10. **Removal**

   a. Operate the battery isolation switch so that the batteries are isolated from the vehicle.

   **CAUTION**

   **NOTE**

   The engine can be replaced as a complete unit.

   g. Loosen the hose clamp securing the engine vent hose (Fig 4(1)) to the turbocharger inlet pipe and disconnect the hose.

   **Figure 3 - Turbocharger Inlet Pipe to Turbocharger Intake - Disconnecting**

   1. Hose clamp

   **Figure 4 - Engine Vent Hose - Removal**

   h. Remove the turbocharger inlet pipe mounting bolt (Fig 5(1)) and nut and then remove the pipe.

   **Figure 5 - Turbocharger Inlet Pipe Mount and Coolant Temperature Sender Unit**

   i. Loosen the hose clamps on the flexible hose (Fig 6(1)) connected to the outlet pipe of the intercooler (Fig 6(2)).
1. Flexible hose
2. Intercooler
3. Transmission oil cooler

**Figure 6 - Intercooler and Transmission Oil Cooler Assembly**

j. Remove the alternator (refer to EMEI Veh D 393 Group 10 - Electrical).

k. Remove the radiator fan final drive belt (refer to EMEI Veh D 393 Group 1 - Engine).

l. Disconnect the coolant temperature sender unit electrical lead (Fig 5(2)) at the sender unit.

m. Remove the four M8 mounting bolts and self locking nuts securing the tension bearing housing (Fig 7(1)) to the radiator support frame and remove the housing.

n. Loosen the hose clamp and remove the heater hose (Fig 8(2)) (below the coolant expansion tank outlet pipe (Fig 8(1))) from the connector pipe on the cylinder head.

**Figure 7 - Tension Bearing Housing - Removal**

1. Tension bearing housing

**Figure 8 - Heater Hose Connection**

o. Remove the coolant expansion tank and mounting bracket (refer to EMEI Veh D 393 Group 2 - Cooling System).

p. Loosen the hose clamp (Fig 9(1)) connecting the upper coolant hose to the radiator and disconnect the hose from the radiator.

q. Loosen the hose clamp securing the lower coolant hose to the coolant pump inlet pipe (immediately behind the alternator mountings) and remove the hose from the pipe.

r. Disconnect the cold start air outlet line at the cold start reservoir.

s. Loosen the hose clamp and disconnect the fuel supply pipe (fuel tank to fuel pre-filter) from the fuel pre-filter (Fig 10(1)).
NOTE

Before cutting cable ties, note the position and number of ties, and the position of lines, pipes and leads to engine components.

Figure 10 - Fuel Line Connections

1. Fuel pre-filter
2. Fuel supply hose (fuel pre-filter to priming pump)
3. Fuel return pipe (fuel injection pump to fuel tank)

Figure 11 - Fuel Filter Connection

v. Remove the banjo bolt securing the oil feed line to the air compressor and move the line to one side. Discard the sealing washers on the banjo bolt.

w. Remove the air conditioner compressor without disconnecting the air conditioner hoses (refer to Group 17 - Air Conditioner, para 248), rotate the air conditioner compressor clear of the engine and secure it on the right hand mudguard.

x. Remove the banjo bolt (with back pressure valve) securing the fuel return pipe (fuel injection pump to fuel tank) (Fig 10(3)) to the fuel injection pump and remove the banjo bolt securing the fuel supply hose (fuel pre-filter to lift pump) (Fig 10(2)) to the lift pump. Discard the sealing washers on the banjo bolts.

y. Disconnect the fuel leak-off line union from the cylinder head connection and the engine shut-off cylinder air line and fuel leak-off line from the mounting bracket on the side of the cylinder head.

z. Disconnect the air line to the engine shut-off cylinder and the engine oil pressure sender unit electrical lead at the oil filter head.

aa. Disconnect the power steering fluid reservoir breather pipe union, from the connector on the injection pump timing case plug.

ab. Mark the position of the inner and outer cables of the speed limiter Bowden cable connection at the throttle linkage (Fig 12(1)) at the rear of the engine block.
1. Throttle linkage
2. Speed limiter inner cable clamp screw
3. Speed limiter outer cable clamp screw

Figure 12 - Speed Limiter Bowden Cable Connections

ac. Loosen the speed limiter inner cable clamp screws (Fig 12(2)) and the speed limiter outer cable clamp screw (Fig 12(3)) securing the Bowden cable at the throttle linkage and slide the cable out of the throttle linkage brackets.

ad. Remove the clamp (Fig 13 (2)) securing the compressed air delivery line to the air compressor.

ae. Undo compressed air delivery line union nut (Fig 13(1)) and disconnect the line.

ag. Position a jack under the sump guard and remove the four mounting bolts and spacers securing the sump guard to the chassis. Lower the sump guard on a jack and remove it from the vehicle.

NOTE
Do not disconnect the hydraulic fluid lines to the hydraulic steering pump.

ah. Release the tension from the power steering drive belt and remove the belt from the hydraulic steering pump pulley (refer to EMEI Veh D 393 Group 1 - Engine).

ai. Remove the self locking nut (Fig 14(1)) and retaining bolt securing the hydraulic steering pump and mounting bracket to the front engine bearer. If necessary use a soft drift and hammer to remove the retaining bolt, then remove the pump in a downward direction.

aj. Disconnect the exhaust pipe (Fig 15(4)) at the flange on the engine exhaust brake manifold, loosen the pipe clamp at the muffler and lower the exhaust pipe (refer to EMEI Veh D 393 Group 3 - Exhaust).
1. Engine exhaust brake manifold
2. Fuel filter
3. Speed limiter linkage
4. Exhaust pipe

**Figure 15 - Engine Exhaust Brake Manifold**

**ak.** Remove the engine exhaust brake manifold (Fig 15(1)), see para 31.

**al.** Disconnect the main transmission oil cooler pipes as follows:

1. Remove the 6 mm bolt and lock nut securing the transmission oil cooler pipes clamp to the support bracket on the left hand side of the front engine mount bearer.

2. Remove the 6 mm bolt and lock nut securing the transmission oil cooler pipe clamps to the mounting bracket on the left hand rear of the engine block.

**am.** Remove the two M8 bolts securing the two mounting brackets for the engine wiring loom to the left hand side of the engine block.

**an.** Cut the cable tie securing the engine wiring loom to the turbocharger oil feed line and the cable ties securing the engine wiring loom to the support bracket mounted on the left hand side of the front engine mount bearer.

**ao.** Undo the clamp (Fig 16(1)) securing the flange of the charge air duct connecting the intercooler to the turbocharger. Pull the charge air duct down and away from the turbocharger. Remove and discard the O-ring from the charge air duct.

**Figure 16 - Charge Air Duct - Connection**

**ap.** Remove the two M12 bolts securing the earth leads and strap to the underside of the starter motor intermediate flange.

**aq.** Remove the splitter transmission (refer to Group 6 – Transmission Group, para 67).

**ar.** Place a suitable container under the turbocharger, loosen the hose clamps securing the hose on the turbocharger oil return line and then remove the hose.

**NOTE**

Before cutting cable ties, note the position and number of ties and the position of lines, pipes and leads to engine components.

**as.** Remove the remaining clamps/cable ties securing the wiring loom to the left hand side of the engine and swing the loom to the left hand side of the chassis. Ensure the coolant temperature sender unit electrical lead is clear of the engine.

