29. **Reassembly.** Reassemble the oil pump as follows:

a. Install the relief valve plunger, spring, lock tab and cap into the oil pump housing cover (Figure 49) then tighten the relief valve cap to 81 N.m (60 lbf.ft).

**NOTE**

After the relief valve cap has been tightened, bend the locking tab.

Relief valve opening pressure 186–276 kPa (27–40 PSI).
b. Install the oil pump inlet flange cover and gasket on the housing cover with patchlock bolts.

c. Install the oil pump driving gear key on the driven gear shaft (Figure 50).

d. Install the driven gear with shaft into the housing and check for free spin (Figure 51).
e. Install the idler gear on its shaft (Figure 52).

![Figure 52 Installing the Idler Gear](image)

**NOTE**

Before proceeding with reassembly, check the end clearance, side clearance and backlash of the drive gears.

f. **End Clearance.** Check the end clearance by placing a straight edge across the face of the gears and running a 0.030 mm (0.001 in) feeler gauge under the straight edge. This is the low limit check and the feeler gauge should pass freely without binding. If it binds check the gears for burrs or nicks. To check the high limit, run a 0.180 mm (0.007 in) feeler gauge under the straight edge. This should be very tight. If not, replace the gears (Figure 53).

![Figure 53 Checking End Clearance](image)

g. **Side Clearance.** To check the side clearance, place a feeler gauge between the side of the gears and the housing. Use a 0.050 mm (0.002 in) feeler gauge to check the low limit. It should pass between the gears and the housing without drag. If it drags, check the gears and housing for nicks or burrs. Replace parts as needed. To check the high limit, insert a 0.150 mm (0.006 in) feeler gauge. It should not pass through. If it does, replace the housing (Figure 54).
h. **Gear Backlash.** To check the backlash low limit, insert a 0.330 mm (0.013 in) feeler gauge between the gears. This should pass through without binding. If it binds, check the gears for burrs or nicks. Replace as required. To check the high limit, insert a 0.710 mm (0.028 in) feeler gauge between the gears. This should not pass through. If it does, replace the gears (Figure 55).

i. Remove the idler gear and invert the pump. Install the driving gear on the shaft aligning slot in the driving gear with the key on the shaft (Figure 56). Press the gear onto the shaft.
j. Place a new self-locking nut on the shaft and tighten to 90 N.m (65 lbf.ft) (Figure 57).

k. Invert the pump and install the idler gear, then position the housing cover over the housing. Apply Loctite 242 to the cover retaining bolt threads and tighten.

l. Refit the oil pump inlet flange cover using a new gasket.

m. Install the pump into the engine cylinder block and tighten the retaining bolts to 40 N.m (29 lbf.ft).

NOTE
Before installing the oil pump feed pipe, check it for restrictions, cracks or damage. Repair or replace as necessary. Use a new gasket when installing the pipe to the pump.

n. Refit the oil pump feed pipe and support bracket.

o. Remove the old engine sump gasket and clean the sump then check the sump for flatness (Figure 58). Correct as required.
p. Install the sump to the engine block using a new gasket. Tighten the oil pan mounting patchlock bolts to 41 N.m (30 lbf.ft) for the 9.50 mm (3/8 in) bolts and 75 N.m (55 lbf.ft) for the 12.70 mm (1/2 in) bolts.

q. Inspect the engine sump drain plug threads for damage and condition of the sealing washer. Replace as necessary. Install the drain plug and tighten it to 75 N.m (55 lbf.ft).

r. Replace the oil filters, and refill the engine with 55.3 litres of engine oil SAE Grade 40 (OMD-115).

### Engine Fault Finding

30. Table Error! Reference source not found. details engine fault finding solutions to common engine symptoms.

#### Table 6 Engine Fault Finding

<table>
<thead>
<tr>
<th>Serial</th>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engine misfiring</td>
<td>Injector nozzle spray holes blocked</td>
<td>Replace injectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cracked injector body or nozzle</td>
<td>Replace injectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly adjusted injectors</td>
<td>Replace injectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly adjusted valves</td>
<td>Adjust the valves to the correct clearance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn or broken piston rings</td>
<td>Replace engine</td>
</tr>
<tr>
<td>2</td>
<td>Engine stalls at low speed</td>
<td>Air leaks in the fuel supply</td>
<td>Trace the leak then rectify</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal or external fuel leaks</td>
<td>Rectify</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly adjusted throttle linkage</td>
<td>Adjust linkages to the correct specifications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Governor weights incorrectly adjusted</td>
<td>Replace pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water in fuel</td>
<td>Drain and flush the fuel tank. Replace the fuel filters then fill the tank with clean fuel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect fuel pump calibration</td>
<td>Replace pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cylinder head gasket blow-by or leakage</td>
<td>Replace cylinder head gasket</td>
</tr>
<tr>
<td>3</td>
<td>Erratic engine speed</td>
<td>Governor weights assembled incorrectly</td>
<td>Replace pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly calibrated fuel injection pump</td>
<td>Replace pump</td>
</tr>
<tr>
<td>4</td>
<td>Low power</td>
<td>Dirty turbocharger compressor wheel</td>
<td>Replace turbocharger</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly calibrated fuel injection pump</td>
<td>Replace fuel injection pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect injector flow</td>
<td>Replace injectors</td>
</tr>
</tbody>
</table>
Table 5  Engine Fault Finding (Continued)

<table>
<thead>
<tr>
<th>Serial</th>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Engine will not reach no-load governed speed</td>
<td>Water in fuel</td>
<td>Drain and flush the fuel tank. Replace the fuel filters then fill the tank with clean fuel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly calibrated fuel injection pump</td>
<td>Replace pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect injector flow</td>
<td>Replace injectors</td>
</tr>
<tr>
<td>6</td>
<td>Excessive fuel consumption</td>
<td>Cracked injector body or nozzle</td>
<td>Replace injector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly calibrated fuel injection pump</td>
<td>Replace fuel pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly adjusted fuel injectors</td>
<td>Replace injectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clogged air cleaner elements</td>
<td>Replace air cleaner elements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oil level too high resulting in parasitic drag on crankshaft</td>
<td>Correct the oil level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overloaded engine</td>
<td>Ensure correct driving techniques</td>
</tr>
<tr>
<td>7</td>
<td>Engine overheats</td>
<td>Blocked coolant passages</td>
<td>Flush system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrectly calibrated fuel injection pump</td>
<td>Replace pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exterior of the engine caked with excessive dirt and grime</td>
<td>Clean engine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clogged or blocked intercooler</td>
<td>Remove and clean intercooler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blocked radiator</td>
<td>Clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broken or loose belts</td>
<td>Adjust or replace</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low coolant level</td>
<td>Fill to correct level</td>
</tr>
</tbody>
</table>

COOLING SYSTEM

Water Pump

31. **Removal.** Remove the water pump from the engine in accordance with EMEI Vehicle G 703.

32. **Disassembly.** Disassemble the water pump as follows:
   
a. Remove the impeller from the water pump using tool J-26861 (Table Error! Reference source not found., Serial 1).
   
b. Remove the front hub and pulley assembly, using tool MACPP522 (Table Error! Reference source not found., Serial 2) if necessary.
   
c. Remove the circlip from inside the pump bearing housing (Figure 59).

![Figure 59  Removing the Circlip](image)

d. Remove the Woodruff key from the impeller shaft (Figure 60).
e. Remove the impeller shaft assembly from the bearing housing using a suitable press. The shaft must be pressed out from the flange end towards the drive end of the housing (Figure 61).

f. Remove the water pump seal from the bearing housing then remove the O ring from the inner bearing area.

g. Remove the bearings, spacer and oil slinger from the impeller shaft using a press and suitable hollow drifts or collars.

h. Clean all components and inspect for wear or damage. Replace components that show signs of wear or damage. An exploded view of the water pump is shown in Figure 62.
33. **Reassembly.** Reassemble the water pump as follows:

a. Apply XG-291 grease to the O ring and install it in the inner bearing bore of the bearing housing (Figure 63). Ensure that the O ring is correctly seated in the groove.

NOTE

The oil slinger must be fitted with the shoulder towards the shaft thread.

b. Fit the oil slinger onto the shaft (Figure 64).
c. Pack both bearings with XG-291 grease, then fit both bearings and spacer to the shaft (Figure 65).

![Figure 65 Installing Bearings and Spacer](image)

Figure 65 Installing Bearings and Spacer

d. Lubricate the outer surface of the inner bearing and fit the shaft assembly into the pump bearing housing from the drive end (Figure 66). Use a suitable press to gradually press the assembly fully home.

![Figure 66 Installing the Shaft Assembly](image)

Figure 66 Installing the Shaft Assembly

e. Fit the circlip to the bearing housing with the rounded cup edge facing outwards (Figure 67). Use a hammer and drift to lightly tap the circlip until it beds into the groove.

![Figure 67 Installing the Circlip](image)

Figure 67 Installing the Circlip
f. Fit the Woodruff key to the impeller shaft. (Figure 68).

![Figure 68 Installing the Woodruff Key](image)

Figure 68 Installing the Woodruff Key

g. Position the hub and pulley assembly on the shaft, then press into place (Figure 69).

![Figure 69 Positioning and Installing Hub and Pulley Assembly](image)

Figure 69 Positioning and Installing Hub and Pulley Assembly

h. Fit a new self-locking nut to the shaft (Figure 70), then tighten the nut to 204 N.m (150 lbf.ft).

![Figure 70 Installing Self-locking Nut](image)

Figure 70 Installing Self-locking Nut

i. Apply a suitable sealant to the outside circumference of the impeller seal (Figure 71).
j. Position the seal in the bearing housing then press it into place. (Figure 72).

k. Using a press, install the impeller onto the shaft. Ensure that the clearance between the impeller vanes and the bearing housing is 0.76 mm (0.030 in) (Figure 73).

l. Lubricate the water pump with XG-291 grease then fit the pump to the engine in accordance with EMEI Vehicle G 703.
FUEL

Turbocharger

34. **Removal.** Remove the turbocharger in accordance with EMEI Vehicle G 703.

35. **Inspection.** Inspect the turbocharger as follows:
   a. Check that the turbo shaft rotates freely.
   b. Inspect for signs of rubbing or wheel impact damage.
   c. Check that the end-to-end (axial) movement of the shaft is within 0.08–0.25 mm (0.003–0.010 in) and the side-to-side (radial) movement of the shaft is within 0.08–0.18 mm (0.003–0.007 in) (Figure 74).

   ![Axial Bearing Clearance Check](image1)
   ![Radial Bearing Clearance Check](image2)

   **Figure 74  Bearing Clearance Check**

   d. Inspect the air intake system for cleanliness, leakage and foreign material.
   e. Inspect the exhaust manifold for leakage and foreign matter.
   f. Inspect the oil drain line for restriction.
   g. Inspect the oil supply line for restriction, deterioration or leakage under pressure. Ensure that the check valve is working.
   h. Inspect the turbocharger mounting pad on the exhaust manifold for erosion and flatness. The old gasket must be completely removed.

36. **Installation.** Install the turbocharger in accordance with EMEI Vehicle G 703.

Fuel Supply Pump (Transfer Pump)

37. **Disassembly.** Disassemble the fuel supply pump as follows (Figure 75):
   a. Secure the fuel supply pump in a suitable soft-jawed vice.
   b. Remove the valve spring retaining screw (Item 26), gasket (Item 25), and withdraw the valve spring (Item 24) and outlet valve (Item 23).
   c. Remove the hand primer assembly (Items 1–9), withdraw the spring (Item 10) and the inlet valve (Item 11).
   d. Remove the plunger spring retaining screw (Item 15), gasket (Item 14) and withdraw the plunger spring (Item 13) and plunger (Item 12).
   e. Using a suitable drift, tap out the tappet retaining pin (Item 22) sufficiently to allow removal of the tappet assembly (Items 19, 20 and 21), tappet spring (Item 18) and plunger (Item 17).
   f. Remove the hand priming barrel (Item 4) and gasket (Item 7).
   g. Remove the bracket assembly (Item 1) from the barrel.
38. **Inspection.** Inspect the fuel supply pump as follows (Figure 75):

   a. Examine the valve seats in the supply pump housing. These should be clean and smooth. If they are pitted, they must be resurfaced, using a valve seat reconditioning tool and a drill press.

   b. Carefully examine the seating surfaces on the inlet and outlet valves, ensuring that their flat surfaces are clean and smooth. Worn or damaged valves must be replaced.

   c. Examine the tappet roller (Item 21) and tappet housing (Item 19) for wear. Check the play between the tappet roller (Item 21) and the tappet pin (Item 20). If excessive play exists, replace both parts.

   d. Inspect the plunger (Item 17) for pitting, rust, corrosion or damage.

   e. Inspect the entire supply pump housing carefully for excessive wear or damage. Make sure the surfaces of the inlet and outlet connections are free from nicks and scratches which might cause the joints to leak.

   f. Inspect the bore of the hand priming barrel (Item 4) for scoring or grooving. Replace as necessary.

39. **Reassembly.** Reassemble the fuel supply pump as follows (Figure 75):

   **NOTE**

   During reassembly lubricate all parts with diesel fuel and replace all O rings and sealing gaskets.

   a. Secure the fuel supply pump in a suitable soft-jawed vice.

   b. Install the inlet and outlet valves (Items 11 and 23), valve springs (Items 10 and 24), gaskets (Items 9 and 25) and outlet valve spring retaining screw (Item 26).

   **NOTE**

   The arrow cast on top of the pump housing indicates fuel flow direction.
c. Install the plunger (Item 12), plunger spring (Item 13), gasket (Item 14) and plunger spring retaining screw (Item 15).

d. Install the plunger (Item 17), tappet spring (Item 18) and tappet assembly parts (Items 19, 20 and 21). Using a suitable drift tap the tappet retaining pin (Item 22) into position.

e. Position the O ring (Item 6) on the plunger and rod (Item 5), apply a thin film of rubber grease to the O ring then install the plunger rod and O ring assembly (Items 5 and 6) into the barrel (Item 4).

f. Position the O ring (Item 3) on top of the barrel (Item 4).

g. Push the plunger and rod (Item 5) up into the barrel.

h. Hold the plunger and rod stem and install the plunger knob (Item 2).

i. Position the bracket assembly (Item 1) over the barrel and place the gasket (Item 7) on the adapter (Item 8). Assemble the adapter to the hand primer and tighten the adapter to 47–54 N.m (35–40 lbf.ft). Install the assembly on to the supply pump and tighten the assembly to 41–47 N.m (30–35 lbf.ft).

Fuel Injection Pump

40. Removal. Remove the fuel injection pump as follows (Figure 76):

![Figure 76 Removing the Fuel Injection Pump](image)

a. Clean the fuel injection pump, connections and the area around the fuel injection pump.

b. Remove the accelerator linkage and stop cable.

c. Mark and remove the fuel lines from the fuel injection pump and blank off all openings.

d. Remove the oil feed line.

e. Remove the air line at the puff limiter cylinder.

f. Disconnect the tachometer cable.

g. Remove the dipstick tube assembly.

h. Remove the supporting bracket from the rear of the fuel injection pump.

i. Remove the oil filler tube (two bolts) and cover the hole.

j. Disconnect the six injector lines and blank off all openings.

k. Remove the wiring from the Dynatard switch on the governor housing.
l. Remove the three bolts retaining the injection pump adapter to the timing gear housing.
m. Remove the fuel injection pump and adapter as an assembly.

41. Installation. Installation is the reverse of removal, but particular attention must be paid to the following:
   a. Align the master drive spline on the Celoron coupling with the pin on the drive shaft and install the pump (Figure 77);
   b. Prime the fuel system in accordance with EMEI Vehicle G 703;
   c. Check the full throttle setting;
   d. Check the stop cable adjustment; and
   e. Start and run the engine. Make any necessary adjustments.

![Figure 77 Timing of the Drive Shaft and Celoron Coupling](image1)

Tip Turbine Fan

42. Disassembly. Disassemble the tip turbine fan as follows:

   **NOTE**

   Before disassembling the tip turbine check for any damage to the blades or wheel, then rotate the wheel by hand and listen for any drag or binding.

   a. Remove the inlet housing bolts and remove the inlet housing (Figure 78).

![Figure 78 Removing the Inlet Housing](image2)
b. Remove the inlet check valve housing bolts and remove the valve housing and the check valve (Figure 79).

43. Prior to further disassembly, inspect the tip turbine fan for axial end play and radial run-out In accordance with Para 44.

![Figure 79 Removing the Check Valve](image)

44. Inspection. Inspect the tip turbine fan as follows:

**NOTE**

Any variation from the axial or radial specifications will require repair or replacement of the unit.

a. **Axial End Play.** Check axial end play as follows:

(1) Install a plunger type dial indicator to the flange of the bearing housing so that the plunger rests against the end of the shaft.

(2) Apply finger pressure to move the shaft axially in as far as possible against spring tension, then allow the shaft to return to its original position. The total indicator reading must be in the range of 0.025–0.762mm (0.001–0.030 in.) (Figure 80).

![Figure 80 Measuring Axial End Play](image)

b. **Radial Run-out.** Check radial run-out as follows:
(1) Install a suitable dial indicator to the flange of the inlet housing so that the indicator tip rests against the wheel nut shoulder.

(2) Move the shaft from side to side to check for a run-out of 0.279 mm (0.11 in) or less (Figure 81).

![Figure 81 Measuring Radial Run-out](image)

45. **Disassembly Continued.** Continue disassembly of the tip turbine fan as follows:
   a. Remove the wheel by installing a ring spanner on the shaft nut, and holding the front of the shaft with a 5/16 in hex socket.
   b. Loosen and remove the nut and slide the wheel off the shaft.
   c. Remove and save the shim found behind the wheel. These shims are to be re-installed to maintain the proper wheel-to-wheel housing clearance (Figure 82).