**at.** Remove the engine breather filter (Fig 17(1)) (refer to EMEI Veh D 393 Group 1 - Engine).

**Figure 17 - Engine Breather Filter**
USE A LIFTING DEVICE, WITH A CAPACITY GREATER THAN 500KG FIXED TO A MOBILE GANTRY.

au. Attach the lifting sling (Table 2, Item 39) to the lifting brackets on the engine (Fig 18), and using a suitable lifting device take the weight of the engine.

av. Remove the centre bolts and thrust plate from the right hand rear engine mount (Fig 19(1)). Remove the centre bolts, thrust plate and lower retaining plate from the left hand rear engine mount (Fig 19(2)).

aw. Remove the centre bolt (Fig 20(1)), washer, deflector plate and thrust washer from the front engine mount.

Figure 18 - Engine - Removal

1. Centre bolt

Figure 20 - Front Engine Mount

1. Centre bolt

WHEN REMOVING THE ENGINE FROM THE VEHICLE ENSURE THAT THE AIR COMPRESSOR AND THE FUEL INJECTION PUMP DO NOT SUSTAIN DAMAGE BY FOULING THE RIGHT HAND MUDGUARD AND SHOCK ABSORBER MOUNT.

ax. Raise the engine, while manoeuvring it clear of the chassis. Remove the engine from the vehicle and lower it to the ground ensuring that no weight is taken by the sump.

11. Disassembly

a. Remove all components and fittings from the unserviceable engine that are to be transferred to the replacement engine, including the clutch and pressure plate (refer to Group 5 - Clutch System, para 61).

12. Cleaning

ENSURE THE SAFETY REQUIREMENTS FOR USE OF COMPRESSED AIR ARE STRICTLY ADHERED TO. INADVERTANT USE OF COMPRESSED AIR EQUIPMENT MAY RESULT IN INJURY TO PERSONNEL.

a. Cap all open pipes and lines on the vehicle.

Protect electrical connectors and bare metal surfaces with preservative/tape.
b. Thoroughly clean the underside of the cab and the chassis section where the engine is located. Blow dry the cab and chassis with compressed air.

c. Seal all openings on the components and fittings, removed from the unserviceable engine and clean with an appropriate cleaning agent. Blow dry with compressed air.

13. Inspection

a. Inspect all components and fittings transferred from the unserviceable engine to the replacement engine. Repair/replace as required.

NOTE

If the replacement engine does not have an engine number refer to EMEI Vehicle A 012-2 for corrective action.

b. Inspect the engine mounts, replace as required. If replacing the clutch housing (with integral right hand rear engine mount) torque the housing mounting bolts to 110 Nm.

c. The build standard of the engine block, cylinders and pistons is indicated by letter and number codes. The letters and numbers denote:

(1) The nominal diameter of the cylinder bores;
(2) The type of cylinder (dry or wet);
(3) Any special features (e.g. oil spray nozzle insert);
(4) The engine block height;
(5) Cylinder bore identification when all cylinder bores are within the same tolerance group; and
(6) Cylinder bore identification when bores are not within the same tolerance group.

d. The letters and numbers are stamped on the engine block, refer to Figure 21.

e. Translation of the letter and number codes depicted in Figure 21 is listed in Table 4.

---

**Table 4 - Engine Block Identification Codes**

<table>
<thead>
<tr>
<th>Cylinder bore identification</th>
<th>Associated piston</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>BA</td>
</tr>
<tr>
<td>B</td>
<td>BA or BC</td>
</tr>
<tr>
<td>C</td>
<td>BC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>a Nominal diameter of cylinder bore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
</tr>
<tr>
<td>Deviation 0.3</td>
</tr>
<tr>
<td>Deviation 0.6</td>
</tr>
<tr>
<td>Deviation 0.9</td>
</tr>
</tbody>
</table>

| b With cylinder liner insert, identification: "Z" |
|                                               |
| With piston oil spray nozzle insert, identification: "K" |

<table>
<thead>
<tr>
<th>d Housing height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation stage</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>Standard</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Installation stage- 0.3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Installation stage - 0.6</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Installation stage - 0.9</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

| E Cylinder bore identification "A", "B" or "C" (when all cylinder bores are within the same tolerance group). |

| f Cylinder bore identification "A", "B" or "C" (with different tolerances the specification is for each cylinder individually). |

<table>
<thead>
<tr>
<th>Cylinder bore identification</th>
<th>Associated piston</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>BA</td>
</tr>
<tr>
<td>B</td>
<td>BA or BC</td>
</tr>
<tr>
<td>C</td>
<td>BC</td>
</tr>
</tbody>
</table>
14. **Reassembly**
   a. Attach the components and fittings that were removed from the unserviceable engine to the replacement engine, including the clutch and pressure plate (refer to Group 5 - Clutch System, para 63).

15. **Installation**

   **WARNING**

   USE A BLOCK AND TACKLE, WITH A CAPACITY GREATER THAN 500KG, FIXED TO A MOBILE GANTRY.

   **NOTE**

   Before installing the replacement engine in the vehicle, ensure that all components are thoroughly cleaned, correctly located and secured to the crankcase and mounting brackets of the replacement engine.

   a. Attach the lifting sling (Table 2, Item 39) to the lifting brackets on the engine (Fig 18) and using a suitable lifting device take the weight of the engine.

   **CAUTION**

   WHEN INSTALLING THE ENGINE IN THE VEHICLE ENSURE THAT THE AIR COMPRESSOR AND THE FUEL INJECTION PUMP DO NOT SUSTAIN DAMAGE BY FOULING THE RIGHT HAND MUDGUARD AND SHOCK ABSORBER MOUNT.

   b. Manoeuvre the engine into the chassis and lower it onto the engine mounts.

   c. Install the lower retaining plate, thrust plate, and centre bolts for the left hand rear engine mount (Fig 19(2)). Torque the bolts to 140 ± 20 Nm.

   d. Install the thrust plate and centre bolts for the right hand rear engine mount (Fig 19(1)). Torque the bolts to 140 ± 20 Nm.

   e. Install the thrust washer, deflector plate and centre bolt (Fig 20(1)) for the front engine mount. Torque the bolt to 140 ± 20 Nm.

   f. Remove the lifting sling, and install the engine breather filter (Fig 17(1)) (refer to EMEI Veh D 393 Group 1 - Engine).

   **NOTE**

   Ensure that all cable ties (noted on removal) are replaced. As a rule of thumb cable ties must fasten wiring looms and air lines at intervals of 500 mm but may be fitted at shorter intervals when required.

   h. Position the wiring loom on the left hand side of the engine and secure with the clamps and cable ties disconnected on removal. Feed the coolant temperature sender unit electrical lead into position on the engine and connect it to the sender unit.

   i. Slide the hose onto the turbocharger oil return line and secure with the two hose clamps.

   j. Fit the earth leads and strap to the underside of the starter motor intermediate flange and secure with the two M12 bolts.

   k. Connect the electrical cables to the starter motor (refer to EMEI Veh D 393 Group 10 - Electrical).

   l. Install the alternator (refer to EMEI Veh D 393 Group 10 - Electrical).

   m. Connect the charge air duct to the turbocharger with the clamp (Fig 16(1)). Fit a new sealing O-ring.

   n. Secure the engine wiring loom brackets to the left hand side of the engine block with the two M8 bolts. Secure the engine wiring loom to the turbocharger oil feed line with a cable tie.

   o. Secure the engine wiring loom to the support bracket, mounted on the left hand side of the front engine mount bearer, with the cable ties.

   p. Install and tighten the 6 mm bolts and lock nuts securing:

      (1) The transmission oil cooler pipe clamps to the mounting bracket mounted on the left hand rear of the engine block; and

      (2) The transmission oil cooler pipes clamp to the support bracket mounted on the left hand side of the front engine mount bearer.

   q. Install the engine exhaust brake manifold (Fig 15(1)), see para 33.

   r. Connect the exhaust pipe (Fig 15(4)) to the flange on the engine exhaust brake manifold, and tighten the exhaust pipe clamp at the muffler (refer to EMEI Veh D 393 Group 3 - Exhaust).
s. Connect the hydraulic steering pump as follows:

1. Position the hydraulic steering pump against the engine front bearer so that the mounting bolt holes are aligned and install and hand tighten the retaining bolt and self locking nut (Fig 14(1)).