![Figure 82 Removing the Fan Wheel](image)

    **NOTE**
    Do not immerse the housing assembly in the solvent.

   d. Clean the wheel and inlet housing with a non-caustic cleaning solvent and a nylon brush.

46. **Reassembly.** Reassemble the tip turbine fan as follows:

    **NOTE**
    Replace all parts, including any part requiring more than a light clean-up using a silicone carbide abrasive cloth, for like parts that are supplied in the repair kit.
    Ensure the assembly is cleaned and dried prior to reassembly.

   a. Install the previously removed shims, slide the fan wheel on the shaft, fit the nut and tighten it to 23–24.5 N.m (17–18 lbf.ft).
b. Using a straight edge and a feeler strip, check that the outer ring of the turbine fan vanes is within 0.05 mm (0.002 in) of the inlet housing mounting surface when the shaft is held upward. If adjustment is needed to obtain proper clearance, remove shims, as required (Figure 83).

![Figure 83 Measuring the Fan Wheel Clearance](image)

**CAUTION**

Failure to replace the air inlet check valve may allow dirt to be drawn into the engine at idle, leading to premature ring and piston wear.

c. Install a new air inlet check valve (Figure 84).

![Figure 84 Check Valve Installation](image)

d. Install the inlet housing and tighten the bolts to 10.4–12.5 N.m (7.5–9.2 lbf.ft) (Figure 85).

![Figure 85 Installing the Inlet Housing](image)
NOTE

If the tip turbine fan is to be stored indefinitely, wrap it in a heavy-duty plastic bag, enclosing several silica-gel moisture absorbing packets with the unit, then close and securely tie the bag.

CLUTCH

Clutch Release Shaft and Yoke

47. Removal. Remove the clutch release shaft and yoke as follows:
   a. Remove the transmission in accordance with Para 51.
   b. Remove the pinch bolt from the clutch release adjusting lever. Mark the adjusting lever and the release shaft for correct position when reinstalling.
   c. Remove the release lever from the release shaft.
   d. Drive the release shaft and yoke assembly towards the right-hand side to remove the blanking plug.
   e. Remove the two grub screws from the yoke (Figure 86).

   ![Figure 86 Removing the Grub Screws](image)

   f. Drive the splined release shaft inward and remove the Woodruff key (Figure 87) then drive the splined release shaft outward and remove.

   ![Figure 87 Removing the Release Shaft Woodruff Key](image)

   g. Slide the release stub shaft inward then remove it complete with the clutch release yoke (Figure 88).
48. **Installation.** Install the clutch release shaft and yoke as follows:
   a. Install the yoke to the release stub shaft then push the stub shaft and yoke assembly into the housing.
   b. Align the grub screw hole in the yoke with the groove on the release stub shaft and install the grub screw. Tighten the grub screw to 19–32 N.m (14–24 lbf.ft).
   c. Install the splined release shaft and drive shaft through the yoke.
   d. Insert the woodruff key in the shaft then align the key with the keyway in the yoke and drive the shaft back into the yoke until the groove in the shaft aligns with the grub screw hole in the yoke.
   e. Install the grub screws and tighten to 19–32 N.m (14–24 lbf.ft).
   f. Install the clutch release lever onto the release shaft splines. Align the mating marks then insert the pinch bolt and tighten it.
   g. Check the operation and adjustment of the clutch (adjust as necessary).

**Clutch Assembly**

49. **Removal.** Remove the clutch assembly as follows:
   a. Remove the transmission.
   b. Install a clutch aligning tool.
   c. Install two 19mm (3/4 in) blocks of wood between the release bearing and the clutch flywheel ring.
   d. Install suitable lifting equipment.
   e. Remove the flywheel ring retaining bolts.
   f. Withdraw the clutch assembly from the flywheel housing.

50. **Inspection.** Inspect the clutch assembly for the following:
   a. Check for heat cracks and wear in both the pressure plate and the intermediate plate.
   b. Check for excessive wear in all drive slots.
   c. Check for broken springs.
   d. Check for a dry or damaged release bearing.
   e. Inspect for excessive driven disc hub spline wear.
   f. Check intermediate plate driving lugs to slot clearance (Table Error! Reference source not found., Serial 11). Rectify damaged or worn parts as necessary.
   g. Remove the spigot bearing from the crankshaft using a slide hammer or similar. Clean the bearing and check its condition. Replace the bearing if the balls or races are chipped or scored.
51. **Installation.** Install the clutch assembly as follows (Figure 89):

**NOTE**

Ensure that the spigot bearing is of the correct type and dimension.

![CAUTION]

**CAUTION**

Ensure that the space to be occupied by the transmission input shaft spigot is not filled with grease, or damage to the spigot bearing seal will occur when the transmission is installed.

a. Hand-pack the spigot bearing with grease (XG-291) and install the bearing into the crankshaft then pack the cavity behind the bearing with the same type of grease.

b. Install two 7/16 in – 14NC x 5 in guide studs into the two upper clutch mounting holes of the flywheel. Rotate the flywheel if necessary to level the guide studs.

c. Slide the clutch aligning tool through the release bearing sleeve and assemble the rear driven disc onto the tool.

d. Place the intermediate plate in the clutch cover assembly, aligning the plate driving lugs with the slots provided, then install the front driven disc on the tool.

![CAUTION]

**CAUTION**

Ensure that the clutch driven discs are correctly positioned and installed as incorrect fitting may cause interference between the driven discs, preventing correct clutch function.

![Figure 89 Installing Clutch Plate](image)

e. Using suitable lifting equipment, position the clutch assembly on the two guide studs.

f. Slide the clutch assembly forward and position the aligning tool in the spigot bearing. Install the eight flywheel ring retaining bolts and lock washers until finger tight.

g. Tap the clutch aligning tool in to ensure it has entered and centred in the spigot bearing.
Avoid tightening the flywheel ring by running one retaining bolt completely down with an impact wrench. This procedure can crack or break the spigot bearing.

h. Tighten the flywheel ring retaining bolts progressively and evenly to pull the clutch ring evenly into its correct position.

i. Remove the two guide studs and install the two remaining retaining bolts and lock washers.

NOTE

As the retaining bolts are tightened, the two 19mm (3/4 in) blocks of wood should fall free. If not, remove them at this time. The final tightening will clamp the front and rear driven discs in position.

j. Progressively tighten all the retaining bolts and tighten to 47–54 N.m (35–40 lbf.ft).

k. Remove the clutch aligning tool.

l. Install the transmission.

m. Adjust the clutch and clutch brake in accordance with EMEI Vehicle G 703.

n. Road test the vehicle.

Clutch Specifications

52. Table Error! Reference source not found. details the clutch assembly specifications.

Table 7 Clutch Specifications

<table>
<thead>
<tr>
<th>Serial</th>
<th>Component/Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimum bell housing size for mounting (S.A.E.)</td>
<td>No 2</td>
</tr>
<tr>
<td>2</td>
<td>Pilot diameter</td>
<td>4 35.7–4 35.8 mm (17.153–17.158 in)</td>
</tr>
<tr>
<td>3</td>
<td>Bolt circle</td>
<td>4 22.2 mm (16.625in)</td>
</tr>
<tr>
<td>4</td>
<td>Flywheel pot depth</td>
<td>Flat</td>
</tr>
<tr>
<td>5</td>
<td>Clutch bell to centre line of release yoke</td>
<td>1 12.7 mm (4.437 in)</td>
</tr>
<tr>
<td>6</td>
<td>Disc and facing thickness – standard</td>
<td>11.5–12.4 mm (0.452–0.488 in)</td>
</tr>
<tr>
<td>7</td>
<td>Hub spline size</td>
<td>50.8 mm (2.0 in) – 10 spines</td>
</tr>
<tr>
<td>8</td>
<td>Disc assembly maximum run-out (total indicator run-out)</td>
<td>0.38 mm (0.015 in)</td>
</tr>
<tr>
<td>9</td>
<td>Disc assembly maximum out-of-flat</td>
<td>0.508 mm (0.020 in)</td>
</tr>
<tr>
<td>10</td>
<td>Release sleeve bushing diameter (new)</td>
<td>44.6–51.0 mm (1.754–2.008 in)</td>
</tr>
<tr>
<td>11</td>
<td>Intermediate plates driving lugs to slot clearance (new min)</td>
<td>0.152 mm (0.006 in)</td>
</tr>
<tr>
<td>12</td>
<td>Intermediate plates driving lugs to slot clearance (max worn)</td>
<td>0.38–0.53mm (0.015–0.021 in)</td>
</tr>
<tr>
<td>13</td>
<td>Pressure plates driving lugs to slot clearance (new)</td>
<td>0.076–0.25mm (0.003–0.010 in)</td>
</tr>
<tr>
<td>14</td>
<td>Pressure plates driving lugs to slot clearance (max worn)</td>
<td>0.40–0.53mm (0.016–0.021in)</td>
</tr>
<tr>
<td>15</td>
<td>Intermediate plates and pressure plates (out-of-flat)</td>
<td>0.00–0.10 mm (0.000–0.004 in concave)</td>
</tr>
<tr>
<td>16</td>
<td>Scoring – maximum depth that can be re-used</td>
<td>0.38 mm (0.015 in)</td>
</tr>
<tr>
<td>17</td>
<td>Re grind – max depth that can be re-used</td>
<td>0.38 mm (0.015 in)</td>
</tr>
<tr>
<td>18</td>
<td>Fulcrum wear (max) rework</td>
<td>0.76 mm (0.030 in)</td>
</tr>
<tr>
<td>19</td>
<td>Release sleeve retainer driving lugs to slot clearance (max worn)</td>
<td>0.508 mm (0.020 in)</td>
</tr>
</tbody>
</table>

TRANSMISSION

53. Removal. Remove the transmission as follows:
a. Remove both the driver and co-driver seats, complete with the seat risers.
b. Remove the fire extinguisher mounting bracket.
c. Remove the rubber boots from the gear lever and the transfer case shift lever.
d. Remove the floor mat.
e. Remove and tag the air hoses from the accelerator pedal valve, and disconnect and tag the wires from the headlight dipper switch.
f. Remove the brake treadle valve and the two floor plates.
g. Disconnect the flexible air hose from the air compressor air outlet line at the union nut located on top of the transmission.
h. Remove the air compressor air outlet line by disconnecting at the air compressor and removing the two mounting brackets located on top of the transmission.
i. Disconnect the transmission breather tube.
j. Remove the wiring from the reverse light switch.
k. Disconnect the engine earth wire from the top cover plate.
l. Remove the gear lever, and cover the hole to prevent dirt entering the transmission.
m. Disconnect the two brackets retaining the air starter supply hose to the transmission.
n. From under the vehicle remove the crossover bracket from the rear mounts of the front springs.
o. Remove the transmission-to-transfer case propeller shaft.
p. Disconnect the front propeller shaft at the differential flange. Mark the shaft at the slip joint (for correct alignment when re-installing) and slide it out of the slip joint.
q. Disconnect the cutch cable from the release lever.
r. Disconnect the release bearing lubrication fitting from the bell housing inspection plate and remove the plate.
s. Tag and disconnect all air lines to the primary and secondary air tanks, and remove the air tanks.
t. Remove the transfer case shift lever and linkage by removing the clevis pin from the linkage support end, and the six bolts from the shift lever base plate.
u. Remove the four transmission mounting bolts (two each side).
v. Raise the transmission, using a suitable cradle support, e.g. transmission jack.
w. Remove the lower mounting insulators.
x. Support the rear of the engine in this position by placing blocks of wood between the differential housing and engine sump. Remove the PTO control cable and the winch drive propeller shaft (winch models only).
y. Remove the transmission-to-flywheel housing retaining bolts, noting the position of the air line brackets.
z. Withdraw the transmission towards the rear of the truck, until the input shaft clears the clutch release bearing.

aa. Lower the transmission, taking care not to snare any hoses, pipes or lines.

54. **Installation.** Install the transmission as follows:

a. Raise the transmission until the input shaft aligns with the clutch. Ensure the transmission is straight and that the release bearing lubrication fitting is clear.

**NOTE**

Ensure that the release bearing is correctly positioned, with the lubrication fitting feeding in from the right-hand side of the bearing to the top.
b. Push the transmission towards the engine, positioning the clutch release yoke between the pressure plate and the release bearing. It may be necessary to turn the input shaft slightly to align the splines on the shaft with the splines on the clutch plate.

**CAUTION**

Do not leave the transmission hanging by the input shaft. Install the transmission-to-flywheel housing retaining bolts before lowering or removing the cradle support or damage to the clutch plates will result.

c. Install the transmission-to-flywheel housing retaining bolts and place the air line brackets in their correct position.

d. Raise the transmission and remove the wood supporting the engine.

e. Install the lower mounting insulators.

f. Lower the transmission and install the upper mounting insulators and bolts. Apply an anti-seize compound to the bolt threads, install the washers and nuts and tighten them securely. Remove the jack and cradle support.

g. Install the transfer case shift lever and reconnect the linkage.

h. Install the brake air tanks and reconnect the air lines.

i. Reinstall the front propeller shaft, ensuring that the alignment marks are correctly aligned otherwise the universal joints will be out of phase. Tighten the flange bolts to 54–60 N.m (40–44 lbf.ft).

j. Reconnect the clutch cable to the release lever.

k. Reinstall the crossover bracket to the spring mounting brackets.

l. Refit the transmission-to-transfer case propeller shaft.

m. Refit the gear lever.

n. Reconnect the PTO control cable and winch drive propeller shaft (winch models only).

o. Refit the air starter supply hose mounting brackets to the transmission.

p. Reconnect the engine earth wire to the transmission top cover plate.

q. Reconnect the reverse light switch wiring.

r. Reconnect the transmission breather tube.

s. Reconnect the air compressor air outlet line to the air compressor then refit the mounting brackets to the top of the transmission.

t. Reconnect the flexible hose to the air compressor air outlet line.

u. Refit the two floor plates, reconnect the air lines to the accelerator pedal valve, reinstall the brake treadle valve and reconnect the wiring to the dipper switch.

v. Refit the floor mat.

w. Refit the rubber boots to the gear lever and transfer case shift lever.

x. Reinstall the fire extinguisher mounting bracket.

y. Reinstall the driver and co-driver seats.

z. Adjust the clutch in accordance with EMEI Vehicle G 703.

aa. Install the release bearing lubrication fitting to the inspection plate and then install the inspection plate.

**NOTE**

To start the engine, it will be necessary to use the hand throttle. Allow the air pressure in the brake system to build up before attempting to move the truck.
POWER TAKE OFF (PTO)

55. **Removal.** Remove the PTO as follows (Figure 90):

   a. With the main transmission in neutral, run the engine for a few minutes to warm up the oil in the gearbox. Stop the engine and remove the drain plug, allowing all oil to drain from the gearbox.

   ![Figure 90 Power Take Off](image)

   b. Clean the PTO and surrounding area.

   c. Disconnect the PTO cable from the control lever on the PTO and remove the cable from the mounting bracket.

   d. Disconnect the propeller shaft from the PTO and move the shaft to one side.

   e. Remove the bolts securing the PTO to the gearbox then remove the PTO from the truck.

   f. Remove all gasket residue from the mating surface on the gearbox where the PTO is fitted.

56. **Installation.** Install the PTO as follows:

   **NOTE**
   
   The backlash for the PTO gears must be no less than 0.15mm (0.006 in) when the PTO gaskets are fully compressed.

   a. Using your hand, rock the transmission PTO drive gear to establish the amount of backlash built into the transmission. Likewise rock the PTO meshing gear whilst holding the output shaft of the unit.

   b. Place the unit onto the gearbox and rock the PTO output shaft. Compare this backlash with the previous backlash then gauge the thickness of gasket required to bring the backlash within limits.

   c. Ensure that the PTO is in the disengaged position. With oil proof gaskets against each metal surface, attach the PTO to the gearbox. Install and evenly tighten the retaining bolts to 27 N.m (20 lbf.ft).

   d. Check the action of the PTO by moving the control lever to the engaged then disengaged position several times. The movement must be accomplished easily and smoothly, without having to use excessive force.

   e. Install and tighten the gearbox drain plugs then fill the gearbox to the correct level with OEP-220.

   f. Start the engine, disengage the clutch and shift the PTO into gear. Slowly engage the clutch and note if the PTO whines or rattles. If the PTO whines, add gaskets as required; if the PTO rattles, remove gaskets as required.

   g. Attach the propeller shaft to the PTO. Install and tighten the locking bolt then secure it with locking wire. Attach the PTO cable to the mounting bracket on the PTO and fit the clevis claw to the PTO control lever. Install and secure the clevis pin.

   h. Test the operation of the PTO.
Transmission Fault Finding

57. Table Error! Reference source not found. lists fault finding solutions to common transmission symptoms.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Noisy</td>
<td>Chipped or damaged gears</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PTO installed either too tight</td>
<td>Reinstall PTO correctly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or too loose (winch models)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excessive main shaft gear</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>end-play</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bearing failure</td>
<td>Replace transmission</td>
</tr>
<tr>
<td>2</td>
<td>Difficult gear selection</td>
<td>Selector shaft detent balls</td>
<td>Clean holes and balls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>binding in their holes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loose locating screws in the</td>
<td>Tighten and secure screws</td>
</tr>
<tr>
<td></td>
<td></td>
<td>selectors or selector forks</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn selector shaft bores</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn spigot bearing</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clutch brake ears broken</td>
<td>Replace clutch and transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clutch discs worn into the front</td>
<td>Replace clutch and transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>input shaft</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Gear disengagement</td>
<td>Weak or broken selector shaft</td>
<td>Replace springs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>detent ball springs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bent or worn selector forks</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bent selector shaft or worn</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>detents</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>Excessive main shaft gear</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>end-play</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Worn taper or chipped teeth on</td>
<td>Replace transmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the sliding clutch</td>
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<td></td>
<td></td>
<td>Worn spigot bearing</td>
<td>Replace bearing</td>
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<td></td>
<td>Engine flywheel housing</td>
<td>Rectify</td>
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<td>Oil leaks</td>
<td>Selector shaft expansion plugs</td>
<td>Replace expansion plugs</td>
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<td></td>
<td></td>
<td>loose or missing</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Gaskets or O rings damaged,</td>
<td>Replace gaskets or O rings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>shifted or squeezed out of</td>
<td></td>
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<td></td>
<td></td>
<td>position</td>
<td></td>
</tr>
</tbody>
</table>

TRANSFER CASE GROUP

Transfer Case

58. Removal. Remove the transfer case as follows:

**WARNING**

If the vehicle is fitted with the transfer case cooling and filtration system ensure, before disconnecting any hydraulic hoses, that the oil is sufficiently cool and the system has been relieved of all pressure. Failure to do so may result in injury or death.

**NOTE**

Drain the transfer case lubricant if the transfer case is to be dismantled.

a. Disconnect the propeller shafts. The front axle propeller shaft centre bearing will have to be removed in accordance with EMEI Vehicle G 703.

b. Disconnect the cooling and filtration system circulation pump suction, delivery and return hoses at their connections either side of the motor/pump and secure the hoses out of the way in accordance with EMEI Vehicle G 703.

c. Disconnect the selector linkage and tie it up out of the way.
d. Disconnect the power divider lockout air supply line.

e. Disconnect the speedometer cable.

f. Remove the transfer case breather hose.

g. Install a support cradle (Figure 91) on a heavy-duty hydraulic jack and position it beneath the transfer case then take up the weight of the transfer case.

![Figure 91 Transfer Case Support Cradle](image)

h. Remove the four vertical bolts from the rubber mounts. Raise the transfer case and remove the rubber mounts.

i. Raise or lower the transfer case as necessary to enable the mounting bracket retaining bolts to be removed.

**NOTE**

It may be necessary to raise the left-hand side of the truck to allow the transfer case to be withdrawn.

j. Lower the transfer case and withdraw it from under the vehicle (Figure 92).

![Figure 92 Removing the Transfer Case](image)

**59. Installation.** To install the transfer case, proceed as follows:

a. Position the transfer case under the vehicle.

b. Raise the transfer case as close as possible to the right-hand side chassis rail mount to allow sufficient room to fit the left-hand side transfer case mounting bracket bolts.
c. Move the transfer case as close as possible to the left-hand side chassis rail and fit the right-hand side mounting bracket bolts.

d. Centralise the transfer case in the chassis and install the rubber mounts and vertical bolts. Lower the transfer case and tighten the bolts and nuts securely.

e. Remove the support cradle.

f. Reconnect the transfer case breather hose, speedo cable, power divider lockout air supply line and the selector linkage.

g. Reconnect the cooling and filtration system circulation pump suction, delivery and return hoses at their connections either side of the motor/pump in accordance with EMEI Vehicle G 703.

h. Refit the propeller shafts in accordance with EMEI Vehicle G 703.

i. Check the oil level in the transfer case, top up or refill as necessary.

Circulation Pump Assembly

60. Removal. Remove the circulation pump assembly from the transfer case in accordance with EMEI Vehicle G 703.

61. Disassembly. Disassemble the circulation pump as follows (Figures 93 and 94):

   Do not remove the plug (Figure 94, Item 14) unless it is the old type M10 plug, in which case it is to be replaced in accordance with EMEI Vehicle G 797-27. Removing the new non-removable brass plug may cause the system to leak and fail after reassembly.

   a. Remove the spin-on filter element and seal.
   b. Remove all adaptors from the motor/pump ports.
   c. Remove the four socket head cap screws securing the pump cover to the main housing and remove the cover and seal. The pump cover has the letter ‘P’ clearly stamped on the periphery.

   NOTE
   Do not mix geroters, pressure plates or covers as they have different displacement and performance characteristics.

   d. Remove the pump geroter (Figure 94, Items 3 and 11) from the shaft and remove the woodruff key from its keyway.
   e. Remove the pump pressure plate.
   f. Remove the four socket head cap screws securing the motor cover to the main housing and remove the cover and seal. The motor cover has the letter ‘M’ clearly stamped on the periphery.
   g. Remove the motor geroter (Figure 94, Items 2 and 3) from the shaft and remove the Woodruff key from its keyway.
   h. Remove the motor pressure plate.
   i. Remove the common drive shaft by sliding it through the bearings and seals.
   j. Remove the pump and motor bearings.
   k. Remove the pump and motor seals.
   l. Remove the environmental protection check valve.

   NOTE
   Do not mix relief valves as they have different settings. The motor relief valve is stamped 15.0 and the pump relief valve is stamped 6.9. The numeral indicates the valve setting in Bars.
m. Remove the motor and pump relief valves.
62. **Cleaning and Inspection.** Clean and inspect the components of the circulation pump as follows:

a. Wash the components of the disassembled circulation pump and inspect for undue wear and abrasion. Replace worn parts as necessary.

b. Polish seal journals with 500 grit paper if necessary. Replace the shaft if heavy wear grooving is identified.

c. Polish pressure plates and geroters with 500 grit paper on a flat surface plate to remove any burrs if necessary. If the pressure plates and geroters have heavy wear, they should be replaced.

d. Relief valves may be tested with a flow of 10 to 20 litres per minute, if a suitable facility is available. Discard, adjust or overhaul faulty valves.

63. **Reassembly.** Reassemble the circulation pump as follows (Figure 94):

**NOTE**

Ensure that the seal’s garter springs are still in place after insertion.
a. Lubricate the shaft seals (Item 7) with petroleum jelly and gently push the seals into their housings. The seal’s garter spring must face away from the circulation unit housing as shown.

b. Push the bearings gently into their housings.

NOTE

Do not mix geroters, pressure plates or covers as they have different displacement and performance characteristics.

c. Fit new O rings to each pressure plate and retain in position using petroleum jelly. When fitting, note the bias of the eccentric pressure plates in relation to the screw holes.

d. Replace the common drive shaft.

NOTE

Ensure that the Woodruff keys are still in their correct positions after fitting geroters.

e. Fit the Woodruff keys and geroters to the shaft, ensuring that assembly marks are aligned and are facing the covers.

f. Fit the O rings to the pump and motor covers. Ensure that the threads of the cap screws are free of burrs which can damage the aluminium body. Fit the covers to the body then tighten the 1/4 in socket head cap screws to 8 lbf.ft.

g. Fit new O rings to the hose nipples, then install and tighten the nipples to the torque values shown in Table Error! Reference source not found..

h. Install a new spin-on filter and seal and tighten it firmly using a suitable filter strap.

i. Install the motor and pump relief valves. The motor relief valve is stamped 15.0 and the pump relief valve is stamped 6.9. The numerical value indicates the valve setting in Bar.

j. Install a new environmental protection check valve (1.0 PSI valve).

Table 9  Torque Settings – UN Threaded Hose Nipples, Fitting and Adapters

<table>
<thead>
<tr>
<th>Serial</th>
<th>Size</th>
<th>Torque Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/16 in</td>
<td>32–33 N.m (23.5–24.5 lbf.ft)</td>
</tr>
<tr>
<td>2</td>
<td>3/4 in</td>
<td>55–57 N.m (40.5–42.0 lbf.ft)</td>
</tr>
<tr>
<td>3</td>
<td>7/8 in</td>
<td>59–64 N.m (43.5–47.5 lbf.ft)</td>
</tr>
</tbody>
</table>

64. Testing. Test the reassembled circulation pump assembly as follows:

a. Provide a suitable oil source to drive the motor. The oil source should provide 40 litres per minute on the motor, maximum flow of 50 litres per minute and a maximum pressure drop of 300 PSI or 20 Bar.

b. The pump should be tested using OEP 220 oil however, it can be tested using any gear, hydraulic or engine oil that is compatible with the transfer case oil.

65. Installation. Reinstall the circulation pump assembly in accordance with EMEI Vehicle G 703.

AXLES

Rear Axle Assembly

66. Removal. Remove the rear axle assembly as follows:

a. Raise the vehicle and remove the rear wheels from the axle assembly to be removed.

b. Support the axle assembly on suitable safety stands.

c. Support the vehicle chassis on safety stands at the vehicle ride height.

d. Drain the air from the vehicle brake tanks.

e. Remove the brackets securing the air lines to the axle assembly.
f. Disconnect the air lines from the brake chambers and the spring brake assemblies.

g. Remove the bolts, nuts, washers and spacers securing the longitudinal torque rod to the chassis crossmember (Figure 95).

h. Remove the locknut securing the torque rod to the axle housing, then remove the torque rod.

i. Remove the bolts, nuts, washers, and spacer securing the transverse torque rod to the chassis rail.

j. Remove the locknut securing the torque rod to the torque rod mounting plate on the axle housing, then remove the torque rod.

k. Disconnect the propeller shaft from the differential input flange.

l. Remove the transverse beam.

m. Support the equalising beam, then remove the bolts, nuts and washers securing the axle assembly to the beam hanger bracket.

n. Pivot the equalising beam away from the axle assembly.

o. Raise the axle assembly with suitable lifting equipment and remove the safety stands, then lower and remove the axle assembly from beneath the vehicle.

Figure 95  Axle Assembly – Removal

h. Remove the locknut securing the torque rod to the axle housing, then remove the torque rod.

i. Remove the bolts, nuts, washers, and spacer securing the transverse torque rod to the chassis rail.

j. Remove the locknut securing the torque rod to the torque rod mounting plate on the axle housing, then remove the torque rod.

k. Disconnect the propeller shaft from the differential input flange.

l. Remove the transverse beam.

m. Support the equalising beam, then remove the bolts, nuts and washers securing the axle assembly to the beam hanger bracket.

n. Pivot the equalising beam away from the axle assembly.

o. Raise the axle assembly with suitable lifting equipment and remove the safety stands, then lower and remove the axle assembly from beneath the vehicle.

67. Installation. Install the rear axle assembly as follows:

a. Position the axle assembly beneath the chassis on safety stands at the approximate ride height.

b. Raise and support the equalising beam, then install the bolts, nuts and washers and secure the axle assembly to the beam hanger bracket. Tighten the fine thread bolts and nuts to 1084 N.m (800 lbf.ft) and the course thread bolts to 950 N.m (700 lbf.ft).

c. Install the transverse beam.

NOTE
Do not tighten the castellated nut until the crossmember bolts have been installed.
d. Position the longitudinal torque rod at the axle housing and install the castellated nut and tighten it securely, then install the split pin.

e. Install the bolts, nuts, washers and spacers and secure the longitudinal torque rod to the chassis crossmember. Tighten the bolts securely.

**NOTE**

Do not torque the locknut until the chassis bolts have been installed.

f. Position the transverse torque rod at the torque rod mounting plate on the axle housing and secure it with the locknut. Tighten the locknut securely.

g. Position the torque rod and spacer at the chassis rail and secure them with the bolts washers and nuts. Tighten the bolts securely.

h. Connect the propeller shaft to the differential input flange and tighten the bolts to 123–136 N.m and the locknuts to 37–50 N.m.

i. Secure the air lines to the axle assembly with the brackets.

j. Connect the air lines to the brake chambers and the spring brake assemblies.

k. Install the wheels and remove the safety stands from beneath the chassis, then remove the wheel chocks.

l. Start and run the engine until a pressure of 448 kPa is maintained, inflate the air springs and check the operation of the braking system.

68. Table Error! Reference source not found. lists the rear axle specifications.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Item</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transverse beam castellated nut</td>
<td>271 N.m (200 lbf.ft)</td>
</tr>
<tr>
<td>2</td>
<td>Air spring mounting bolts</td>
<td>47 N.m (35 lbf.ft)</td>
</tr>
<tr>
<td>3</td>
<td>Shock absorber nut</td>
<td>149 N.m (110 lbf.ft)</td>
</tr>
<tr>
<td>4</td>
<td>Equalising beam hanger bolt and locknut</td>
<td>271 N.m (200 lbf.ft)</td>
</tr>
<tr>
<td>5</td>
<td>Beam hanger bracket to axle bolt and nut (fine thread)</td>
<td>1 084 N.m (800 lbf.ft)</td>
</tr>
<tr>
<td>6</td>
<td>Beam hanger bracket to axle bolt (course thread)</td>
<td>950 N.m (700 lbf.ft)</td>
</tr>
<tr>
<td>7</td>
<td>Propeller shaft flange bolts</td>
<td>123–136 N.m (90–100 lbf.ft)</td>
</tr>
<tr>
<td>8</td>
<td>Propeller shaft flange locknuts tightening torque</td>
<td>37–50 N.m (27–37 lbf.ft)</td>
</tr>
</tbody>
</table>

Intermediate Axle Assembly

69. Removal. The removal of the intermediate axle assembly is similar to the removal of the rear axle. Additional items such as the transfer case-to-intermediate carrier propeller shaft, the power divider lockout air line and the brake air line brackets on the intermediate carrier input shaft housing must be removed. The axle must also be moved forward before being moved out from under the truck.

70. Installation. Installation of the axle assemblies is the reverse of removal.

Rear Differential Carrier

71. Removal. Remove the rear differential carrier as follows:

a. Steam clean the axle.

b. Remove the drain plug and allow all oil to drain from the axle housing.

c. Mount the axle on a suitable stand. Remove the retaining nuts from the half-shaft flanges.
Do not use levers or chisels to pry the flanges from the wheel hubs.

d. Tap the half-shaft flanges sharply using a heavy nylon or copper headed hammer freeing the flange from the hub.

e. Remove the half-shafts from the axle casing and remove the oil seals from the wheel hubs.

f. Remove the torque rod from the carrier and fix a sling attached to an overhead lifting device through the carrier torque rod bracket.

**WARNING**

The carrier unit is heavy and severe injury to personnel could result if the unit is mishandled or dropped during removal.

g. Remove the bevel gear compartment cover and the two retaining bolts inside the carrier housing. Take up the slack in the sling and remove the remaining bolts securing the carrier to the axle housing (Figure 96).

![Figure 96](image_url)  Removing Carrier Retaining Bolts

h. Raise the differential carrier from the axle housing until clear of the casing and move it to one side. (Figure 97).

![Figure 97](image_url)  Removing Carrier Housing
i. Remove all gasket residue from the axle casing.

j. Inspect the axle housing for cracks or loose studs. Remove any nicks or burrs with a honing stone or fine file and repair any other defects as necessary.

**72. Installation.** Installation of the differential carrier is the reverse of removal. Pay particular attention to the following points:

- **a.** Before installing the carrier in the axle casing, install and tighten the drain plug, then pour one litre of fresh oil into the differential gears through the axle shaft hole in the side gears.
- **b.** Apply a coating of non-hardening sealing compound to the mating surface of the axle casing before installing the carrier.
- **c.** Alternately tighten four equally spaced bolts to draw the carrier squarely into the axle casing. Do not use a hammer to drive the carrier into the casing.
- **d.** The retaining bolts that secure the carrier to the casing must be tightened to between 205–310 N.m (150–230 lbf.ft).
- **e.** After installing the axle assembly and fitting the wheels, rotate the wheels a few times by hand to pre-lubricate the internal working components. Fill the axle casing to the correct level.
- **f.** Raise and support the rear of the vehicle so that all drive wheels are just clear of the ground. Start the engine then engage 5th gear and run the engine at the equivalent of 50 km/hr for five minutes, to ensure adequate lubrication of the internal working components of the carrier.

**Intermediate Differential Carrier**

**73. Replacement.** The procedure for replacing the intermediate differential carrier is the same as that detailed for the rear differential carrier.

**Rear and Intermediate Axle Fault Finding**

**74. Table Error! Reference source not found.** lists fault finding solutions to common rear and intermediate axle symptoms.

**Table 11 Rear and Intermediate Axle Fault Finding**

<table>
<thead>
<tr>
<th>Serial</th>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bearing failure</td>
<td>Improper lubrication</td>
<td>Replace axle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn, damaged or failed yoke</td>
<td>Replace yoke</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect bearing pre-load</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pump failure</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Misaligned gears</td>
<td>Replace carrier</td>
</tr>
<tr>
<td>2</td>
<td>Vibration</td>
<td>Driveline phasing incorrect</td>
<td>Correct phasing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Driveline angle incorrect</td>
<td>Correct driveline angle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn, damaged or failed yoke</td>
<td>Replace yoke</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Failed universal joint</td>
<td>Replace universal joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn or failed bearings</td>
<td>Replace carrier</td>
</tr>
<tr>
<td>3</td>
<td>Gear failure</td>
<td>Worn or failed bearings</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incorrect tooth contact</td>
<td>Replace carrier</td>
</tr>
<tr>
<td>4</td>
<td>Power divider failure</td>
<td>Pump failure</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Worn plungers and cams</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seized components</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Failed shifter fork</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oil seal failure</td>
<td>Replace carrier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faulty control valve</td>
<td>Replace carrier</td>
</tr>
</tbody>
</table>
Front Axle Assembly

75. Removal. Remove the front axle assembly as follows:
   a. Set the park brake and chock the rear wheels.
   b. Loosen the wheel nuts on the front wheels.
   c. Raise the front of the truck and place suitable stands under the chassis behind the front axle (towards the rear of the truck).
   d. Remove the front wheels.
   e. Disconnect the brake air supply lines at the junctions mounted on the upper ball joint.
   f. Remove the steering drag link from the steering arm in accordance with EMEI Vehicle G 703.
   g. Remove the shock absorbers in accordance with EMEI Vehicle G 703.
   h. Disconnect the differential housing breather hose.
   i. Remove the propeller shaft flange bolts and nuts.
   j. Support the front axle with a suitable trolley jack then remove the U-bolt nuts and spacer.
   k. Lower the axle assembly and draw it forward from under the truck.