2. Adjust the power steering drive belt (refer to EMEI Veh D 393 Group 1 - Engine), and torque the retaining bolt to 200 Nm.

t. Connect the compressed air delivery line as follows:

1. Connect the front portion of the compressed air delivery line to the air compressor with the union nut (Fig 22(1)).

2. Connect the front portion of the compressed air delivery line to the rear portion of the compressed air delivery line at the joiner immediately behind the splitter transmission. Fit a new thrust washer and sealing ring prior to connection.

3. Secure the compressed air delivery line mounting bracket to the splitter transmission housing.

4. Secure the delivery line with the clamp (Fig 22(2)) at the air compressor.

u. Slide the inner and outer cables of the speed limiter Bowden cable into the throttle linkage brackets and secure the cables with the clamp screws (Fig 12(2) and (3)) in the positions marked on removal.

v. Connect the power steering fluid reservoir breather pipe union to the connector on the injection pump timing case plug.

w. Connect the electrical lead for the engine oil pressure sender unit to the oil filter head.

x. Connect the air line to the engine shut-off cylinder.

y. Connect the fuel supply hose (pre-filter to lift pump) (Fig 22(3)) to the fuel priming pump and connect the fuel return line (Fig 22(4)) to the fuel injection pump with the banjo bolt (with back pressure valve). Renew the sealing washers on the banjo bolts prior to installation.

z. Install the air conditioner compressor (refer to Group 17 - Air Conditioner, para 249) and the air compressor drive belt (refer to EMEI Veh D 393 Group 1 - Engine).

aa. Connect the oil feed line to the air compressor. Renew the sealing washers on the banjo bolt prior to installation.

ab. Connect the fuel supply pipe (fuel injection pump to fuel filter) at the fuel filter. Renew the sealing washers on the banjo bolt prior to installation.

NOTE

Ensure that all cable ties (noted on removal) are replaced. As a rule of thumb, cable ties must fasten wiring looms and air lines at intervals of 500 mm but may be fitted at shorter intervals when required.

ac. Clamp or cable tie the electrical leads and, fuel, air compressor and air conditioner hoses to the right hand side of the engine and to the engine mount.

ad. Connect the fuel supply pipe (fuel tank to fuel pre-filter) to the fuel pre-filter and secure with the hose clamp.

ae. Connect the cold start air outlet pipe to the cold start reservoir.

af. Connect the fuel leak-off line to the cylinder head connector and cable tie the engine shut-off cylinder air line and the fuel leak-off line to the bracket on the cylinder head.

ag. Fit the lower coolant hose to the coolant pump inlet pipe (immediately behind the alternator mountings) and secure with the hose clamp.

ah. Connect the upper coolant hose to the radiator and secure with the hose clamp (Fig 23(1)).
1. Upper coolant hose clamp
2. Radiator vent hose clamp
3. Flexible hose

Figure 23 - Coolant Pipe and Charge Air Duct Connections

ai. Connect the heater hose (Fig 24(2)) (below the coolant expansion tank outlet pipe (Fig 24(1))) to the connector pipe on the cylinder head and secure with the hose clamp.

aj. Install the coolant expansion tank and mounting bracket (refer to EMEI Veh D 393 Group 2 - Cooling System).

ak. Connect the turbocharger inlet pipe as follows:

(1) Position the turbocharger inlet pipe in its mounted position and connect the lower end of the turbocharger inlet pipe to the turbocharger intake hose. Do not tighten the hose clamp (Fig 25(1)) at this stage.

1. Hose clamp

Figure 25 - Turbocharger Inlet Pipe to Turbocharger Intake - Connecting

(2) Secure the turbocharger inlet pipe to engine with the mounting bolt (Fig 26(1)) and nut.

1. Turbocharger inlet pipe mounting bolt
2. Coolant temperature sender unit lead

Figure 26 - Turbocharger Inlet Pipe Mount and Coolant Temperature Sender Unit

(3) Tighten the hose clamp (Fig 25(1)) securing the lower end of the turbocharger inlet pipe to the turbocharger intake hose securely.

(4) Slide the engine vent hose (Fig 27(1)) onto the fitting on the turbocharger inlet pipe and secure with the hose clamp.

TO PREVENT DAMAGE TO THE TURBOCHARGER AIR INLET AND, THE RADIATOR DURING OPERATION, ENSURE THAT A MINIMUM CLEARANCE OF 7 MM EXISTS BETWEEN THE TURBOCHARGER AIR INLET PIPE AND THE RADIATOR.
1. Engine vent hose

**Figure 27 - Engine Vent Hose - Installation**

**al.** Mount the radiator fan final drive tension bearing housing (Fig 28(1)) on the radiator support frame and secure with the four M8 mounting bolts and self locking nuts. Check that the tension bearing housing pulley is aligned with the crankshaft drive belt pulley, and that a minimum clearance of 7 mm exists between the turbocharger air inlet pipe and the radiator. Adjust the fan bracket strut length if required (refer to EMEI Veh D 393 Group 2 - Cooling).

**an.** Connect the flexible hose (Fig 29(1)) between the outlet pipe of the intercooler (Fig 29(2)) and the charge air duct to the inlet manifold and secure with the hose clamps.

**Figure 28 - Tension Bearing Housing - Installation**

**am.** Install the fan intermediate drive belt and the radiator fan final drive belt and adjust (refer to EMEI Veh D 393 Group 1 - Engine).

**Figure 29 - Intercooler and Transmission Oil Cooler Assembly**

**ao.** Close the drain tap at the bottom of the radiator, fill the engine cooling system with coolant and pressure test the system (refer to EMEI Veh D 393 Group 2 - Cooling System).

**ap.** Check the engine and power steering fluid reservoir oil levels, top-up if required.

**aq.** Prime the fuel system. **DO NOT** start the engine (refer to EMEI Veh D 393 Group 4 - Fuel System).

**ar.** Operate the battery isolation switch so that the batteries are connected to the vehicle.

---

**CAUTION**

**DO NOT OPERATE THE STARTER MOTOR FOR LONGER THAN 20 SECONDS AT A TIME. CONTINUOUS CRANKING EXCEEDING 20 SECONDS WILL DAMAGE THE STARTER MOTOR. ALLOW THE STARTER MOTOR TO COOL BETWEEN CRANKING PERIODS.**
DO NOT ALLOW THE ENGINE TO START UNTIL OIL PRESSURE IS INDICATED. SEVERE DAMAGE TO THE TURBOCHARGER AND ENGINE CAN RESULT FROM LACK OF LUBRICATION.

as. Lock the throttle linkage in the no fuel position. Without touching the accelerator, turn the engine over using the starter motor until oil pressure is indicated on the oil pressure gauge.

THE ENGINE WILL NOT SHUT DOWN IF THE ALTERNATOR IS NOT ENERGISED OR IF THERE IS NO AIR IN THE SYSTEM. THE ENGINE CAN BE SHUT DOWN MANUALLY IF REQUIRED BY PUSHING THE FUEL INJECTION PUMP STOP LEVER (FIG 30(2)) FORWARDS TO THE STOP POSITION.