   NOTE
   Assistance may be required to steady the axle as it is removed from under the truck.

76. Installation. Install the front axle assembly as follows:
   a. Position the axle under the truck with the spring spacer installed on the spring seats.
   b. Raise the axle and ensure the spring centre bolt has entered the hole provided in the spring spacer.
   c. Install the U-bolts, spacers and nuts and tighten the nuts to 746–814 N.m (500–600 lbf.ft).
   d. Reconnect the differential housing breather hose.
   e. Reconnect the propeller shaft to the axle flange. Install the retaining bolts and nuts and tighten them to 54–60 N.m (40–44 lbf.ft).
   f. Refit the shock absorbers.
   g. Reconnect the drag link to the steering arm then tighten the nut to 323–353 N.m (238–260 lbf.ft) and install the split pin.
   h. Reconnect the brake air supply lines.
   i. Refit the front wheels and install the wheel nuts.
   j. Raise the front of the truck. Remove the stands and lower the truck.
   k. Tighten the front wheel nuts to 610–678 N.m (450–500 lbf.ft).

BRAKES

Brake Treadle Valve

77. Disassembly. Disassemble the brake treadle valve as follows (Figure 98):
   a. Remove the double check valves, brake warning and Dynatard switches from the brake valve.
**Figure 98  Brake Treadle Valve – Exploded View**

b. Remove the bolts securing the treadle to the brake valve and remove the treadle.

c. Remove the exhaust diaphragm (Item 46) and washer (Item 47) from the exhaust cover by removing the screw plug (Item 48).

d. Remove the exhaust cover (Item 43) by removing the four screws (Item 45) securing it to the lower body.

e. Remove the No. 2 inlet and exhaust valve assembly (Items 35 to 42) from the lower body.
f. Disassemble the No. 2 inlet and exhaust valve assembly by removing the circlip (Item 42).
g. Separate the washer (Item 41), O ring retainer (Item 38), both O rings (Items 39 and 40), the spring (Item 37) and the valve retainer (Item 36).
h. Remove the four retaining bolts (Item 34) securing the lower body to the upper body and separate the body halves.
i. Remove the rubber seal O ring (Item 34) from the lower body.
j. Lift the three lock tabs off the primary piston retainer (Item 9) out and up, while applying thumb pressure to the primary piston.
k. Using a suitable clamping device (one which will enable the ESNA nut and the stem to be removed), clamp the primary piston (Item 13) and the relay piston (Item 28) together. Install a 3/8 in spanner on the ESNA nut (Item 5) and insert a screwdriver in the exhaust passage through the centre of the valve to engage the slotted head of the stem (Item 30). Turn the screwdriver anti-clockwise and remove the stem (Item 30), stem spring (Item 7), spring guide (Item 6) and ESNA nut (Item 5). Release the clamp and remove the relay piston (Item 28), relay piston spring (Item 26), primary piston (Item 13) and primary piston return spring (Item 14) from the upper body.

**CAUTION**

The ESNA nut and stem contain the primary piston return spring, stem spring and the relay piston spring. The combined force of these springs is approximately 68 N.m (50 lbf.ft). Care must be taken when removing the ESNA nut as the spring forces will be released.

l. Disassemble the primary piston by rotating the spring seat nut (Item 8) anticlockwise. Separate the spring seat nut, spring seat (Item 10) and rubber spring (Item 11) then remove the piston O ring (Item 12).
m. Remove the large (Item 29) and small (Item 27) O rings from the relay piston (Item 28).

**WARNING**

Ensure the safety requirements for use of compressed air are strictly adhered to. Inadvertent use of compressed air equipment may result in injury to personnel.

n. Disassemble the No1 inlet and exhaust assembly by removing the circlip (Item 25) and separating the washer (Item 23), O ring retainer (Item 20), both O rings (Items 21 and 22), valve spring (Item 19) and valve retainer (Item 18).

**WARNING**

The handling, storage and use of chemical substances is to be in accordance with MSDS and EMEI Workshop E series requirements.

78. **Inspection.** Inspect the brake treadle valve as follows:

a. Clean all parts in a suitable cleaning solution and dry with clean, dry compressed air.
b. Inspect all parts for excessive wear or deterioration.
c. Inspect the valve seats for nicks or burrs.
d. Check the springs for cracks, corrosion or wear.
e. Replace all rubber parts and any part excessively worn or damaged.
79. **Reassembly.** Reassemble the brake treadle valve as follows (Figure 98):

**NOTE**

Prior to reassembly, lubricate all O rings, O ring grooves, piston bores and metal to metal moving surfaces with a suitable lubricant.

a. Reassemble the No 1 inlet and exhaust valve assembly by first placing the valve retainer (Item 18) and the valve spring (Item 19) over the inlet and exhaust valve (Item 17).

b. Place the O ring retainer (Item 20), with the O ring grooves away from the spring, over the inlet and exhaust valve and install the O rings (Items 21 and 22) in their proper grooves.

c. Place the washer (Item 23) over the inlet and exhaust valve, against the O ring retainer (Item 20) and the O rings (Items 21 and 22), and install the circlip (Item 25).

d. Install the No 1 inlet and exhaust assembly in the upper body and install the circlip (Item 24) to secure it. Ensure the circlip is seated completely in its groove.

e. Install the large (Item 29) and small (Item 27) O rings on the relay piston (Item 28).

f. Install the O ring (Item 12) in the primary piston O ring groove.

g. Install the rubber spring (Item 11), concave side down, in the primary piston, then place the spring seat (Item 10), flat side up, over the rubber spring.

h. Install the primary piston spring seat nut (Item 8), with its hex closest to the spring seat. Turn the nut clockwise until the top surface of the spring seat is flush with the top surface of the piston.

i. Place the primary piston return spring (Item 14) in the upper body piston bore.

j. Install the primary piston (Item 13) with the spring seat out, over the return spring (Item 14) and press the piston into the body bore.

k. Install the relay piston return spring (Item 26) in the upper body and place the relay piston over the spring, so that the concave side of the piston is against the spring.

l. Using the clamping device used at disassembly, compress and hold the primary piston and relay piston into the upper body. Install the stem (Item 30) through the exhaust passage of the lower body so that the threaded section of the stem is visible at the primary piston.

m. Hold the slotted head of the stem with a screwdriver then install the stem spring (Item 7) and spring guide (Item 6) over the primary piston.

n. Install the ESNA nut (Item 5) on the stem and tighten to 2.3–3.4 N.m (20–30 lbf.in).

o. Install the primary piston retainer (Item 9) over the piston, making certain all three lock tabs have engaged the outer lip of the body.

p. Reassemble the No 2 inlet and exhaust valve assembly by first placing the valve retainer (Item 36) and valve spring (Item 37) over the lower inlet and exhaust valve (Item 35).

q. Place the O ring retainer (Item 38), with the O ring grooves away from the spring, over the inlet and exhaust valve and install the O rings (Items 39 and 40) in their proper grooves.

r. Place the washer (Item 41) over the inlet and exhaust valve (against the O ring retainer and O rings) and install the circlip (Item 42).

s. Install the No 2 inlet and exhaust valve assembly in the lower body.

t. Place the exhaust cover (Item 43) on the lower body and install the four retaining bolts (Item 45) with lockwashers (Item 44) to secure it to the body. Tighten the screws to 2.3–3.4 N.m (20–30 lbf.in).

u. Install the exhaust diaphragm (Item 46) and diaphragm washer (Item 47) to the exhaust cover and secure with the screw plug (Item 48) and lock washer.

v. Install the O ring (Item 31) in the lower body (Item 32) and secure the lower body to the upper body using the four retaining bolts (Item 34) and lock washers. Tighten the bolts to 7.9–11.2 N.m (70–100 lbf.in).
w. Install the double check valves and switches onto the brake valve in their original position.

80. **Installation.** Install the brake treadle valve as follows:

a. Position the brake treadle valve assembly under the cab floor, install the retaining nuts and tighten them to 9–11.2 N.m (80–100 lbf.in).

b. Reconnect the air lines and wiring to the brake valves in their correct positions, leaving a delivery port disconnected in both the upper and lower sections of the brake valve assembly to allow the fitting of test gauges.

c. Install the gauges, then start the engine and allow air to reach operating pressure in the brake system.

d. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.

e. Check that the readings on the test gauges fall off to zero promptly after a full application is released.

**NOTE**

With the gauges connected it will be noted that the primary circuit delivery pressure is about 14 kPa (2 PSI) greater than the secondary circuit delivery pressure. This is normal for this valve.

f. Remove the gauges and refit the air lines securely.

g. Remove the chocks from the wheels, then check the operation and performance of the brakes before returning the truck to service.

**Hand Control Brake Valve**

81. **Disassembly.** Disassemble the hand control brake valve as follows (Figure 99):

a. Drive out the spiral pin (Item 2) and remove the handle (Item 4), valve head (Item 6) and O ring (Item 9).

b. Remove the handle O ring (Item 5).

c. Remove the tab washer (Item 7).

d. Remove the screws holding the body (Item 30) and valve cover (Item 10) together, and separate the valve cover from the body.

e. Remove the gasket (Item 16) and graduating spring (Item 32).

f. Remove the cam (Item 13) and cam follower (Item 12) from the valve cover (Item 10).

g. Unscrew and remove the adjusting ring (Item 8).

h. Remove the piston (Item 14) and return spring (Item 15) from the body (Item 30).

i. Remove the piston O ring (Item 31).

j. Remove the inlet and exhaust retaining screws (Item 22) and lock washers (Item 21). Remove the inlet valve seat (Item 25) and O ring (Item 29).

k. Insert a suitably sized bolt into the supply port to hold the inlet and exhaust valve (Item 24) on its seat.

l. Depress the exhaust valve guide (Item 27) and valve spring (Item 26) and remove the inlet and exhaust valve (Item 24).

m. Remove the valve stem (Item 28) and inlet and exhaust valve (Item 24) from the inlet seat. Remove the inlet and exhaust valve from the valve stem.
Figure 99  Handbrake Control Valve – Exploded View
82. Inspection. Inspect the hand control brake valve as follows:
   a. Clean all parts in a suitable cleaning solution.
   b. Inspect valve seats for nicks or burrs and remove any deposits.
   c. Check all springs for distortion, cracks and corrosion.
   d. Check all rubber parts for wear or deterioration.
   e. Replace all parts considered non-serviceable during inspection.

83. Reassembly. Reassemble the hand control brake valve as follows (Figure 99):

   **NOTE**

   Before assembling the hand-controlled brake valve, lubricate the body and cover bores, cam and cam follower, piston O ring and valve cover with rubber grease.

   a. Press the inlet and exhaust valve (Item 24) onto the valve stem (Item 28). A little soap on the stem will make it easier to press the inlet valve on.
   b. Position the inlet and exhaust valve and valve stem in the inlet valve seat (Item 25) and insert a suitably sized bolt to hold the inlet valve against its seat.
   c. Position the valve spring (Item 26) and exhaust valve guide (Item 27).
   d. Depress the guide and spring, then press the inlet and exhaust valve (Item 24) onto the stem.
   e. Position the O ring (Item 29) over the inlet valve seat (Item 25), then install the valve seat into the body and secure it with retaining screws (Item 22) and lock washers (Item 21). Tighten the screws to 6.8–9.0 N.m (60–80 lbf.in).
   f. Install the piston return spring (Item 15).
   g. Install the piston O ring (Item 31) onto the piston (Item 14) then install the piston into the body (Item 30).
   h. Install the adjusting ring (Item 8) into the valve cover (Item 10) and screw it down until it is flush with the top of the valve cover.
   i. Position the cam follower (Item 12) and cam (Item 13) in the cover.
   j. Position the graduating spring (Item 32) and gasket (Item 16) in the body.
   k. Connect the body to the valve cover. Install and tighten the retaining bolts (Item 20) evenly to 11.2–15.6 N.m (100–140 lbf.in).
   l. Install the tab washer (Item 7), valve head seal O ring (Item 9) and valve head (Item 6).
   m. Install the handle O ring (Item 5), handle (Item 4) and the spiral pin (Item 2).

Air Compressor

84. Removal. Remove the air compressor, proceed as follows:
   a. Drain the cooling system.
   b. Remove the exhaust pipe.
   c. Disconnect the coolant inlet and outlet hoses from the compressor.
   d. Remove the air outlet and inlet pipes from the compressor and governor.
   e. Remove the power steering pump retaining nuts and remove the pump from the compressor. (Stow the pump away from the engine without disconnecting the pipes.)
   f. Remove the three adaptor housing mounting bolts and remove the compressor.

85. Installation. Install the air compressor as follows:
   a. Position the compressor on the engine and install the retaining bolts. Tighten the bolts to 95 N.m (70 lbf.ft).
   b. Refit the power steering pump and tighten the retaining bolts.
c. Refit the air outlet and inlet pipes to the compressor and governor.

d. Refit the coolant inlet and outlet hoses to the compressor.

e. Refit the exhaust pipe.

f. Close off the cooling system drain cock. Refill the cooling system.

Air Compressor Governor

86. Removal. Remove the air compressor governor as follows:

   a. Remove the air hoses from the governor.
   
   b. Remove the retaining screws and remove the governor.

87. Installation. Installation of the governor is the reverse of the removal procedure.

Spring Brake Valve

88. Disassembly. Disassemble the spring brake valve as follows (Figure 100):

   a. Remove the pipe plug (Item 18).
   
   b. Remove the check valve spring (Item 17), spring guide, and the check valve (Item 15).
   
   c. Remove the two machine screws (Item 21) and remove the exhaust cover (Item 19).
   
   d. Separate the exhaust diaphragm (Item 22) from the cover.
   
   e. Remove the inlet and exhaust valve assembly (Item 30).
   
   f. Remove the inlet and exhaust valve cap nut (Item 31) and separate the cap nut O ring (Item 32).
   
   g. Remove the valve stop (Item 33), valve spring (Item 34) and inlet and exhaust valve (Item 35).

   h. Remove the four machine screws (Item 2) and lock washers (Item 3) that secure the cover (Item 4) to the body (Item 14).
   
   i. Remove the cover and the three piston springs (Items 5, 6 and 10).
   
   j. Remove the inversion valve piston (Item 12) and the small and large O rings (Items 13 and 11).
   
   k. Remove the piston (Item 8) and the large and small O rings (Items 7 and 9).

89. Cleaning and Inspection. Clean and inspect the spring brake valve as follows:

   a. Clean all parts in a suitable cleaning solution.
   
   b. Inspect all parts for excessive wear or deterioration.
   
   c. Inspect the valve seats for nicks or burrs.
   
   d. Check the springs for cracks or corrosion.
   
   e. Replace all rubber parts and any part not found to be fully functional during the inspection.
### Figure 100  Spring Brake Valve – Exploded View

90. **Reassembly.** Reassemble the spring brake valve as follows (Figure 100):

**NOTE**

Prior to reassembly of the spring brake valve, lubricate all O rings, O ring grooves, piston bores and metal to metal surfaces with the silicone base lubricant packaged in the maintenance kit.

All torques specified are assembly torques and can be expected to fall off after assembly is accomplished. Do not re-torque after initial assembly.

- **a.** Assemble the spring guide, and the check valve (Item 15), check valve spring (Item 17) and insert them into the body (Item 14).