WHEN THE ENGINE IS RUN WITH THE CABIN RAISED, ENSURE THAT THE ENGINE AIR INTAKE HOSE AND THE AIR COMPRESSOR INTAKE HOSE IS CONNECTED TO THE AIR CLEANER TO PREVENT THE INGRESS OF CONTAMINANTS.

WHEN THE ENGINE IS RUN WITH THE CABIN RAISED ENSURE THE HEATER HOSES AND UPPER STEERING SHAFT ARE CLEAR OF MOVING PARTS TO PREVENT DAMAGE TO COMPONENTS.

at. Turn the heater control slide to maximum heat, start and briefly run the engine at idle speed and check the following:

(1) Observe the oil pressure indicator, after 10 seconds oil pressure must be indicated.

(2) Check for leaks and/or unusual noises and check the power steering fluid reservoir oil level whilst the engine is running (refer to the Operator Handbook).

(3) Check that the alternator charge light is extinguished and check the function of the engine shut-off cylinder.

au. Restart and run the engine until normal operating temperature is reached. Stop the engine and check the engine oil and the coolant levels, top up as necessary.

av. Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

aw. Check the function of the positive stop mechanism (Fig 30(1)), the adjustment of the throttle linkage and engine idle speed (refer to EMEI Veh D 393 Group 4 - Fuel System).

GOVERNMENT LEGISLATION PROHIBITS UNAUTHORISED REPAIRS AND ADJUSTMENT TO SPEED LIMITERS. REPAIRS AND ADJUSTMENTS ARE ONLY TO BE CARRIED OUT BY AN AUTHORISED AND ACCREDITED REPAIRER USING SPECIALISED TEST EQUIPMENT.
NOTE

Refer to Chapter 2, Section 1 of the Operator Handbook for running-in procedures for a new engine.

ax. Road test the vehicle and check the operation of the speed limiter. Inspect for leaks after the road test, rectify as required.

**WARNING**

**SUPPORT THE SUMP GUARD WITH A JACK PRIOR TO FITTING THE SUMP GUARD MOUNTING BOLTS TO PREVENT THE GUARD FROM DROPPING IN AN UNCONTROLLED MANNER AND INJURING PERSONNEL.**

ay. With the aid of a jack fit the sump guard and spacers to the chassis and secure with the four mounting bolts.

**Engine Flywheel and Ring Gear**

**NOTE**

The flywheel and ring gear assembly can be removed and installed with the engine fitted in the vehicle.

16. **Removal**

a. Remove the splitter transmission (refer to Group 6 – Transmission Group, para 67).

b. Remove the pressure plate and the clutch plate (refer to Group 5 - Clutch System, para 61).

c. Scribe an alignment mark (Fig 31(2)) on the flywheel and crankshaft flange.

d. Remove the eight M12 waisted flywheel mounting bolts (Fig 31(1)) holding the flywheel assembly to the flange on the crankshaft.

**NOTE**

If difficulty is experienced in removing the flywheel, remove the starter motor (refer to EMEI Veh D 393 Group 10 - Electrical System) and use a hammer and soft drift to drive the assembly off the crankshaft.

e. Screw two M8 bolts (about 100 mm long) into the flywheel to provide a grip and pull the assembly off the crankshaft.

17. **Cleaning**

**WARNING**

ENSURE THE SAFETY REQUIREMENTS FOR USE OF COMPRESSED AIR ARE STRICTLY ADHERED TO. INADVERTANT USE OF COMPRESSED AIR EQUIPMENT MAY RESULT IN INJURY TO PERSONNEL.

a. Wash the parts in an appropriate cleaning agent and blow dry with compressed air.

18. **Inspection**

a. Inspect the flywheel surface for cracks, scorched marks, or irregularities. The flywheel may be repaired by surface grinding or turning in a lathe provided the permissible allowance is not exceeded (refer to Table 5 and Figure 32).

**Table 5 - Flywheel Inspection**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between the clutch face and the flywheel mounting flange</td>
<td>d: 38.100 to 37.900 mm</td>
</tr>
<tr>
<td>Permissible material removal at the clutch face</td>
<td>Note 1: 1.0 mm</td>
</tr>
<tr>
<td>Overall width of the flywheel</td>
<td>a: 51.5 mm</td>
</tr>
<tr>
<td>Waisted bolts elongation</td>
<td>max 26.3 mm</td>
</tr>
</tbody>
</table>

**Note 1.** The mounting surface of the clutch pressure plate at the flywheel must be remachined in correspondence with the material removal at the clutch face of the flywheel.
b. Inspect the ring gear for damage, repair as required, see para 19.

c. Inspect the waisted flywheel mounting bolts for elongation (max length 26.3 mm) (Fig 33). Replace with new bolts if necessary.

19. Repair

a. Uniformly heat the ring gear until it can be removed from the flywheel using a hammer and soft drift; discard the ring gear.

b. Allow the flywheel to air cool to ambient temperature then clean the flywheel.

c. Heat the new ring gear to between 250°C and 280°C and fit it onto the flywheel (Fig 34).

NOTE

Ensure that the ring gear is fully home all the way around the circumference of the flywheel.

d. Ensure that the ring gear does not warp during the fitting process and allow the assembly to air cool to ambient temperature.

20. Installation

TO PREVENT THE CLUTCH FROM SLIPPING KEEP THE CLUTCH PLATE BEARING FACE CLEAR OF ANY LUBRICANT.

a. Coat the flywheel ring gear teeth with a long-life lubricant (Lubricant, Dry Film; Molybdenum Disulphide).

b. Screw two M8 bolts (about 100 mm long) into the flywheel to provide a grip, align the scribe marks drawn before removal and fit the assembly to the crankshaft.

c. Install the eight flywheel mounting bolts, and tighten the bolts in a crosswise fashion to an initial torque of 40 Nm and then tighten another 90°-110° (Fig 35).
Figure 35 - Flywheel Mounting Bolts - Tensioning

d. Attach a dial gauge, slowly turn the engine over by hand and check the vertical and lateral run-out of the flywheel. The maximum permissible run out is 0.1 mm, repair/replace as required.

e. Install the clutch plate and the pressure plate (refer to Group 5 - Clutch System, para 63).

f. Install the splitter transmission (refer to Group 6 – Transmission Group, para 69).

g. Bleed the clutch (refer to EMEI Veh D 393 Group 5 - Clutch System).

h. Road test the vehicle, inspect for leaks and test the performance of the clutch.

Oil Pump Assembly

NOTE

The oil pump can be replaced or repaired with the engine fitted in the vehicle.

21. Removal

a. Remove the engine sump (refer to EMEI Veh D 393 Group 1 - Engine).

b. Remove the three M8 bolts (Fig 36(2)) securing the oil pump to the crankcase and remove the oil pump from the engine.

c. Remove the two M8 bolts securing the oil feed pipe and strainer to the oil pump. Discard the gasket.
22. Cleaning and Inspection

a. Clean the mating surfaces on the crankcase, the oil pump strainer and the oil feed pipe assembly. Ensure that all gasket residue is removed from the crankcase and oil pump sealing surfaces.

b. Clean and inspect the oil pump housing. Replace the oil pump if it is damaged or worn beyond the tolerances listed in Table 6.

c. Remove the pressure relief valve screw plug (Fig 36(4)) from the oil pump housing.

d. Remove the compression spring and piston from the oil pump housing.

e. Clean all parts of the oil pump pressure relief valve in an appropriate cleaning agent and inspect (refer to Table 8). Replace worn or damaged parts.

f. Inspect all the parts removed with the oil pump. Replace any parts that are damaged or worn.

g. Install the pressure relief valve piston and compression spring into the oil pump. Coat the pressure relief valve screw plug with a thread locking agent (Loctite 243) and install the plug. Torque the screw plug to 20 Nm.

23. Installation

a. Lightly lubricate a new gasket with grease (XG-274) and attach it to the mating surface of the oil feed pipe. Fit the oil feed pipe and strainer to the oil pump and secure with the two M8 bolts. Torque the bolts to 35 Nm.

b. Prime the pump with engine oil (OMD-115).

c. Fit the oil pump to the crankcase and secure with the three M8 bolts (Fig 36(2)). Torque the bolts to 35 Nm.

d. Install the engine sump and sump guard (refer to EMEI Veh D 393 Group 1 - Engine).

e. Fill the engine with oil (OMD-115) (refer to Operator Handbook).

24. Testing

a. Run the engine and attain normal operating temperature.

b. Remove the engine oil pressure sender unit (refer to EMEI Veh D 393 Group 10 - Electrical).

NOTE

Ensure the master gauge connection at the oil filter head is tight and does not leak.

c. Connect a master gauge to the oil pressure sender unit orifice in the oil filter head.

d. Run the engine and when the engine has reached operating temperature, compare the readings with the specifications listed in Table 7. Repair/replace as required.

e. Remove the master gauge and install the engine oil pressure sender unit (refer to EMEI Veh D 393 Group 10 - Electrical).
## Table 6 - Tolerances - Oil Pump Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore in the oil pump housing for the drive shaft</td>
<td>17.000 mm minimum</td>
</tr>
<tr>
<td></td>
<td>17.018 mm maximum</td>
</tr>
<tr>
<td>Diameter of the drive shaft - dimension A</td>
<td>16.976 mm minimum</td>
</tr>
<tr>
<td></td>
<td>16.984 mm maximum</td>
</tr>
<tr>
<td>Diameter of the idle shaft - dimension B</td>
<td>15.028 mm minimum</td>
</tr>
<tr>
<td></td>
<td>15.039 mm maximum</td>
</tr>
<tr>
<td>Permissible clearance between the helical drive gear and upper edge of pump casing with the drive gear resting on the upper edge of the pump casing - dimension D</td>
<td>0.5 ± 0.2 mm</td>
</tr>
<tr>
<td>Radial play of the drive shaft</td>
<td>0.016 mm to 0.042 mm</td>
</tr>
<tr>
<td>Radial play between oil pump gear and oil pump shaft</td>
<td>0.011 mm to 0.040 mm</td>
</tr>
<tr>
<td>Overlap between oil pump shaft and housing</td>
<td>0.010 mm to 0.039 mm</td>
</tr>
<tr>
<td>Radial clearance between the oil pump gears and the oil pump housing</td>
<td>0.030 mm to 0.105 mm</td>
</tr>
<tr>
<td>Axial play between oil pump gears and housing cover</td>
<td>0.025 mm to 0.089 mm</td>
</tr>
<tr>
<td>Backlash of oil pump gears</td>
<td>0.15 mm to 0.25 mm</td>
</tr>
<tr>
<td>Backlash of oil pump drive gears (helical gears)</td>
<td>0.096 mm to 0.128 mm</td>
</tr>
<tr>
<td>Height of oil pump gears</td>
<td>49.936 mm to 49.975 mm</td>
</tr>
<tr>
<td>Height of gear housing - dimension F</td>
<td>50.0 ± 0.25 mm</td>
</tr>
<tr>
<td>Installed height of oil pump idler shaft - dimension C</td>
<td>48.0 ± 0.5 mm</td>
</tr>
<tr>
<td>Clearance of the oil pump drive shaft (installed) - dimension E</td>
<td>7.5 mm ± 0.3 mm</td>
</tr>
<tr>
<td>End float of the drive shaft</td>
<td>0.04 mm</td>
</tr>
</tbody>
</table>

### Figure 38 - Oil Pump Component Clearances
Table 7 - Oil Pump Test Specifications

<table>
<thead>
<tr>
<th>Description</th>
<th>RPM</th>
<th>l/min</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery, measured with SAE 10 oil, at 50°C oil temperature, 4 bar back pressure</td>
<td>300 RPM</td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>1400 RPM</td>
<td></td>
<td>58.0</td>
</tr>
<tr>
<td>Opening pressure of relief valve</td>
<td>bar</td>
<td></td>
<td>5.2 ± 0.5</td>
</tr>
<tr>
<td>Oil pressure gauge reading for new engine (at operating temperature)</td>
<td>idling at about 700 RPM</td>
<td>bar</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>at max. speed</td>
<td>bar</td>
<td>5</td>
</tr>
<tr>
<td>Minimum allowable oil pressure gauge reading for used engine (at operating temperature)</td>
<td>idling at about 700 RPM</td>
<td>bar</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>at max. speed</td>
<td>bar</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 8 - Pressure Relief Valve (Oil Pump) - Spring Dimensions

<table>
<thead>
<tr>
<th>Serial</th>
<th>Designation</th>
<th>Dimension (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outside diameter of the spring</td>
<td>9.3</td>
</tr>
<tr>
<td>2</td>
<td>Diameter of the wire gauge</td>
<td>1.7</td>
</tr>
<tr>
<td>3</td>
<td>Unladen length of the spring</td>
<td>49.4</td>
</tr>
<tr>
<td>4</td>
<td>Length of the spring tested under an initial loading of 43.9 Newtons</td>
<td>45.4</td>
</tr>
<tr>
<td>5</td>
<td>Length of the spring tested under a final loading of 145 Newtons</td>
<td>36.2</td>
</tr>
</tbody>
</table>

Table 9 - Oil Pump - Torque Specifications

<table>
<thead>
<tr>
<th>Designation</th>
<th>Thread</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil pump to crankcase</td>
<td>M8</td>
<td>35</td>
</tr>
<tr>
<td>Cover to oil pump</td>
<td>M8</td>
<td>35</td>
</tr>
<tr>
<td>Strainer to oil pump cover</td>
<td>M8</td>
<td>35</td>
</tr>
<tr>
<td>Pressure relief valve screw plug (with Loctite 241)</td>
<td>M24</td>
<td>20</td>
</tr>
</tbody>
</table>
Cylinder Head

NOTE

The cylinder head can be replaced with the engine fitted in the vehicle.

25. Removal

THE ENGINE MUST BE COLD BEFORE THE CYLINDER HEAD IS REMOVED.

a. Raise and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

b. Operate the battery isolation switch so that the batteries are isolated from the vehicle.

c. Clean the engine around the cylinder head thoroughly.

d. Drain the engine coolant into a suitable clean container. Retain the coolant for re-use (refer to EMEI Veh D 393 Group 2 - Cooling System).

e. Remove the coolant expansion tank and the expansion tank mounting bracket (refer to EMEI Veh D 393 Group 2 - Cooling System).

f. Disconnect the coolant temperature sender unit electrical lead to the sender unit.

g. Remove the fan intermediate drive belt, the coolant pump/alternator drive belt and the air-conditioner compressor drive belt (refer to EMEI Vehicle D 393 Group 1 - Engine).

h. Remove the M8 nut, bolt and washer securing the turbocharger inlet hose.

i. Loosen the hose clamp securing the engine vent hose to the turbocharger inlet hose and remove the hose.

j. Disconnect the clamp securing the turbocharger air intake hose to the turbocharger and remove the hose.

k. Disconnect the upper coolant hose, the thermostat vent hose, and the compressor coolant line from the thermostat housing.

l. Remove the three thermostat mounting bolts (Fig 39(1)), mounting bracket and spacers and then remove the thermostat housing up and away from the cylinder head and the connecting pipe to the coolant pump.

m. Remove the thermostat connecting pipe and two sealing rings from the coolant pump. Discard the sealing rings.

n. Disconnect the banjo bolt securing the smoke limiter sensing line to the inlet manifold. Discard the sealing washers.