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>#</th>
<th>Description</th>
<th>#</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spring brake valve – complete</td>
<td>13</td>
<td>O ring</td>
<td>25</td>
<td>O ring</td>
</tr>
<tr>
<td>2</td>
<td>Machine screw</td>
<td>14</td>
<td>Body</td>
<td>26</td>
<td>O ring</td>
</tr>
<tr>
<td>3</td>
<td>Lock washer</td>
<td>15</td>
<td>Spring guide and check valve</td>
<td>27</td>
<td>Valve spring</td>
</tr>
<tr>
<td>4</td>
<td>Cover</td>
<td>16</td>
<td>Check valve assembly</td>
<td>28</td>
<td>Valve retainer</td>
</tr>
<tr>
<td>5</td>
<td>Piston spring</td>
<td>17</td>
<td>Check valve spring</td>
<td>29</td>
<td>Inlet and exhaust valve</td>
</tr>
<tr>
<td>6</td>
<td>Spring</td>
<td>18</td>
<td>Pipe plug</td>
<td>30</td>
<td>Valve assembly, inlet and exhaust</td>
</tr>
<tr>
<td>7</td>
<td>O ring</td>
<td>19</td>
<td>Exhaust cover</td>
<td>31</td>
<td>Cap nut</td>
</tr>
<tr>
<td>8</td>
<td>Piston</td>
<td>20</td>
<td>Lock washer</td>
<td>32</td>
<td>O ring</td>
</tr>
<tr>
<td>9</td>
<td>O ring</td>
<td>21</td>
<td>Machine screw</td>
<td>33</td>
<td>Valve stop</td>
</tr>
<tr>
<td>10</td>
<td>Spring</td>
<td>22</td>
<td>Exhaust diaphragm</td>
<td>34</td>
<td>Valve spring</td>
</tr>
<tr>
<td>11</td>
<td>O ring</td>
<td>23</td>
<td>Snap ring</td>
<td>35</td>
<td>Inlet and exhaust valve</td>
</tr>
<tr>
<td>12</td>
<td>Inversion valve piston</td>
<td>24</td>
<td>Valve guide</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

```
b. Apply a suitable pipe sealant to pipe plug (Item 18) and install it in the body. Tighten the pipe plug to 5–19 N.m (130–170 lbf.in).

c. Place the inlet and exhaust valve assembly (Item 30) into the valve body.

d. Secure the exhaust cover (Item 19) using the two machine screws (Item 21) and lock washers (Item 20).

e. Tighten the two machine screws to 2.2–3.4 N.m (20–30 lbf.in). Insert the exhaust diaphragm (Item 22) into the exhaust cover (Item 19).

f. Place the inlet and exhaust valve (Item 35) in the body and install the valve spring (Item 34) and valve stop (Item 33).

g. Install the O ring (Item 32) on the cap nut (Item 31) and install the cap nut in the body. Tighten the cap nut to 11.2–14.0 N.m (100–125 lbf.in).

h. Install the small and large O rings (Items 13 and 11) on the inversion valve piston (Item 12) and insert the piston in the body.

i. Install the large and small O rings (Items 7 and 9) on the piston (Item 8) and insert the piston in the body.

j. Install the piston springs (Items 10, 6 and 5) in their respective pistons (Items 12 and 8).

k. Secure the cover (Item 4) to the body using four machine screws (Item 2) and lock washers (Item 3).

l. Tighten the four machine screws to 5.6–9.0 N.m (50–80 lbf.in).

Reserve Air Valve

91. Disassembly. Disassemble the reserve air valve as follows (Figure 101):

    NOTE

    Do not remove the plug from the port marked ‘Del’ in the upper body.

a. Remove the two screws (Item 16) and lock washers (Item 15) securing the lower body (Item 14) to the body (Item 9) and remove the lower body.

b. Insert a rod or punch in the upper plunger pin hole and hold the plunger from turning while the ESNA nut (Item 12) is removed.

c. Remove the washer (Item 11) and inlet/exhaust valve (Item 10).

d. Pull the plunger (Item 5) from the body.

e. Remove the plunger spring (Item 7) and O ring (Item 6).

f. Remove the body O ring (Item 13).
92. **Inspection.** Inspect the reserve air valve as follows:
   a. Wash all parts in a suitable cleaning solution and dry them. Ensure that the ports in the upper body are thoroughly cleaned.
   b. Inspect all parts for excessive wear and deterioration.
   c. Inspect the seat in the upper body for nicks or burrs. Redress the seat if damaged.
   d. Inspect the plunger bore for deep scratches or nicks. The plunger bore should be smooth and clean.
   e. Check the spring for distortion, corrosion and cracks.

93. **Reassembly.** Reassemble the reserve air valve as follows (Figure 101):
   a. Prior to reassembly lubricate O rings and metal parts with rubber grease.
   b. Install the plunger O ring (Item 6).
   c. Position the plunger spring (Item 7) in the body (Item 9), then press the plunger (Item 5) down inside the spring in the body.
   d. Place the inlet/exhaust valve (Item 10), then the washer (Item 11) over the threaded protruding end of the plunger. Install the ESNA nut (Item 12) and tighten it to 3.4–4.6 N.m (30–40 lbf.in).
   e. Place the body seal O ring (Item 13) in place and fasten the lower body to the upper assembly with the two screws (Item 16) and lock washers (Item 15). Tighten the screws evenly and securely.
Trailer Emergency Valve

94. As the trailer emergency valve is identical to the reserve air valve, refer to procedures detailed Paras 91 to 93 inclusive for the overhaul procedure of the valve.

Tractor Protection Valve

95. **Disassembly.** Disassemble the tractor protection valve as follows (Figure 102):

![Figure 102 - Tractor Protection Valve – Exploded View](image_url)

- a. Remove the snap-ring (Item 16) with circlip pliers then remove the valve’s internal assembly. Place the valve’s internal assembly on a smooth surface with the plunger down.
- b. Remove the exhaust diaphragm pan-head screw (Item 15), washer (Item 14) and diaphragm (Item 13) while holding the seat down against the valve spring tension.
- c. Separate the plunger (Item 4), valve spring (item 10) and check valve seat (Item 12).
- d. Remove the check valve O ring (Item 9).
- e. Remove the plunger O rings (Items 3 and 8).
- f. Remove the valve retainer (Item 6).
- g. Carefully pry off the snap-ring (Item 7) from the plunger (Item 4).

96. **Inspection.** Inspect the tractor protection valve as follows:
a. Clean all parts in a suitable cleaning solution and dry them.
b. Inspect all parts for excessive wear or deterioration.
c. Inspect the valve seat for nicks and burrs. Redress seats if damaged.
d. Inspect the plunger bore for deep scratches or nicks. The plunger bore should be smooth and clean.
e. Check the spring for distortion, corrosion and cracks.

97. Reassembly. Reassemble the tractor protection valve as follows (Figure 102):
   a. Prior to reassembly lubricate O rings and seals with rubber grease.
   b. Place the washer (Item 14), with the lip out, on the exhaust diaphragm (Item 13). Install and tighten the pan-head screw (Item 15).
   c. Install the snap-ring (Item 7) on the plunger (Item 4). Position and force the valve retainer (Item 6) down over the valve.
   d. Install the plunger O rings (Items 3 and 8) into their correct grooves.
   e. Position the valve spring (Item 10) on the check valve seat (Item 12).
   f. Position the check valve O ring (Item 9) on the seat and place the complete insert in the valve body.
   g. Using circlip pliers, install the insert snap-ring (Item 16) in the valve body. Ensure that the ring snaps fully into its groove in the valve body.

SUSPENSION

Front Springs

98. Removal. Remove the front springs as follows:
   a. Remove the nuts and washers securing the U-bolts.
   b. Extend the shock absorber and, at the same time, tap the shock absorber bracket with a hammer until it is free of the U-bolts then move it aside.
   c. Remove the lower mounting bracket from the U-bolts. If necessary use a hammer to tap the bracket downwards and off the U-bolts.
   d. Lever the U-bolts off the spring and remove them from the truck. Clean all components that were removed, the spring and immediately adjacent components.
   e. Inspect all components for wear or damage and repair or replace as necessary.

99. Installation. Installation of the U-bolts is the reverse of removal, paying particular attention to the following points:
   a. Before fitting the retaining nuts to the U-bolts, coat the U-bolt threads and the threads in the nuts with XG-276 grease.
   b. Tighten the U-bolt rear retaining nuts until they are snug and repeat for the U-bolt front retaining nuts. Tighten the U-bolt rear retaining nuts to 610–814 N.m (500–600 lbf.ft) and repeat for the front retaining nuts.
   c. After installing the U-bolts, road test the vehicle and re-tighten the U-bolt retaining nuts to the specified torque.

Front Springs Shackle Pins and Bushes

100. Removal. Remove the shackle pins and bushes as follows:
   a. Clean the front shackle and immediately adjacent areas.
   b. Raise the front of the truck chassis sufficiently to take the weight off the springs. Place axle stands directly beneath the chassis and lower the truck onto the stands.
   c. Place a suitable jack directly beneath the spring towards the spring eye. Operate the jack until it comes in contact with, and will support the spring when the shackle pin is removed.
d. Remove the locating screw that secures the shackle pin in the shackle, and remove the pin. A drift and hammer may be used to drive the pin out of the shackle, if necessary.

e. Gradually lower the jack and spring until the spring is clear of the front shackle.

f. Using suitable tools and equipment, remove the eye-bush from the spring.

g. Clean the interior of the spring eye then inspect the shackle and spring for any defects or damage. Repair or replace as necessary.

101. Installation. Installation of the shackle pins and bushes is the reverse of removal, with particular attention being paid to the following points:

a. Before installing the bush in the spring eye, apply a liberal coating of grease (XG-291) to both the interior of the eye and to the shackle pin.

b. After installing the spring and before lowering the truck to the ground, grease the bush again.

Front Suspension Spring Assembly

102. Removal. Remove the front suspension spring assembly as follows:

a. Remove the front axle.

b. Support the weight of the spring with a suitable trolley jack.

c. Remove the slipper joint bolt.

d. Remove the grub screw locating the front fixed shackle pin and push the pin out.

e. Lower the spring and remove it from the truck.

103. Inspection. Inspect the front suspension spring assembly as follows:

a. Check for broken or cracked leaves or broken centre bolt.

b. Check the fixed pin for cracks and excessive wear.

c. Check the alignment clips for wear, cracks, looseness or damage.

d. Check the slipper joint rubber insulator for wear.

e. Replace components as required.

104. Installation. Installation of the front springs is the reverse procedure of removal.

Transverse Beam

105. Removal. Remove the transverse beam as follows:

**NOTE**

The vehicle should be unladen and the wheels chocked to prevent the vehicle rolling.

a. Support the chassis on suitable safety stands at the vehicle ride height, then deflate the air springs.

b. Remove the bolts and Nyloc nuts securing the shock absorbers to the transverse beam mounting bracket (Figure 103). Discard the Nyloc nuts.
Figure 103  Transverse Beam – Removal

c. Remove the levelling valve vertical linkage from the axle mounting.
d. Remove the bolts and washers securing the air spring to the transverse mounting bracket.
e. Using a suitable pin punch, remove the roll pins from the castellated nuts and the equalising beam.

NOTE
If the transverse beam is difficult to remove, a porta-power located between the axle housing and the beam may be required.

f. Using special socket NSN 5120-66-128-8252 and a socket wrench, remove the castellated nuts and spacers from the equalising beam, then remove the transverse beam.

106. Inspection. Inspect the transverse beam as follows:

WARNING

The transverse beam is to be discarded if any cracking is evident.

a. Inspect all parts for wear, cracks or weld failures.

107. Bush Replacement. Replace the transverse beam bush(es) as follows:

CAUTION

The beam support fixture must be securely mounted on the hydraulic press.

NOTE

A hydraulic press with a capacity of 5 000 kg or greater must be used to remove the bushing.
a. Position and secure the beam on a suitable hydraulic press, then press out the bushing.
b. Clean the bush receptacles in the beam of any foreign material.
c. Lubricate the new bush(es) with an approved rubber lubricant or a soap and water solution.
d. Position the bush at the receptacle and press the bushing into the receptacle ensuring that the bushing is centred in the beam (Figure 104).

**Figure 104  Transverse Beam Bushing – Replacement**

108. **Installation.** Install the transverse beam as follows:

   a. Position the transverse beam on the equalising beams, then install the spacer and the castellated nuts.
   b. Tighten the castellated nuts to 271 N.m (200 lbf.ft), then align the next slot in the nut with the hole in the equalising beam and install the roll pin.
   c. Align the air spring with the transverse mounting bracket and secure with the bolts and washers. Tighten the bolts to 47 N.m (35 lbf.ft).
   d. Position the shock absorbers at the axle mounting brackets and install the bolts and new Nyloc nuts. Tighten the bolts and nuts to 149 N.m (110 lbf.ft).
   e. Install the levelling valve linkage onto the axle mounting, then inflate the air springs.
   f. Raise the vehicle and remove the safety stands and wheel chocks.

**Equalising beam**

109. **Removal.** Remove the equalising beam as follows:

   **NOTE**

   Before starting the removal procedure, ensure the vehicle is unladen and the wheels are chocked.

   a. Raise the vehicle and remove the wheels adjacent to the beam to be removed. Support the chassis on suitable safety stands at the vehicle ride height and deflate the air springs.
   b. Remove the transverse beam.
   c. Support the axle assembly on suitable safety stands.
   d. Support the equalising beam and remove the chassis hanger bracket pivot pin, locknut, washers and alignment bushing (Figure 105).
   e. Remove the bolt, locknut, washers and adaptor bushings securing the equalising beam to the beam hanger bracket.
   f. Remove the equalising beam from the vehicle.
110. **Inspection.** Inspect the equalising beam as follows:

**WARNING**

The equalising beam is to be discarded if any cracking is evident.

a. Inspect all parts for wear, cracks or weld failures.

![Figure 105 Pivot Pin – Removal](image)

111. **Bush Replacement.** Replace the equalising beam bush(es) as follows:

**CAUTION**

The beam support fixture must be securely mounted on the hydraulic press.

**NOTE**

A hydraulic press with a capacity of 5 000 kg or greater must be used to remove the bushing.

a. Position and secure the beam on a suitable hydraulic press, then press out the bushing.

b. Clean the bush receptacles in the beam of any foreign material.

c. Lubricate the new bush(es) with an approved rubber lubricant or a soap and water solution.

d. Position the bush at the receptacle and press the bushing into the receptacle ensuring that the bushing is centred in the beam (Figure 106).

![Figure 106 Equalising Beam Bushing – Replacement](image)
112. **Installation.** Install the equalising beam as follows:
   
   a. Align the equalising beam with the chassis hanger bracket and install the alignment bushings, washers, pivot pin and locknut.
   
   b. Position the equalising beam at the beam hanger bracket and install the adaptor bushings, bolt, washer and locknut.
   
   c. Tighten the beam hanger bracket to axle bolt to the Torque specified in Table Error! Reference source not found.
   
   d. Install the transverse beam.

**Levelling Valve**

**WARNING**

Components in this valve are under spring tension. Care must be taken to avoid injury.

113. **Disassembly.** Disassemble the levelling valve as follows (Figure 107):
   
   a. Remove the levelling valve from the vehicle in accordance with EMEI Vehicle G 703.
   
   b. Secure the valve body and remove the upper fitting and filter screen. Discard the O ring.
   
   c. Remove and discard the check seals and the coil spring.
   
   d. Remove the exhaust cap and the felt filter and discard the filter.
   
   e. Remove the piston guide locknut, the piston guide, the piston shaft and the spring. Discard the piston guide and the O ring from the piston shaft.
   
   f. Remove the locking screw securing the eccentric shaft into the valve body from the valve body, then remove the shaft and eccentric pin.
   
   g. Discard the eccentric shaft O ring.

114. **Reassembly.** Reassemble the levelling valve as follows (Figure 107):
   
   a. Thoroughly clean the valve body with a suitable cleaning agent.
   
   b. Install the O ring on the piston shaft, then screw the piston guide onto the shaft and secure it with the locknut.
   
   c. Install the O ring on the eccentric shaft.
   
   d. Position the piston guide, shaft and the lightest coil spring in the valve body.
   
   e. Install the eccentric pin in the valve body, ensuring that it aligns with the groove in the piston guide, then install and secure the eccentric shaft with the locking screw.
   
   f. Install the felt filter and the exhaust cap.
   
   g. Install the O ring on the upper fitting.
   
   h. Install the lower check seal in the valve body with the rubber surface facing downwards.
   
   i. Install the heaviest coil spring in the valve body followed by the upper check seal with the rubber surface facing upwards.
   
   j. Install the upper fitting and tighten it securely.
   
   k. Install the levelling valve on the vehicle in accordance with EMEI Vehicle G703.
Inversion Valve

115. **Disassembly.** Disassemble the inversion valve as follows (Figure 108):

```
WARNING

Components in this valve are under spring tension. Care must be taken to avoid injury.