NOTE

Before removing cylinder head cover ensure the area around the cover is clean to prevent foreign material entering the engine.

o. Remove the cylinder head cover (refer to EMEI Veh D 393 Group 1 - Engine).

p. Disconnect the leak-off line from the cylinder head. Discard the sealing washers on the banjo bolt.

q. Remove the bracket holding the leak-off line and the smoke limiter sensing line to the cylinder head.

r. Remove the two vertical M12 bolts securing the fuel filter mounting bracket to the air conditioner compressor main mounting bracket.

s. Undo the fuel injection pipe cap nuts at the fuel injection pump using the injector cap nut wrench (Table 2, Item 1) and disconnect the pipes from the pump. Cap all open connections.
DO NOT DISCONNECT THE HOSES FROM THE AIR CONDITIONER COMPRESSOR. THE HOSES AND COMPONENTS OF THE AIR CONDITIONING SYSTEM ARE UNDER HIGH PRESSURE AND SERIOUS INJURY CAN OCCUR IF THE SYSTEM IS OPENED WITHOUT FOLLOWING CORRECT PROCEDURES.

- Remove the air conditioner compressor drive belt (refer to EMEI Veh D 393 Group 1 - Engine).
- Remove the air conditioner compressor adjusting bolt on the upper mounting bracket.
- Disconnect the cold start air outlet pipe at the cold start reservoir.
- Remove the two self locking nuts and the two bolts securing the air conditioner compressor lower mounting brackets to the air conditioner compressor main mounting bracket. Move the air conditioner compressor and fuel filter with associated hoses, lines, leads and fittings clear of the engine. Tie up the compressor to prevent damage to hoses and fittings.
- Remove the inlet manifold (refer to EMEI Veh D 393 Group 1 - Engine).
- Remove the engine exhaust manifold with turbocharger (refer to EMEI Veh D 393 Group 1 - Engine).

**NOTE**

Take careful note of the position of the two nipples on the nipple assembly between the rocker shafts for installation purposes (Fig 40).

**Figure 40 - Rocker Shaft Nipple Assembly**

**Figure 41 - Nipple Assembly - Removal**
aa. Remove the rocker shaft mounting bolts (Fig 42(1)) securing the rocker shaft assemblies to the cylinder head and remove the assemblies from the cylinder head. Note the position of the rocker shaft mounting bolts that accept the rocker cover securing bolts.

Figure 42 - Rocker Shaft

TO AVOID DISPLACING THE CAM FOLLOWERS LOOSEN THE PUSH RODS WITH SHORT, SHARP SIDEWAYS MOVEMENTS PRIOR TO WITHDRAWAL.

ab. Withdraw the push rods from the push rod tunnels with care.

ac. Remove the cylinder head bolts in the reverse sequence to tightening (Fig 43).

Figure 43 - Cylinder Head Bolts - Tightening Sequence

ad. Screw the lifting handles (Table 2, Item 2) into the cylinder head, lift the head from the engine block (Fig 44) and place the cylinder head on a suitable support. Discard the cylinder head gasket.

Figure 44 - Cylinder Head - Removal

26. Disassembly

a. Remove the injector leak-off pipe, injection pipes and gland nuts (refer to EMEI Veh D 393 Group 4 - Fuel System).

NOTE

The six injector nozzle sealing washers may adhere to the injectors or to the injector sleeves in the cylinder head.

NOTE

The nozzle holder sealing washer determines the distance (1.8 mm to 2.5 mm) that the nozzle projects over the lower edge of the cylinder head. The washers are supplied in two thicknesses (1.0 mm and 1.5 mm). Ensure that the thickness of the old sealing washer is determined before the washer is discarded.

b. Remove the injectors and protective sleeves from the cylinder head (refer to Group 5 - Fuel System, para 52).

c. Remove the springs and rocker arms from the rocker arm shaft. Note the position of the rocker arms and the rocker posts to assist on reassembly.

d. Remove the rear engine lifting bracket from the cylinder head.

e. Remove the air conditioning compressor main mounting bracket and the front engine lifting bracket from the cylinder head.

f. Remove the two bolts securing the heater inlet pipe to the cylinder head and remove the pipe and gasket. Discard the gasket.
27. Cleaning

**WARNING**

ENSURE THE SAFETY REQUIREMENTS FOR USE OF COMPRESSED AIR ARE STRICTLY ADHERED TO. INADVERTANT USE OF COMPRESSED AIR EQUIPMENT MAY RESULT IN INJURY TO PERSONNEL.

a. Wash the removed and disassembled parts in an appropriate cleaning agent and blow dry with compressed air. Clean the mating surfaces of the cylinder head, engine block and disassembled parts. Ensure that all gasket residues are removed.

b. Clean off all oil carbon residues from the cylinder head.

c. Use compressed air to blow dirt, gasket flakes, oil and water from the bolt holes and cylinders of the engine block. Ensure all blind holes in the block are free of dirt, oil and water residue.

d. Use compressed air to ensure the oil galleries in the engine block, cylinder head, rockers, rocker shafts and rocker posts are clear.

e. Wipe the cylinder walls and the mating surface of the engine block with a lightly oiled clean cloth.

28. Inspection

**CAUTION**

THE MAXIMUM PERMISSABLE DISTORTION LIMITS OF THE CYLINDER HEAD ARE:

OVER A LENGTH OF 150 MM = 0.04 MM
ENTIRE LENGTH = 0.15 MM.

a. Inspect the cylinder head surface for distortion using a straight edge and feeler gauge (Fig 45). If the distortion exceeds 0.04 mm over a length of 150 mm and/or 0.15 mm over the entire length, replace the cylinder head.

b. Inspect the cylinder head cover mating surface for distortion. If the distortion exceeds 0.3 mm, replace the cylinder head cover.

**WARNING**

ENSURE THE SAFETY REQUIREMENTS FOR USE OF COMPRESSED AIR ARE STRICTLY ADHERED TO. INADVERTANT USE OF COMPRESSED AIR EQUIPMENT MAY RESULT IN INJURY TO PERSONNEL.

c. Check the condition of all bolts and studs; clean the threads with an appropriate die and replace any bolt or stud found to be bent or damaged. Run an appropriate tap into all threaded holes and dress the threads. Clean the swarf from the holes with compressed air.

d. Inspect the expansion plugs for serviceability. To replace a plug, pierce the plug with a sharp instrument and then prise the plug out. Install new plugs using sealant and ensure they are correctly seated.

**NOTE**

When renewing the cylinder head bolts only install twelve point headed bolts.

e. Inspect the waisted cylinder head mounting bolts for elongation (twelve point headed, max length 113 mm) (Fig 46). Replace with new twelve point bolts if the bolts are not within specifications or are the superseded type.
f. Inspect the push rod ball and socket for wear.

NOTE
Worn or bent push rods tend to vibrate and therefore may produce incorrect diagnoses.

g. Check the push rods for runout (Fig 47). The maximum runout tolerance is 0.2 mm.

Figure 47 - Push Rod - Inspection for Runout

h. Inspect the rocker shafts for wear. Replace any shaft which has worn rocker bush surfaces.

i. Check the plugs at the end of the rocker shafts for leaks (Fig 48(1)).