a. Remove the inversion valve from the vehicle in accordance with EMEI Vehicle G 703.
b. Secure the valve body and remove the cap and the O ring. Discard the O ring.
c. Remove the valve stop, valve spring and the valve.
d. Invert the body and remove the exhaust nut, diaphragm, diaphragm retainer, piston spring, shim washer and the piston. Remove and discard the piston O rings.
```
116. **Reassembly.** Reassemble the inversion valve as follows (Figure 108):

**NOTE**

Measure the thicknesses of the shim removed from the valve and ensure an equivalent size shim is replaced.

- **a.** Thoroughly clean the valve body and components with a suitable cleaning agent.
- **b.** Install new O-rings on the piston and the cap, then install the piston, shim washer, piston spring, diaphragm retainer, exhaust nut and the diaphragm. Tighten the exhaust nut securely.
- **c.** Invert the body and insert the valve, valve spring, valve stop and the cap and O-ring. Tighten the cap securely.
- **d.** Install the valve on the vehicle in accordance with EMEI Vehicle G 703.
117. Table Error! Reference source not found. and Figure 109 details the rear suspension specifications.

Table 109  Rear Suspension

<table>
<thead>
<tr>
<th>Serial</th>
<th>Description</th>
<th>Tension</th>
<th>lbf. ft</th>
<th>Fig Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transverse beam castellated nut</td>
<td>271 N.m</td>
<td>200 lbf. ft</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Air spring mounting bolts</td>
<td>47 N.m</td>
<td>35 lbf. ft</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Shock absorber securing bolt</td>
<td>271 N.m</td>
<td>200 lbf. ft</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Equalising beam hanger bolt and locknut</td>
<td>271 N.m</td>
<td>200 lbf. ft</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Beam hanger bracket to axle bolt and nut (fine thread)</td>
<td>524 N.m</td>
<td>400 lbf. ft</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Beam hanger bracket to axle bolt (course thread)</td>
<td>950 N.m</td>
<td>700 lbf. ft</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Propeller shaft flange bolts</td>
<td>123–136 N.m</td>
<td>96 lbf. ft</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Propeller shaft flange locknuts</td>
<td>37–50 N.m</td>
<td>33 lbf. ft</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Equalising beam pivot bolts</td>
<td>813 N.m</td>
<td>600 lbf. ft</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Equalising beam to chassis frame bolts</td>
<td>345 N.m</td>
<td>255 lbf. ft</td>
<td>1</td>
</tr>
</tbody>
</table>
STEERING

General

118. Two models of steering gears (old and new) are currently in service. The differences between the two pitman arm securing assemblies are easily identified (Figure 110).

![Figure 110](image)

Steering Gear – Overhaul (Old Type)

119. Removal. Remove the steering gear as follows (Figure 111):
   a. Remove the drain plug from the steering gear housing and drain the oil from the system into a suitable container.
   b. Disconnect the oil lines (Item 1) from the steering gear.
   c. Remove the pinch bolt (Item 2) from the steering column universal joint at the steering gear and remove the column from the steering gear.

![Figure 111](image)
d. Disconnect the drag link (Figure 112, Item 1) from the Pitman arm.

e. Remove the socket head lock bolt (Figure 112, Item 2) from the Pitman arm retaining nut (Item 3), then remove the nut.

**CAUTION**

Do not pound on the Pitman arm or apply excessive heat, as damage to the Pitman arm or output shaft could cause a serious accident at a later date. The Pitman arm and/or output shaft are not to be welded.

![Figure 112 Removing the Drag Link and Pitman Arm Nuts](image)

f. Remove the Pitman arm from the output shaft using a suitable puller (Figure 113).

![Figure 113 Removing the Pitman Arm](image)

g. Remove the bolts retaining the steering gear to the chassis rail and remove the steering gear from the vehicle.
120. Disassembly (Old Type). Disassemble the steering gear as follows:

CAUTION

The power steering gear is a precision machined assembly and care must be taken during repair to keep it free from dirt and foreign material. All internal parts must be handled carefully to avoid damaging the machined surfaces. Remove all nicks and burrs with a fine hand-stone before reassembly as they can cause damage to mating parts. It is advisable to carry out repairs of the steering gear on a soft cardboard or plywood surface work-bench.

a. Make reference marks on the bearing cap, cylinder head and housing so that the steering gear can be reassembled in the same configuration (Figure 114).

NOTE

The cylinder head or bearing cap will fit either end of the housing.

b. Remove the eight bolts attaching the pinion gear cover to the housing (Figure 115).

c. Clean the exposed portion of the output shaft to prevent damaging the bearing. Using a soft hammer, tap on the end of the output shaft to loosen the cover (Figure 116).
d. Carefully slide the output shaft pinion gear and cover through the housing. Pull the output shaft out of the cover. Remove and discard the cover O ring seal (Figure 117).

e. Remove the plungers from the cylinder head and bearing cap. Remove and discard the O rings (Figure 118).
f. Remove the bolts from the bearing cap and turn the actuating shaft to free the bearing cap from the piston and housing (Figure 119).

![Figure 119 Removing the Bearing Cap Retaining Bolts](image)

**Figure 119** Removing the Bearing Cap Retaining Bolts

---

g. Support the bearing cap and turn the actuating shaft until it is free of the piston. Remove and discard the gasket (Figure 120).

![Figure 120 Removing the Actuating Shaft](image)

**Figure 120** Removing the Actuating Shaft

---

h. Remove the cylinder head and discard the gasket (Figure 121).

![Figure 121 Removing the Cylinder Head Retaining Bolts](image)

**Figure 121** Removing the Cylinder Head Retaining Bolts
i. Carefully slide the piston assembly from the bore of the housing (Figure 122).

![Figure 122 Removing the Piston Assembly](image1)

Maladjustment of the top adjustment nut will cause erratic steering.

j. Before disassembling the piston, mark the top adjustment nut and piston so that the nut can be reinstalled in its original position (Figure 123).

![Figure 123 Marking the Adjustment Nut and Piston](image2)

k. Carefully remove the pin locking the adjustment nut to the piston assembly (Figure 124).

![Figure 124 Removing the Locking Pin](image3)
Do not remove the bottom adjusting nut inside the piston.

1. Use special peg spanner ‘A’ (Table Error! Reference source not found., Serial 3) to remove the top adjusting nut from the piston (Figure 125).

![Figure 125 Removing the Top Adjusting Nut](image)

m. Remove the top reversing spring from the nose of the actuating valve (Figure 126).

![Figure 126 Removing the Top Reversing Spring](image)

n. Pull the actuating valve from the piston. Do not force the valve from the piston bore. The actuating valve and piston are serviced only as an assembly due to the critical tolerances of these items (Figure 127).

![Figure 127 Removing the Actuating Valve](image)
o. Remove the actuating valve positioning pin from the piston (Figure 128).

![Figure 128 Removing the Positioning Pin](image)

**NOTE**

The reversing springs are the only serviced parts in the piston assembly.

![CAUTION]

The relief balls are under slight spring pressure. Handle them carefully to avoid loss or personal injury.

p. Use an Allen key to remove the relief valve seats, relief balls and spring (Figure 129).

![Figure 129 Removing the Relief Valve](image)

**CAUTION**

The piston bottom plug should not be removed except in cases of severe oil contamination, and for cleaning. On reinstallation the plug must be pinned (Figure 130).

![Figure 130 Bottom Plug and Pin Location](image)
q. To remove the actuating shaft and bearing assembly from the bearing cap, pull the locking pin from the housing using long-nose pliers then use the special peg spanner ‘B’ (Table Error! Reference source not found., Serial 4) to remove the bearing retaining nut (Figure 131).

![Figure 131 Bearing Cap Assembly and Spanner](image)

r. Tap or press the actuating shaft and bearing from the bearing cap (Figure 132).

NOTE

The actuating shaft and bearing are serviced only as an assembly. Do not separate.

s. The actuating shaft may be one of several types. The Acme thread may be machine cut or rolled. The rolled thread may appear rough and flaky and seem to have a split in the thread. This is normal (Figure 133).

![Figure 133 Actuating Shaft](image)
NOTE

Three seals are used for high pressure and actuating shaft protection. The pressure seal is protected by a dirt seal and a salt seal. A grease cavity between the dirt seal and the salt seal is filled with XG-291 grease to block dirt or salt entry. This cavity is flushed by forcing grease through the cavity with a low pressure grease gun (Figure 134).

![Figure 134 Bearing Cap](Image)

The three seals can be pressed towards the inside with a piece stock 38mm (1.490 in) in diameter (Figure 135).

![Figure 135 Pressing Seals From Bearing Cap](Image)

NOTE

The back-up washer will also be displaced with the seals and should be recovered for reinstallation with new seals (Figure 136).

![Figure 136 Seals and Washer](Image)
NOTE
Disassemble only if replacement of shaft or gear is required; otherwise, do not disturb them.

CAUTION
Use safety precautions when shearing the pin under pressure.

NOTE
If the retaining pin cannot be drilled out it can be sheared off with approximately 10 tons of pressure on the press. Drive half the pin out of the pinion gear then drill the remaining half out of the shaft.

u. To remove the pinion gear, first punch out the roll pin which keeps the retaining pin in position. Drill out the retaining pin (Figure 137).

![Figure 137 Removing the Roll Pin](image1)

v. Press the pinion gear off the output shaft (Figure 138).

![Figure 138 Removing the Pinion Gear](image2)
w. Remove and discard the quad ring oil seal from the gear housing (Figure 139).

![Figure 139 Removing the Quad Ring](image)

x. Use a drift punch to drive the bronze bush out of the housing. Alternately tap one side of the bush and then the opposite side to keep it moving evenly (Figure 140).

![Figure 140 Removing the Bush From the Housing](image)

y. Withdraw the bronze bush from the cover with a suitable bush remover (Figure 141).

![Figure 141 Gear Cover Bush](image)

121. Cleaning. Cleanliness is of utmost importance. Dirt and foreign material introduced into the steering system during repair operations can cause damage and steering malfunctions at a later date. Clean machined parts individually to avoid damaging critical surfaces. Use clean, suitable solutions to wash parts, and dry with compressed air. Nicks or burrs must be removed with a fine hand stone before assembly. Use only clean SAE Grade 40 (OMD-115) to coat parts to ease assembly.
NOTE

All O rings, seals and gaskets must be replaced as a part of any repair.

122. Inspection. Carefully inspect all steering gear parts for wear or signs of stress or fatigue. Any parts showing these symptoms must be replaced. Steering gears that have been accident damaged are to be replaced. Distorted Pitman arms, broken or bent reversing springs, twisted output shafts, broken or cracked rack and pinion gear teeth are some signs of impact damage. Common conditions and their possible causes are as follows:

a. Parts Discoloured (Blue). This may be caused by:
   (1) extremely high operating temperatures,
   (2) excessive flow rate,
   (3) excessive system back pressure,
   (4) a binding steering column,
   (5) a blocked actuating valve, or
   (6) a malfunctioning supply pump.

b. Bronze Bearing Wear. The cause for this may be:
   (1) the use of incorrect lubricant,
   (2) excessive temperature,
   (3) overloading, or
   (4) contaminated oil.

c. Actuating Shaft and Actuating Valve Acme Thread Wear. This may be caused by:
   (1) overloading,
   (2) insufficient operating pressure,
   (3) insufficient oil flow, or
   (4) continued operation at high temperature.

d. Broken or Bent Reversing Spring. The cause for this may be:
   (1) accident damage, or
   (2) air in the system.

e. Broken Housing. The cause for this may be:
   (1) accident damage, or
   (2) uncontrolled operating pressure.

f. Actuating Shaft Bearing Retaining Nut Stripped. This may be caused by:
   (1) impact or accidental damage, or
   (2) air in the system.

g. Housing or Piston Scoring. This may be caused by:
   (1) entry of foreign material,
   (2) severe overloading,
   (3) the use of incorrect lubricant,
   (4) excessive temperature,
   (5) a damaged supply pump, or
   (6) air in the system.
NOTE
Minor scoring or scuffing of the piston and housing is acceptable, but should be polished with a fine hand stone to allow free movement of mating parts. If scoring is severe, leakage will affect steering reaction time and slow, binding, or uneven steering input will be noticeable. In this case the damaged parts must be replaced. Slow, binding or uneven steering input can also be caused by problems with the hydraulic supply pump.

123. Reassembly. Reassemble the steering gear as follows:

NOTE
When installing the bush in the output shaft housing, if the bush goes in easily without heavy press resistance, carefully remove the bush. Thoroughly clean the bush and housing bore, then coat both the bush and housing bore with Loctite high strength retainer compound and re-install the bush. Allow six hours curing time, after which clean off excess Loctite.

The bronze bushes are pre-sized and boring or honing is not required.

a. Install new bushings in the gear housing and cover using a press. The bush is pressed into the gear housing so that the inside face of the bush is flush with the inside face of the gear housing. When a new bush is pressed into the cover, the face of the bush must be recessed 7.9mm (5/16 in) from the cover face (Figures 142 and 143).
b. Install a new quad ring in the groove in the gear housing. The quad ring is a ‘stuff-fit’ and at first glance may appear to be too large (Figure 144).

![Figure 144 Installing the Quad Ring](image)

Figure 144 Installing the Quad Ring

c. Position the relief valve spring and one relief valve ball into the valve bore. Using a 4.8mm (3/16 in) Allen key, install one of the valve seats. The valve seat must be tight and flush with or slightly below the end surface of the piston. Install the valve ball and seat at the other end of the piston in the same manner (Figure 145).

![Figure 145 Installing the Relief Valve](image)

Figure 145 Installing the Relief Valve

d. Position one of the reversing springs in the bottom of the valve bore. Be sure the spring is centred. The end of the valve must enter the inside diameter of the spring.

e. Install the valve positioning pin in the piston. Turn the pin inward with a screwdriver until it is below the outside surface of the piston. The flats must enter into the piston 6.4mm (1/4 in) to engage the mating slot in the valve (Figure 146).

![Figure 146 Installing the Valve Positioning Pin](image)
f. Carefully slide the actuating valve into the piston so that the slot on the end of the valve is positioned over the pin (Figure 147).

![Figure 147 Installing the Actuating Valve](image)

**Figure 147 Installing the Actuating Valve**

g. Position the remaining reversing spring on the shoulder of the valve end (Figure 148).

![Figure 148 Installing the Reversing Spring](image)

**Figure 148 Installing the Reversing Spring**

h. Reinstall the valve adjustment nut, turning it clockwise into the piston until it is against the spring. Align the reference marks on the nut and piston. Lock the nut in place by installing the locking pin. Be sure the pin is below the outside surface of the piston (Figure 149).

![Figure 149 Installing the Valve Adjustment Nut](image)

**Figure 149 Installing the Valve Adjustment Nut**
If the backup washer is incorrectly installed, oil will leak on the first application of pressure.

i. When reassembling the actuating shaft and bearing cap, first reinstall the backup washer with the under cut facing towards outside of the bearing cap. Take a piece of round stock 51mm (2 in) long and turn to 41mm (1.615 in) dia, smoothing one end, and:

(1) Put the piece of round stock in the bearing end against the back up washer.

(2) Set the bearing cap on the press and evenly install the dirt seal (lip out from the other end) until it rests against the backup washer.

j. Evenly install the salt seal (lip out) into the bearing cap until flush with the top.

k. Turn the bearing cap over and evenly install the high pressure oil seal until it rests against the backup washer.

l. Lubricate all three seals with XG-291 grease before installing the actuating shaft assembly (Figure 150).

m. Press the actuating shaft assembly into the bearing cap (Figure 151).

n. Install the bearing retaining nut (Figure 152). Insert the locking pin through the hole in the bearing cap and into the hole in the nut. If a new nut is being used, drill a 2.38mm (3/32 in) hole in the nut. The nut must be in place to drill this hole. Drill through the locking pin hole in the bearing cap and 4.8mm (3/16 in) into the nut.
o. Reassemble the output shaft and gear if disassembled. Align the retaining pin hole on both the gear and the shaft, and press the gear onto the shaft (Figure 153). Install the retaining pin through the gear and seat in the shaft. Install the new roll pin.

p. Apply a light coat of SAE Grade 40 (OMD-115) to the cylinder bore and piston. Carefully install the piston in the cylinder bore with the opening for the actuating shaft towards the bearing cap end of the housing (Figure 154).
q. Apply a light coat of XG-291 grease on the housing bearing and on the quad ring then carefully slide the output shaft through the housing. Align the timing marks on the pinion gear with the timing mark on the rack (Figure 155).

![Figure 155 Aligning the Timing Marks](image)

r. Install the cylinder head with a new seal. Align the reference marks. Install and tighten the bolts to 27 N.m (20 lbf.ft) for 5/16 in bolt or 45 N.m (33 lbf.ft) for 3/8 in bolt (Figure 156).

![Figure 156 Installing the Cylinder Head](image)

s. Install a new O ring on the bearing cap, then thread the actuating shaft into the valve. Align the punch marks on the bearing cap and the gear housing.

t. Turn the shaft until the cap comes into place on the end of the gear housing. Check the plunger hole alignment with the valve seat in the piston. Install and tighten the bolts to 27 N.m (20 lbf.ft) for 5/16 in bolt or 45 N.m (33 lbf.ft) for 3/8 in bolt (Figure 157).

![Figure 157 Installing the Actuating Shaft](image)
u. Place a new O ring seal on the pinion housing cover, and install the cover (Figure 158). It may be necessary to tap the cover into place with the aid of a soft hammer. Install the bolts and tighten them to 227 N.m (167 lbf.ft).

![Figure 158 Installing the Pinion Housing Cover](image)

v. Install the relief valve plungers using new O rings and screw the plungers in approximately six turns. Final adjustment of the plungers is made after the steering gear is installed on the vehicle (Figure 159).

![Figure 159 Installing the Relief Valve Plungers](image)

124. **Installation.** Install the steering gear as follows:

a. Position the steering gear in the chassis rail and install the retaining bolts. Tighten the bolts to 228–236 N.m (168–174 lbf.ft).

b. Refit the drain plug and reconnect the oil lines.

c. Centralize the steering wheel and reconnect the steering column universal joint to the input shaft of the steering gear. Tighten the pinch bolt.

125. **Bleeding Air from the System.** Bleed air from the steering system as follows:

a. Fill the pump reservoir with SAE Grade 40. It will be necessary to continue filling after starting the engine and during the bleeding operation until the correct oil level is maintained.

b. Set the parking brake and block the wheels. Start the engine and allow it to operate at fast idle speed.

c. With the engine running, turn the steering wheel from left to right and return, making several complete cycles to purge all air from the steering system.

d. Stop the engine.
126. Installing the Pitman Arm (Old Type)

a. Install the Pitman arm onto the output shaft ensuring that the reference marks are properly aligned. Check that the Pitman arm outer surface is 3.2–4.8 mm (1/8–3/16 in) from the end of the output shaft (Figure 160).

![Figure 160 Installing the Pitman Arm](image)

b. Apply anti-seize to the threads of the output shaft, retaining nut and lock bolt.

c. Install the Pitman arm retaining nut and tighten it to 1 050 N.m (775 lbf.ft).

d. Install the lock bolt and tighten it to 16–20 N.m (12–15 lbf.ft).

e. Turn the bearing cap relief valve plunger and the cylinder head relief valve plunger into the gear until they bottom.

127. Adjusting Relief Valve Plungers. Adjust the steering gear relief valve plungers as follows:

**CAUTION**

The power steering lock relief plungers are specifically designed to reduce the loads on steering components when the steering hits full lock. If these loads are not reduced, severe damage can occur to the vehicle’s steering and suspension system.

**NOTE**

The adjustment procedure is the same for both early and late type steering gears.

**NOTE**

Do not change the wheel stop adjustment.

a. Loosen both relief valve plunger locknuts and turn the bearing cap relief valve plunger and the cylinder head relief valve plunger into the steering gear four to five turns.

b. With the full weight of the vehicle on the wheels, start the engine and set high idle.

**CAUTION**

Do not force the steering wheel.

c. Use a second person to turn the steering wheel to full right lock until the bearing cap lock relief plunger opens the steering gear relief valve. Hold the steering wheel in that position.
NOTE

An increased effort on the steering wheel indicates that the valve has opened.

d. Adjust the bearing cap lock relief plunger outward, while maintaining effort on the steering wheel, until a clearance of 3.2 mm (1/8 in) is achieved at the right axle wheel lock stop.

e. Hold the bearing cap relief plunger in position and tighten the locknut (Figure 161).

Figure 161  Adjusting the Steering Gear Relief Valve Plunger

f. Repeat the procedure for the cylinder head relief valve plunger.

g. Turn the engine off.

h. The vehicle is now ready for testing.

Steering Gear – Overhaul (New Type)

128. Removal. Remove the steering gear as follows (Figure 162):

a. Remove the drain plug from the steering gear housing and drain the oil from the system into a suitable container.

b. Disconnect the oil lines (Item 1) from the steering gear.

c. Remove the pinch bolt (Item 2) from the steering column universal joint at the steering gear and remove the column from the steering gear.

Figure 162  Oil Lines and Pinch Bolt Locations
d. Disconnect the drag link from the Pitman arm.

NOTE
The majority of in-service ‘new type’ steering box pitman arm assemblies are as per Assembly Type 1. Pitman arm Assembly Type 2 configuration has been included if required (Figure 164).

NOTE
Do not bend the aligning tabs out of the pitman arm.

e. Use the punch to bend the tab lock washer restraining tabs out of the pitman arm retainer (Figure 163).

f. Remove the pitman arm retainer using a suitable Allen socket and impact wrench then remove the tab lock and tab lock friction washers from the sector shaft. (Figure 164).

g. Lubricate the face of the sector shaft with clean chassis lube.
The pitman arm can be extremely tight. Do not use a hammer, or apply heat to the arm. Damage to the sector shaft, pitman arm or seals can result. The pitman arm and/or sector shaft are not to be welded.

h. Fit the pitman arm puller (Table Error! Reference source not found., Serial 5) over the pitman arm, ensuring that the puller jack screw is centrally aligned to the puller friction washer and sector shaft then remove the pitman arm (Figure 165).

![Figure 165 Pitman Arm Puller](image)

i. Remove the bolts retaining the steering gear to the chassis rail and remove the steering gear from the vehicle.

129. **Disassembly (New Type).** For disassembly, inspection and reassembly data pertaining to the steering gear (New Type) refer to the equipment OEM.

130. **Installation.** Install the steering gear as follows:

   a. Position the steering box in the chassis rail and install the retaining bolts. Tighten the bolts to 228–236 N.m (168–174 lbf.ft).
   b. Refit the drain plug and reconnect the oil lines.
   c. Centralize the steering wheel and reconnect the steering column universal joint to the input shaft of the steering gear. Tighten the pinch bolt.

131. **Bleeding Air from the System.** Bleed air from the steering system as follows:

   a. Fill the pump reservoir with SAE Grade 40. It will be necessary to continue filling after starting the engine and during the bleeding operation until the correct oil level is maintained.
   b. Set the parking brake and block the wheels. Start the engine and allow it to operate at fast idle speed.
   c. With the engine running, turn the steering wheel from left to right and return, making several complete cycles to purge all air from the steering system.
   d. Stop the engine.

132. **Installing the Pitman Arm (New Type).** Install the pitman arm (new type) as follows:

   **NOTE**

   Proper pitman arm installation is critical to the safe operation of the vehicle. Correct torque values are important. Always follow these procedures when installing the pitman arm.
If the pitman arm is not applied to the proper specifications it can come loose and cause an accident. Anytime a pitman arm is found loose, replace the pitman arm and the sector shaft.

a. Install the pitman arm onto the sector shaft taking care to align the timing marks (Figure 166).

![Figure 166 Installing the Pitman Arm](image)

**NOTE**

Coat the threads of the retainer and both sides of the tab lock friction washer with anti-seize compound.

b. Fit the tab lock and tab lock friction washers then install the pitman arm retainer to the sector shaft (Figure 167). Take care to align the tab lock washer alignment tabs in the notches of the pitman arm (Figure 168).

![Figure 167 Pitman Arm Assembly](image)
c. Tighten the retainer to 610 N.m (450 lbf.ft) (Figure 169).

![Figure 168  Alignment of the Tab Lock Washer](image1)

Do not back off the retainer to align the tabs. A loose pitman arm or loss of steering control could result.

d. Continue tightening the retainer past 610 N.m (450 lbf.ft) until two of the notches in the retainer align with the restraining tabs of the tab lock washer.

e. Use a punch and hammer to bend the restraining tabs of the tab lock washer into the notches of the retainer.

![Figure 169  Tightening the Retainer](image2)

![Figure 170  Tab Lock Washer Restraining Tabs](image3)
Once the retainer is tightened to the correct torque value and locked in place, do not re-tighten the retainer. Constant retightening of the retainer can cause a loose pitman arm or loss of steering control.

f. Apply torque putty to the tabs for future reference.

![Torque Putty](image171.jpg)

**Figure 171  Torque Putty**

133. **Adjusting Relief Valve Plungers.** To adjust the relief valve plungers, refer to Para 127.

**Power Steering Pump (Vehicle Not Fitted With Transfer Case Cooling System)**

**NOTE**

The following procedures refer to vehicles not fitted with the transfer case cooling and filtration system.

134. **Removal.** Remove the power steering pump as follows:

a. Remove the drain plug from the steering gear housing and drain the oil into a suitable container. Reinstall the drain plug.

b. Remove the exhaust pipe clamp at the turbocharger.

c. Remove the pyrometer sensor.

d. Slacken the exhaust pipe clamp located alongside the steering pump.

e. Remove the bolt from the exhaust mounting bracket and remove the upper section of the exhaust system.

f. Disconnect the hoses from the steering pump.

g. Remove the two bolts retaining the steering pump to the compressor.

h. Remove the pump from the engine.

135. **Disassembly.** To disassemble the power steering pump, proceed as follows:

a. Secure the pump in a vice so that the cover end is up.

b. Scribe mating marks on the cover, the cam ring and the pump body so that they can be reassembled in the same position.

c. Remove the four bolts retaining the cover, lift the cover off and remove the O ring.

d. Remove the plug, spring and flow control valve from the cover. Do not remove the orifice unless necessary.

e. Remove the pressure plate and spring.

f. Remove the pin and locating pin.
g. Remove the vanes from the rotor and slide the rotor from the shaft.

h. Turn the pump body over, remove the key from the shaft and remove the outer bearing snap-ring.

i. Remove the shaft from the housing by tapping on the splined end of the shaft with a soft hammer.

j. Remove the bearing from the shaft by supporting the bearing inner race and pressing the shaft from the bearing.

k. Pull the shaft seal out of the pump body.

l. Press the inner bearing out of the pump body.

136. Cleaning. Clean all parts thoroughly with a solvent which is compatible with the hydraulic fluid. Dry all parts with filtered, dry, compressed air. Keep all parts clean during inspection and assembly. The close tolerances of the parts make this requirement more stringent than usual.

137. Inspection. Inspect the power steering pump as follows:

   a. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring or excessive wear. Remove light score marks by lapping. Replace badly worn or scored parts.

   b. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace badly worn or scored parts.

   c. Inspect bearings for wear, looseness and pitted or cracked races. Replace as necessary.

   d. Inspect the oil seal wearing surface on the shaft for scoring or wear. If marks are present and cannot be removed by light polishing, replace the shaft.

   e. Check the relief valve subassembly for free movement in the cover bore. Remove burrs with light polishing, but take care not to round off the sharp edges of the lands. Do not attempt to rework the valve bore. Replace the cover if the bore is damaged.

138. Reassembly. Reassemble the power steering pump as follows:

   NOTE

   Due to the possibility of damage to components of a new cartridge kit during shipping, it is advisable to lightly stone all sharp edges of the components prior to installation.

   a. Coat all parts with SAE Grade 40 (OMD-115) before assembly. A small quantity of petroleum jelly can be used to hold the O rings in place during assembly.

   b. Install the flow control valve into the cover (small end first), then the spring and plug.

   c. Press the outer bearing onto the shaft using a suitable tool to support the bearing inner race.

   d. Make sure the bearing is seated firmly.

   e. Press the inner bearing into the body using a tool which contacts the outer race only. Ensure the bearing is firmly seated.

   f. Press the seal into the body then lubricate the seal lip with petroleum jelly.

   NOTE

   The double lip seal should be installed with the seal spring facing the pumping cartridge. The single lip seal has two pressure holes on one side. This seal should be installed with the holes facing the shaft end of the pump.

   g. Slide the driveshaft into place until the outer bearing is seated. A light tap on the end of the shaft with a soft hammer may be necessary. Install the bearing retaining snap ring in the body.

   h. Install a new O ring in the body. Apply a small amount of petroleum jelly to the O ring to hold it in position.

   i. Insert the ring locating pins and assemble the ring so that the arrow points in the correct direction of rotation. Align the mating mark on the ring with that on the body.
j. Install the rotor on the shaft and insert the vanes in the rotor slots. Ensure that the curved edge of each vane is installed towards the cam ring.

k. Place the pressure plate over the locating pins and flat against the cam ring.

l. Install a new O ring in the cover. Apply a small amount of petroleum jelly to the O ring to hold it in position.

m. Insert the pressure plate spring into the recess in the pressure plate.

n. Install the cover. Align the mating mark on the cover with that on the cam ring.

o. Install the cover retaining bolts and torque to 34–41 N.m (25–30 lbf.ft).

p. Rotate the shaft to check for binding.

q. Install the shaft key.

139. Installation. The installation of the steering pump is the reverse of removal with the addition that air must be bled from the system.

Power Steering Pump (Vehicle Fitted with Transfer Case Cooling System)

NOTE

The following procedures refer to vehicles fitted with the transfer case cooling and filtration system.

Removal

140. Remove the power steering pump in accordance with Para 134.

Disassembly

141. Power Steering Pump Disassembly. Disassemble the power steering pump assembly as follows (Figure 172):

a. Clamp the pump body (Item 7) in a vice (not too tightly), cover end up, and remove the four priority valve cover cap screws.

b. Match mark the priority valve cover (Figure 173, Item 5), the rotor ring (Figure 172, Item 5) and the body (Figure 172, Item 7) to ensure correct alignment on reassembly.

c. Remove the priority valve cover (Figure 173, Item 5) and O ring (Figure 172, Item 4).

d. Remove the pressure plate (Item 2) and compression spring (Item 1).

e. Lift off the rotor ring (Item 5) and remove the locating dowel pins.

f. Separate the vanes from the rotor (Item 6) and remove the rotor from the shaft (Item 11).

g. Turn the pump body (Item 7) over, and then remove the circlip (Item 9) which retains the bearing (Item 10).

h. Tap with a soft hammer on the rotor end of the shaft to force the shaft out of the body.

i. Remove the small circlip (Item 12), located on the shaft behind the bearing.

j. Support the bearing inner race (Item 10) and press the shaft out of the bearing.

k. Pull the shaft seal (Item 8) out of the body with a suitable hooked tool.
### Priority Valve Cover Disassembly

Disassemble the priority valve cover as follows (Figure 173):

**NOTE**

DO NOT remove the relief valve seat unless inspection of the relief valve poppet contact area reveals a problem in the seat area.

**NOTE**

If removal of the priority valve relief valve seat is required, thread the seat with a suitable tap approximately 3/8 in into the seat. Thread a long bolt into the seat and pull the bolt and seat from the bore with a small gear puller.

- **a.** Remove the plug (Item 9) and spring (Item 7) from the spool end of the priority valve bore, and the plug (Item 9) from the other end of the bore.
- **b.** Insert a suitable tool into the end of the bore and push the priority valve spool (Item 6) from the cover.
- **c.** Disassemble the relief valve assembly by removing the plug (Item 11), shims (Item 13), spring guide (Item 14), compression spring (Item 15), and relief valve poppet (Item 16).
### Cleaning and Inspection

143. All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement more stringent than usual.

144. Clean all removed parts using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices and cover passages.

145. Discard the used shaft seal and all O rings. Wash the metal parts in a solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

146. **Power Steering Pump Assembly.** Inspect the power steering components as follows:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/4 in UNO to 3/4 in JICM elbow</td>
</tr>
<tr>
<td>2</td>
<td>3/4 in JIC nipple with 1/2 in hosetail</td>
</tr>
<tr>
<td>3</td>
<td>3/4 in JICM to 3/4 in JICF elbow</td>
</tr>
<tr>
<td>4</td>
<td>3/4 in ONO extended nipple to 3/4 in JICM</td>
</tr>
<tr>
<td>5</td>
<td>Priority valve cover</td>
</tr>
<tr>
<td>6</td>
<td>Priority valve spool</td>
</tr>
<tr>
<td>7</td>
<td>Compression spring</td>
</tr>
<tr>
<td>8</td>
<td>O ring</td>
</tr>
<tr>
<td>9</td>
<td>3/4 in UNO plug</td>
</tr>
<tr>
<td>10</td>
<td>7/8 in UNO to 7/8 in JICM elbow</td>
</tr>
<tr>
<td>11</td>
<td>1/2 in UNO plug</td>
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<tr>
<td>12</td>
<td>O ring</td>
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<tr>
<td>13</td>
<td>Relief valve shims</td>
</tr>
<tr>
<td>14</td>
<td>Spring guide</td>
</tr>
<tr>
<td>15</td>
<td>Compression spring</td>
</tr>
<tr>
<td>16</td>
<td>Relief valve poppet</td>
</tr>
<tr>
<td>17</td>
<td>Relief valve seat</td>
</tr>
</tbody>
</table>

![Figure 173 Power Steering Pump Priority Valve Cover](image-url)
a. Check the wearing surfaces of the body, pressure plate, rotor ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

b. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the vanes and rotor if the slots are worn.

c. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

d. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

147. **Priority Valve Cover.** Inspect the priority valve cover components as follows:

a. Insert the pressure plate into the priority valve cover without fitting the spring then, using a straight edge as shown in Figure 174, check that clearance between the pressure plate face and the sealing surface of the priority valve cover is between 0.5–1 mm using feeler gauges. If not, refer to EMEI Vehicle G 797-18, Pressure Plate/Rotor Clearance Check for corrective action.

b. Inspect the priority valve piston and bore for burrs. Remove burrs from the piston by light polishing with crocus or #500 grit paper. DO NOT round off sharp corners of the lands.

c. Inspect the cover bore for scratches, wear and/or a pitted surface. DO NOT attempt to rework the bore. If the bore is damaged, replace the cover.

**NOTE**
The priority valve piston must fit and move within the bore without evidence of bind.

d. Rotate the piston through 360° while inspecting for bind.

**Figure 174  Measuring Pressure Plate Clearance**

**NOTE**
The poppet requires a close inspection in the seat contact area. A slight wear pattern should exist around the poppet area of seat contact. If the wear pattern is broken, a possible leakage path exists between the poppet and its seat. Inspect the seat for possible erosion or other defects. Refer to the seat removal procedure if the seat is defective.
e. Inspect the relief valve spring. The spring ends must be parallel to prevent cocking of the relief valve poppet.

Reassembly

148. General. Coat all components with steering gear oil SAE Grade 40 (OMD-115) to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold O rings in place during assembly.

**NOTE**
During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be stoned, prior to installation.

149. Priority Valve Cover – Relief Valve. Reassemble the priority valve cover relief valve as follows (Figure 173):

a. If the relief valve seat (Item 17) was removed, a new seat must be pressed into the body. Lubricate and insert the new seat chamfered end first into the cover opening. Align it square and press it into place. Use a short length of brass rod as a pressing tool to prevent seat damage.

b. Clean the relief valve bore to remove chips and filings.

c. Insert the relief valve poppet (Item 16) into the bore, align it square and lightly tap the stem of the poppet to mate the poppet and seat.

d. Install the compression spring (Item 15), spring guide (Item 14), relief valve shims (Item 13) and plug (Item 11) into the priority valve cover.

**NOTE**
If the relief valve pressure setting is out of tolerance, readjust by removing or adding relief valve shims. Removing shims reduces pressure, while adding shims increases pressure.

e. Check the pressure setting of the relief valve (1 750 PSI ±50 PSI).

150. Priority Valve. Reassemble the priority valve as follows (Figure 173):

a. Insert the priority valve spool (Item 6), small land first, into the bore.

b. Install the compression spring (Item 7) to the priority valve spool.

c. Install the plugs (Items 9 and 11) at each end of the bore and secure them.

151. Power Steering Pump. Reassemble the power steering pump assembly as follows (Figure 172):

a. Begin assembly by pressing the shaft (Item 11) into the bearing (Item 10) while supporting the bearing inner race.

b. Install the small circlip (Item 9) onto the shaft.

**NOTE**
Before fitting the shaft seal, determine the correct position of the sealing lip. Seals are assembled with the garter spring toward the pumping cartridge.

c. Press the seal (Item 8) firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid.

d. Slide the shaft assembly into the body (Item 7) until the bearing is seated. Tap lightly on the end of the shaft if necessary.

e. Install the large circlip (Item 12).

f. Install new O rings (Items 4 and 13) in the body (Item 7) and cover (Item 16).

g. Insert the rotor ring (Item 5) locating pins in the body (Item 7) and, aligning match marks, assemble the rotor ring so that the arrow on the perimeter points in the direction of rotation (Figure 175).
h. Install the rotor (Figure 172, Item 6) on the shaft and insert the vanes in the rotor slots. Ensure that the radius edges of the vanes are toward the rotor ring.

i. Place the pressure plate (Item 2) on the locating pins and flat against the rotor ring.

j. Place the spring (Item 1) over the pressure plate and then install the priority valve cover paying attention to the match marks.

k. Tighten the cover screws to 102–115 N.m (75–85 lbf.ft).

l. Rotate the shaft by hand to ensure that there is no internal binding.

Testing

152. If a test stand is available, the pump should be tested at the recommended speeds and flow rates shown below:

   a. Port 1 – 6 gpm @ 1 000 rpm, 6 gpm @ 1 500 rpm; and
   b. Port 2 – 3 gpm @ 1 000 rpm, 7.5 gpm @ 1 500 rpm.

Installation

153. Install the power steering pump in accordance with para 139.

FAULT FINDING

Power Steering Pump

154. Table Error! Reference source not found. details the fault finding procedures for the power steering pump hydraulic system.