Figure 48 - Rocker Shaft - Inspection

j. Inspect the rocker arm bushes and tappet adjusting screw ball joints for wear. Replace worn adjusting screws as required. Replace the rocker arms if worn.

k. Inspect the connecting nipples, O-ring and springs (Fig 49), replace as required.

Figure 49 - Connecting Nipples, O-ring and Springs

29. Reassembly

NOTE
Install rocker arms to the positions identified during removal.

a. Install the rocker arm posts, the rocker arms and the springs on the rocker shaft and secure with the countersunk screws (Fig 50(1)) and the outer spring clip (Fig 50(2)). Torque the screws to 5 Nm.

Figure 50 - Rocker Shaft

1. Countersunk screw
2. Spring clip

TO PREVENT DAMAGE TO INJECTOR NOZZLES ENSURE THAT WHEN FITTING NEW INJECTOR NOZZLE SEALING WASHERS THE INJECTOR NOZZLE PROJECTION DISTANCE IS CORRECT (REFER TO GROUP 4 - FUEL SYSTEM, PARA 54).

NOTE
Replace the injector protective sleeve sealing rings.
b. Install the injector protective sleeve and the injector nozzle (refer to Group 4 - Fuel System, para 54).

c. Coat the threads of the leak-off pipe gland nut (Fig 51(2)) with a sealing compound (Loctite 221) and install the nut. Torque the nut to 10 Nm.

d. Install the leak-off line to the injectors. Use new sealing washers on the banjo bolts (Fig 51(1)) (refer to EMEI Veh D 393 Group 4 - Fuel System).

e. Install the heater inlet pipe, fitted with a new gasket, to the cylinder head and secure with the two bolts.

f. Install the air conditioner compressor main mounting bracket and the front engine lifting bracket on the cylinder head and tighten the mounting bolts securely.

g. Install the rear engine lifting bracket on the cylinder head and tighten the mounting bolts securely.

h. Install the injection pipes and gland nuts on the cylinder head. Fit new rubber grommets to gland nuts (refer to EMEI Veh D 393 Group 4 - Fuel System).

30. Installation

a. Position a new cylinder head gasket on the engine block with the inscription OBEN (Top) on the gasket facing up.

DO NOT DAMAGE THE INJECTION NOZZLES OR THE INJECTION LINES WHILST FITTING THE CYLINDER HEAD.

b. Fit the cylinder head to the engine block with the aid of the lifting handles (Table 2, Item 2), noting the position of the locating dowel (Fig 52(1)).

THE CYLINDER HEAD BOLTS ARE ONLY TO BE TIGHTENED IN THE SEQUENCE SHOWN IN FIGURE 53.

NOTE

If a torque value is exceeded with a cylinder head bolt, remove the bolt, check elongation (Fig 46), install and retorque the bolt commencing at tightening stage 1.

c. Lightly lubricate the cylinder head bolts with engine oil (OMD-115), fit the bolts and tighten in four stages in the sequence shown in Figure 53:

(1) 1st tightening stage - 60 Nm.

(2) 2nd tightening stage - 90 Nm.

(3) 3rd tightening stage - 120 Nm to 130 Nm.

(4) 4th tightening stage - 90° to 100° tightening angle.
CAUTION

RETORQUING OF THE CYLINDER HEAD BOLTS IS NOT PERMITTED.

NOTE

Affix the information decal (Fig 54) to the cylinder head cover if not already fitted.

Figure 54 - Cylinder Head Tightening - Information Decal

d. Lubricate the both ends of the push rods with engine oil (OMD-115) and install the push rods in the push rod tunnels. Ensure that the push rods bed home in the cam followers.

NOTE

Lubricate the rocker assemblies with engine oil (OMD-115) prior to installation.


e. Position the rocker shaft assemblies on the cylinder head so that the rocker shaft support with the oil drilling aligns with the oil drilling in the cylinder head. Ensure that the ball-head of the tappet adjusting screws fit exactly into the cupped heads of the push rods.

NOTE

Install the rocker shaft mounting bolts (as noted on removal) so the bolts with the elongated boss (Fig 55(2)) can accept the cylinder head cover securing bolts.

f. Install the rocker shaft mounting bolts (Fig 55(2)) that secure the rocker shaft assemblies to the cylinder head. Back off the tappet adjusting screws (Fig 55(1)) so there is no tension on the push rods, and torque the retaining bolts to 110Nm.

h. Adjust the valve clearances:

(1) Inlet valves - 0.40 mm.
(2) Exhaust valves - 0.60 mm.

i. Torque the tappet adjusting screw lock nuts to 40 Nm on completion of the adjustment.

j. Fit the cylinder head cover, fitted with a new cylinder head cover gasket. Torque the retaining bolts to 25 Nm (refer to EMEI Veh D 393 Group 1 - Engine).

k. Install the exhaust manifold with turbocharger (refer to EMEI Veh D 393 Group 1 - Engine).
l. Install the inlet manifold and the coolant expansion tank (refer to EMEI Veh D 393 Group 1 - Engine).

m. Install the thermostat connecting pipe fitted with two new sealing rings on the coolant pump. Lubricate the sealing rings with Vaseline prior to assembly.

n. Install a new gasket to the thermostat housing and position the housing on the connecting pipe.

o. Attach the thermostat body, spacers and mounting bracket to the cylinder head with the three thermostat housing mounting bolts. Torque the bolts to 30 Nm.

p. Connect the upper coolant hose, the thermostat vent hose, and the compressor coolant line to the thermostat housing, and tighten the hose clamps.

q. Connect the coolant temperature sender unit electrical lead to the sender unit.

r. Position the turbocharger air inlet pipe in its mounted position, fit the lower hose to the turbocharger and tighten the hose clamp.

s. Connect the engine vent hose between the turbocharger air inlet pipe and the engine breather filter housing, and tighten the hose clamps.

do. Lightweight to prevent damage to the turbocharger air inlet and the radiator, during operation, ensure that a minimum clearance of 7 mm exists between the turbocharger air inlet pipe and the radiator.

T. Install the bolt with washer and nut securing the turbocharger air inlet pipe to the engine, and tighten securely.

u. Install the fan intermediate drive belt (refer to EMEI Veh D 393 Group 1 - Engine).

v. Position the air conditioner compressor and fuel filter with associated hoses, lines and fittings on the engine, and secure the air conditioner compressor lower mounting bracket to the main mounting bracket with the two bolts and self-locking nuts. Do not tighten the bolts at this stage.

NOTE

Ensure the power steering fluid reservoir breather line is located between the air conditioner main mounting bracket and the air conditioner compressor.

w. Fit the air conditioner compressor adjusting bolt to the upper mounting bracket; do not tighten the bolt at this stage.

x. Install the air conditioner compressor drive belt. Torque the adjusting bolt to 20 Nm and the mounting bolts to 60 Nm (refer to EMEI Veh D 393 Group 1 - Engine).

y. Connect the cold start air outlet pipe to the cold start reservoir.

z. Secure the fuel filter mounting bracket to the air conditioner compressor main mounting bracket with the two vertical M12 bolts. Secure the bracket holding the leak-off line and the smoke limiter sensing line to the cylinder head.

aa. Connect the leak-off line to the cylinder head with the banjo bolt. Renew the sealing washers on the banjo bolt prior to installation.

ab. Secure the smoke limiter sensing line mounting bracket to the cylinder head cover with the rear mounting bolt of the cover. Torque the bolt to 25 Nm.

ac. Secure the smoke limiter sensing line to the inlet manifold with the banjo bolt. Renew the sealing washers on the banjo bolt prior to installation.

ad. Tighten the injection pipe cap nuts at the fuel injection pump with the injector cap nut wrench (Table 2, Item 1). Torque the nuts to 25 Nm (Fig 57).