### Table 13  Fault Finding – Power Steering Pump

<table>
<thead>
<tr>
<th>Serial</th>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pump not delivering fluid</td>
<td>a Coupling or shaft sheared or disengaged</td>
<td>Disassemble the pump and check the shaft and cartridge for damage. Replace the necessary parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b Fluid intake pipe in reservoir restricted</td>
<td>Check all strainers and filters for dirt and sludge. Clean if necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c Fluid viscosity too heavy to pick up prime</td>
<td>Completely drain the system. Add new filtered fluid SAE Grade 40 (OMD-115)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d Air leaks at the intake, pump not priming</td>
<td>Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e Relief valve stuck open</td>
<td>Disassemble the pump and wash the valve in a suitable cleaning solution. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f Pump vanes not extending</td>
<td>Increase engine speed momentarily to extend the vanes and start the pump action. Usually a temporary and infrequent occurrence and not cause for major pump repair or replacement. If this does not rectify the problem, disassemble the pump. Check for dirt or metal chips. Clean thoroughly and replace any damaged components. If necessary, flush the system and refill it with clean fluid SAE Grade 40 (OMD-115)</td>
</tr>
<tr>
<td>2</td>
<td>Insufficient pressure build–up</td>
<td>a System relief valve set too low</td>
<td>Use a pressure gauge to correctly adjust the relief valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b Low oil flow</td>
<td>Check that supply pump is operating to specification (Paras 149 and 152), rectify as necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c Complete loss of flow from pump</td>
<td>A valve is stuck open permitting free flow to tank. Broken inlet or pressure line. Actuator bypassing the full flow. (Motor valve plate lift)</td>
</tr>
<tr>
<td>3</td>
<td>Pump making noise</td>
<td>a Pump intake partially blocked</td>
<td>Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid SAE Grade 40 (OMD-115)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b Air leaks at the intake or shaft seal. (Oil in reservoir would probably be foamy)</td>
<td>Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. Check that the fluid in the reservoir is above the intake pipe opening</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c Pump drive speed too slow or too fast</td>
<td>Operate the pump at the recommended speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d Coupling misalignment</td>
<td>Check if the shaft seal bearing or other parts have been damaged. Replace any damaged parts. Align the coupled shafts</td>
</tr>
</tbody>
</table>
AIR STARTER

155. Disassembly. Disassemble the air starter assembly as follows:

a. Having removed the air starter, in accordance with EMEI Vehicle G 703, mark adjacent spots on the motor housing, rear cover, gear case, gear case cover and drive housing so that these members can be located in the same relative position when the starter is assembled (Figure 176).

![Figure 176 Punch Marking the Starter Motor]

b. Remove the motor housing cover retaining bolts, and separate the gear case and rear cover from the motor housing (Figure 177).

![Figure 177 Removing the Gear Case]

c. Position the motor assembly vertically, grasping the rotor pinion in soft vice-jaws. Remove the circlip (Figure 178).

![Figure 178 Removing the Rear Bearing Retaining Circlip]
d. Remove the rear rotor bearing and end-plate, cylinder and the rotor vanes (Figure 179).

![Figure 179 Removing the Rear Rotor Bearing and End-plate](image)

**Figure 179** Removing the Rear Rotor Bearing and End-plate

e. Position the rotor vertically, pinion end up, and secure the bottom hub in a soft-jawed vice. Remove the E-clip (horseshoe clip) and remove the pinion (Figure 180).

![Figure 180 Removing the Pinion](image)

**Figure 180** Removing the Pinion

f. Remove the front end-plate and rotor bearing. If the bearing is still in place, support the front end-plate as close to the rotor as possible, and press the front rotor hub from the front rotor bearing. Do not let the rotor fall when it is pressed free (Figure 181).

![Figure 181 Removing the Front Rotor Bearing and End-plate](image)

**Figure 181** Removing the Front Rotor Bearing and End-plate
g. Mount the gear case in a vice and remove the drive housing retaining bolts. Lift the drive housing and Bendix drive from the gear case (Figure 182).

![Figure 182 Removing the Drive Housing](image1)

h. To remove the gear case bearing, thread a 5/8 in, 18 thread bolt into the tapped hole in the bearing ejecting washer. Turn the bolt until the drive shaft rear bearing is removed from the gear case. Remove the bolt (Figure 183).

![Figure 183 Removing the Gear Case Bearing](image2)

i. Withdraw the drive shaft and cover assembly from the Bendix drive. If the gear is tight on the shaft it must be pressed off. Support the drive gear, press out the drive shaft and remove the drive gear key. To remove the bearing, place a sleeve over the drive shaft that will contact only the inner race of the bearing, and press the drive shaft from the bearing bore (Figure 184).

![Figure 184 Checking the Gear for Looseness](image3)
j. Remove the Bendix drive assembly from its housing (Figure 185).

Figure 185  Removing the Bendix Drive Assembly

156. Inspection. Inspect the air starter assembly as follows:

a. When the starter has been disassembled, wash all parts except the Bendix drive and any sealed bearings in kerosene.

   NOTE
   Some starter motor drive housings are fitted with a bush and oiler felt. Check the condition of the bush and replace if it is worn or oval.

b. Check the end-plates for scoring. After long service, especially if the rotor bearings are worn or loose, the rotor may contact and score the end-plates. If the end-plates are scored, either replace or reface as necessary (Figure 186).

   CAUTION
   Do not use emery cloth.

Figure 186  Checking for Scoring

157. Reassembly. Reassemble the air starter assembly as follows

a. Fit the front end-plate, crescent groove side first, onto the splined hub of the rotor (Figure 187).

Figure 187  Installing the Front End-plate
b. Press the front rotor bearing onto the rotor hub as far as possible (Figure 188).

**CAUTION**

Care must be taken to avoid binding the end-plate against the rotor.

**NOTE**

Lubricate the bearings with XG-291 grease.

![Figure 188 Installing the Front Bearing](image)

c. Install the rotor pinion over the splined hub and the rotor pinion E-clip on the hub so that the concave face of the clip is toward the pinion (Figure 189).

![Figure 189 Installing the E-clip Retainer](image)

d. Position the rotor vertically, grasp the rotor pinion in soft vice-jaws, and insert a vane into each rotor vane slot (Figure 190).

**NOTE**

Wipe a thin film of engine oil on the vanes, rotor and cylinder bore.

![Figure 190 Installing the Vanes](image)
e. Place the cylinder over the rotor and onto the front end-plate so that the dowel hole and air ports are in the correct relative position (Figure 191).

![Figure 191 Positioning of Dowel Hole and Air Ports](image)

f. Place the rear end-plate, crescent groove side first, on the rotor hub and against the cylinder (Figure 192).

![Figure 192 Installing the Rear End-plate](image)

g. Install the rotor bearing, shielded side first, onto the short hub of the rotor until it contacts the end-plate. Install the circlip (Figure 193).

![Figure 193 Installing the Rear Bearing Retaining Circlip](image)
h. Align the dowel holes in the cylinder and end-plates and insert the cylinder dowel until it is flush with the face of the front end-plate (Figure 194).

![Figure 194 Installing the Cylinder Dowel]

i. Insert the bolts and lock washers in the motor housing cover. Place a new motor housing cover gasket in the bore of the cover so that the large air port in the gasket is aligned with the air port in the cover and the dowel hole in the gasket is aligned with the correct dowel hole in the cover (Figure 195).

![Figure 195 Gasket Alignment]

j. Place the assembled motor into the housing cover, ensuring that the air port in the end-plate and the one in the cover are aligned. The cylinder dowel must enter the dowel hole in the housing cover (Figure 196).

![Figure 196 End-plate Port Alignment]
k. Slide the motor housing down over the motor, making sure that the punch marks on the motor housing and cover are aligned (Figure 197).

![Figure 197](image)

Figure 197  Positioning the Motor Housing and Cover

l. When installing the gear case needle bearing, ensure that the bearing ejecting washer is installed in the bearing recess first. Press the drive shaft rear bearing (unstamped end first) into the gear case (Figure 198).

![Figure 198](image)

Figure 198  Gear Case Bearing in Position

m. Place a new gasket on the face of the front end-plate and position the gear case on the motor housing, taking care to align the punch marks on the gear case and motor housing (Figure 199).

![Figure 199](image)

Figure 199  Installing the Gear Cover
n. Install the remaining motor housing cover bolts and alternately tighten each progressively to a final torque of 27–34 N.m (20–25 lbf.ft) (Figure 200).

![Figure 200  Tightening Housing Cover Bolts](image)

o. Press the drive shaft front bearing onto the drive shaft until it contacts the drive shaft collar. Install the key in the keyway (Figure 201).

![Figure 201  Front Bearing and Key in Position on the Drive Shaft](image)

p. Align the gear keyway with the key on the shaft. Press the drive gear (long hub first) onto the drive shaft until it contacts the drive shaft front bearing (Figure 202).

![Figure 202  Drive Gear in Position on the Drive Shaft](image)
q. Install a new drive shaft grease seal by pressing it into the gear case cover, lip side first (Figure 203).

![Figure 203 Oil Seal in Position](image)

r. Before installing the drive shaft and gear assembly in the gear case cover, lubricate the bore of the drive shaft grease seal and the circumference of the drive shaft collar with a thin film of light lubricant, e.g. petroleum jelly. Insert the long end of the drive shaft through the bore of the seal, and seat the drive shaft front bearing in the recess in the gear case cover (Figure 204).

![Figure 204 Positioning Drive Shaft and Gear Assembly in Gear Case Cover](image)

s. Before proceeding, check the drive shaft grease seal to ensure that the inner lip of the seal has not folded outward toward the end of the drive shaft. If it has, reinstall the drive shaft using a flat, fine pointed instrument to roll the lip of the seal in the proper direction (Figure 205).

![Figure 205 Checking Grease Seal Sealing Lip](image)
t. Position the drive gear thrust washer on the short hub of the drive shaft, against the face of the drive gear (Figure 206).

![Figure 206 Installing the Thrust Washer](image)

u. Apply a small quantity of XG-291 on the drive gear. Insert the short hub of the drive shaft into the bore of the drive shaft rear bearing in the gear case until the gear case cover is seated against the gear case (Figure 207).

![Figure 207 Installing the Drive Shaft](image)

v. To install a new drive housing bearing, align the bearing with the housing and press it into place. Ensure that the bearing is adequately lubricated with XG-291 grease.

NOTE

With starter motors having a bush in the drive housing, install the bush by aligning the cross-slot in the nose of the drive housing with the bush oiler hole, and pressing the bush in until it is flush. Soak the new felt in oil. Install and secure it in place with the oiler plug.

w. Insert the Bendix drive assembly (pinion end first) in the bore of the drive housing, ensuring that the Bendix drive support shaft enters the bush straight, to avoid damage (Figure 208).

![Figure 208 Installing the Bendix Drive](image)
x. Lubricate the exposed section of the drive shaft with a thin film of XG-291 grease (Figure 209).

y. Slide the drive housing over the drive shaft. Align the punch marks on the gear case, gear case cover, and drive housing. Install the drive housing retaining bolts, and alternately tighten them progressively to a final torque of 11.3 N.m (100 lbf.in) (Figure 210).

158. Testing. Attach an air hose to the inlet and operate the motor slowly to ensure that it functions correctly. When facing the Bendix drive end of the drive housing, the Bendix drive should rotate clockwise. If the direction of rotation is incorrect, disassemble the motor and turn the cylinder end for end.
BODY

Cab Interior Fittings

159. Repair. Repairs to the cab interior fittings are carried out using standard workshop techniques. The same is applicable for the truck sides, canopy and bows and the tail-gate.

Doors

160. Removal. Remove the doors as follows:
   a. Open the door.
   b. Disconnect the windscreen washer wiring and hose at the connector and T-piece located in the lower side cowl panel alongside the accelerator pedal (driver’s door only).
   c. Disconnect the clearance light wiring at the connector located in the lower side cowl panel on either side of cabin.
   d. Remove the eight bolts retaining the door to the hinges and remove the door.

161. Installation. Install the doors as follows:
   a. Lift the door and align it with the hinges.
   b. Install the door-to-hinge retaining bolts, but do not tighten them.
   c. Feed the wiring through the side cowl hinge panel and reconnect at the connector. For the driver's door, feed the windscreen washer hose and wiring through the side cowl hinge panel and reconnect the T-piece and wiring connector.
   d. Close the door. It may be necessary to lift the door.
   e. Check that the gaps around the door are sufficient and straight. If necessary use wedges, eg wood or cardboard, to hold the door in position.
   f. Tighten the door-to-hinge retaining bolts from inside the vehicle (gain entry to the cab through the other door).
   g. After tightening the bolts, open and close the door and check that the operation is smooth. If the alignment of the door is incorrect and the opening/closing action is not smooth, adjust the door-lock striker plate to suit.

CAB HEATING/COOLING

Blower Assembly

162. Removal. Remove the blower assembly as follows (Figure 211):
   a. Remove the blower assembly from the cab in accordance with EMEI Vehicle G 703.
   b. Remove the screws securing the front panel to the blower housing, then remove the panel.
   c. Remove the clamps from the coolant hoses, then remove the hoses from the radiator and housing.
   d. Disconnect the electrical cables at the terminal clusters on the rear of the blower control panel. Disconnect the linkages from the two lever controls and unscrew the securing screws. Remove the control panel from the housing.
   e. Disconnect the electrical cables from the blower motor. Remove the screws securing the motor to the housing and withdraw the motor from the housing. Withdraw the radiator from the housing.
   f. Clean and inspect the housing and all components for wear or damage. Repair or replace as necessary.
163. **Installation.** The blower motor and radiator are replaced as complete units. The installation procedure is the reverse of removal.

**WINCH**

**Winch Assembly**

164. **Removal.** Remove the winch assembly as follows (Figure 212):

a. Remove the winch rope from the winch assembly in accordance with EMEI Vehicle G 703.

b. Open the drain cock on the primary reservoir and vent all air from the system.

c. Disconnect the clevis fork on the air cylinder from the actuating shaft on the winch.

d. Split the drive chain from the torque limiter to the winch by removing the chain master link. Remove the chain from the assembly.

**NOTE**

The universal joints on the propeller shafts must be phased. Before disconnecting the shafts, mark the relative positions of the universal joints to the shafts, for later installation purposes.

e. Remove the mounting bolts securing the torque limiter to the mounting bracket on the chassis. Remove the torque limiter together with the propeller shaft slip joint from the truck.

f. Remove the bolts and nuts securing the propeller shaft to the transfer box drive flange. Disconnect the shaft and move it to one side.

g. Place a trolley jack with a suitable cradle beneath the winch assembly. Raise the jack and cradle to take the weight of the winch when the retaining bolts are removed.

h. Remove the four bolts, nuts and spring washers from the ends of the winch mounting angles and remove the winch.
i. Clean the winch mounting brackets and immediately adjacent areas of the chassis and tray.

j. Clean and inspect components that are to be used when installing a replacement unit. Repair or replace components that show signs of wear or damage.

Figure 212  Winch Assembly

165. Installation. Installation of the winch assembly is the reverse of removal. Particular attention is to be paid to the following points:

a. Align the drive chain by moving the mounting bracket for the torque limiter, forwards or rearwards in line with the truck chassis until both sprockets are in the same vertical line.

b. Tension the winch drive chain so that there is approximately 12 mm (1/2 in) deflection at the centre of the chain span between the two sprockets.

c. Clean and grease the winch rope with ZX-8 grease.

d. Apply a coat of XG-291 grease to the slip joints on the propeller shafts before installation and grease the universal joints after installation.

e. Apply a film of fresh OEP-220 oil to the winch drive chain. Wipe off any excess lubricant.

f. Before winching the rope in, ensure that the winch gear case is filled with OEP-220 oil.

Winch Drum

166. Removal. Remove the winch drum as follows (Figure 213):

a. Remove the winch assembly from the truck. Drain the oil from the winch gear case.

b. Remove the six bolts retaining the front and rear mounting angles on the winch housing.

c. Remove the end-frame together with the drag brakes and springs.

d. Slide the winch drum off the shaft, then remove the thrust ring from the assembly.

e. Clean and inspect all components that are to be used during assembly. Repair or replace components that show signs of wear or damage.
Installation of the winch drum is the reverse of removal.

TRUCK VIBRATION FAULT FINDING

General Information

168. Frequently, undue time and labor are wasted trying to eliminate a vibration complaint. The attached chart (Figure 213) and stationary check can be used to indicate vibration locations without loss of time and unnecessary removal of parts.

169. The Vibration Test Flow Chart (Figure 213) is intended to be a guide for field personnel when attempting to solve a chassis vibration problem. It does not require the use of instrumentation or a chassis dynamometer and presents a step-by-step approach to be used in tracking down the sources of excitation.

170. Before any work is done, the problem must be properly defined and careful observations made while operating the truck under the conditions as outlined in the basic test. These initial observations are the basis upon which the degree of improvement will be judged.

171. It is important that the tests be repeated enough times to definitely establish to the observer whether a change in the objectionable vibration has occurred. Sometimes, due to weather and driving conditions, an apparent change in vibration may occur which is not related to the specific tests being performed. If at all possible, perform the various road tests over the same stretch of highway. It is also helpful to choose a highway with a relatively long upgrade and downgrade, as some chassis vibrations are torque sensitive.

172. It is known that trailers can affect chassis vibrations felt by the driver. Try to perform the various tests with the type of trailer and load which is normally used.

173. In rare cases, two or more components could be contributing to the vibration problem. In this case it will be necessary to repeat the test until the vibrations are reduced to an acceptable level.

Stationary Check (Engine Vibration)

174. If vibration occurs when the truck is stationary with the engine running and the transmission in neutral, and with the clutch either engaged or disengaged, check as follows:

a. Stop the engine and remove the fan belts.

b. Check the crankshaft, water pump and generator pulleys for looseness, excessive wear, damage or misalignment. Repair or replace as necessary.

c. Start the engine and check as follows:
(1) If the vibration ceases to exist, the cause is either the water pump or generator. Repair or replace as necessary.

(2) If the vibration continues and cannot be eliminated through normal engine tune-up procedures, return the truck for Heavy Grade Repair.
Figure 214  Vibration Test Flow Chart

END

Distribution List: VEH G 50.0 - Code 3 (Maint Level)
(Sponsor: CGSVSPO, MDM HVY B VEH)
(Authority: ECO - 007162)

FIG 213

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