Figure 57 - Fuel Injection Pump Injection Pipes - Installation

ae. Fill the cooling system with coolant (refer to EMEI Veh D 393 Group 2 - Cooling System). Ensure that the expansion tank is two-thirds full.

af. Prime the fuel system (refer to EMEI Veh D 393 Group 4 - Fuel System).

ag. Operate the battery isolation switch so that the batteries are connected to the vehicle.
ah. Check the engine oil level, top up if necessary.

**CAUTION**

DO NOT OPERATE THE STARTER MOTOR FOR LONGER THAN 20 SECONDS AT A TIME. CONTINUOUS CRANKING EXCEEDING 20 SECONDS WILL DAMAGE THE STARTER MOTOR. ALLOW THE STARTER MOTOR TO COOL BETWEEN CRANKING PERIODS.

**CAUTION**

DO NOT ALLOW THE ENGINE TO START UNTIL OIL PRESSURE IS INDICATED. SEVERE DAMAGE TO THE TURBOCHARGER AND ENGINE CAN RESULT FROM LACK OF LUBRICATION.

ai. Ensure the engine positive stop mechanism (Fig 30(1)) on the injection pump is in the no-fuel position. Without touching the accelerator, turn the engine over using the starter motor until oil pressure is indicated.

**CAUTION**

WHEN THE ENGINE IS RUN WITH THE CABIN RAISED, ENSURE THAT THE ENGINE AIR INTAKE HOSE AND THE AIR COMPRESSOR INTAKE HOSE IS CONNECTED TO THE AIR CLEANER TO PREVENT THE INGRESS OF CONTAMINANTS.

WHEN THE ENGINE IS RUN WITH THE CABIN RAISED ENSURE THE HEATER HOSES AND UPPER STEERING SHAFT ARE CLEAR OF MOVING PARTS TO PREVENT DAMAGE TO COMPONENTS.

aj. Turn the heater control slide to maximum heat, start the engine and run at idle speed. Observe the oil pressure indicator, after 10 seconds oil pressure must be indicated. Check for leaks and/or unusual noises, repair as necessary.

ak. Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

al. Run the engine until normal operating temperature is reached and check the engine oil and coolant levels.

am. Test drive the vehicle, inspect for leaks and check engine performance.

### Engine Exhaust Brake Manifold

#### 31. Removal

a. Raise and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

b. Operate the battery isolation switch so that the batteries are isolated from the vehicle.

c. Disconnect the engine exhaust brake actuating cylinder air line (Fig 58(2)).

d. Lubricate the threads of the three nuts and bolts connecting the engine exhaust brake manifold to the turbocharger outlet pipe and the exhaust pipe with a suitable penetrating oil, and remove the bolts and nuts.

e. Lubricate the threads of the bolt and nut of the exhaust pipe clamp at the vehicle muffler with a suitable penetrating oil and loosen the bolt and nut (refer to EMEI Veh D 393 Group 3 - Exhaust).

f. Lower the exhaust pipe away from the engine exhaust brake manifold.

g. Remove the engine exhaust brake manifold from the turbocharger.

h. Remove the locking pin and disconnect the ball joint socket (Fig 58(3)) from the throttle valve lever (Fig 58(4)).

![Figure 58 - Engine Exhaust Brake Actuating Cylinder](image)

1. Nut
2. Air line
3. Ball joint socket
4. Throttle valve lever
i. Remove the two M8 bolts securing the mounting bracket and engine exhaust brake actuating cylinder heat shield to the engine exhaust brake manifold and remove the shield, mounting bracket and cylinder.

32. Cleaning
   a. Use a wire brush to clean the mating surfaces on the turbocharger exhaust gas outlet pipe, exhaust pipe and the engine exhaust brake manifold. Ensure that no foreign material enters the turbocharger.

33. Installation
   a. Install the engine exhaust brake actuating cylinder, mounting bracket and heat shield assembly onto the engine exhaust brake manifold and secure with the two M8 mounting bolts.
   b. Coat the inside of the ball joint socket (Fig 58(3)) with high temperature grease and fit the socket onto the throttle valve lever (Fig 58(4)). Lock the socket to the lever with the locking pin.
   c. Fit the engine exhaust brake manifold onto the turbocharger outlet pipe and carefully raise the exhaust pipe until the exhaust pipe flange mates with the engine exhaust brake manifold and the mounting holes are aligned.
   d. Secure the manifold and exhaust pipe with the three mounting bolts and nuts. Torque the nuts to 45 Nm.
   e. Tighten the exhaust pipe clamp at the muffler (refer to EMEI Veh D 393 Group 3 - Exhaust).
   f. Connect the engine exhaust brake actuating cylinder air line (Fig 58(2)).
   g. Check the engine exhaust brake cylinder adjustment, see para 38.

34. Removal
   a. Raise and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).
   b. Operate the battery isolation switch so that the batteries are isolated from the vehicle.
   c. Disconnect the engine exhaust brake actuating cylinder air line (Fig 58(2)) and remove the nut (Fig 58(1)) securing the cylinder.
   d. Remove the locking pin and disconnect the ball joint socket (Fig 58(3)) from the throttle valve lever (Fig 58(4)).
   e. Remove the engine exhaust brake actuating cylinder from the mounting bracket.

35. Installation
   a. Install the engine exhaust brake actuating cylinder on to the mounting bracket and secure the cylinder with the nut (Fig 58(1)). Torque the nut to 25 Nm.
   b. Connect the actuating cylinder ball socket (Fig 58(3)) to the throttle valve lever (Fig 58(4)). Do not lock the socket with the locking pin at this stage.
c. Adjust the engine exhaust brake actuating cylinder, see para 38.

d. Coat the inside of the engine exhaust brake actuating cylinder ball socket (Fig 58(3)) with high temperature grease and fit the socket onto the throttle valve lever. Lock the socket to the lever with the locking pin.

e. Connect the air line (Fig 58(2)) to the engine exhaust brake actuating cylinder.

f. Operate the battery isolation switch so that the batteries are connected to the vehicle.

**CAUTION**

WHEN THE ENGINE IS RUN WITH THE CABIN RAISED, ENSURE THAT THE ENGINE AIR INTAKE HOSE AND THE AIR COMPRESSOR INTAKE HOSE IS CONNECTED TO THE AIR CLEANER TO PREVENT THE INGRESS OF CONTAMINANTS.

WHEN THE ENGINE IS RUN WITH THE CABIN RAISED ENSURE THE HEATER HOSES AND UPPER STEERING SHAFT ARE CLEAR OF MOVING PARTS TO PREVENT DAMAGE TO COMPONENTS.

g. Start the engine, engage the engine exhaust brake and visually inspect the operation of the engine exhaust brake and actuating cylinder. Check for leaks and rectify as required.

h. Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

**NOTE**

The engine exhaust brake efficiency can only be tested with the engine under load on a road test.

i. Road test the vehicle and check the operation of the engine exhaust brake.

36. **Inspection (On-Vehicle)**

**NOTE**

The engine exhaust brake manifold can be replaced with the turbocharger fitted to the engine.

a. Raise and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

b. Operate the battery isolation switch so that the batteries are isolated from the vehicle.

c. Lubricate the threads of the three nuts and bolts connecting the engine exhaust brake manifold to the turbocharger outlet pipe and the exhaust pipe with a suitable penetrating oil, and remove the bolts and nuts.

d. Lubricate the threads of the bolt and nut of the exhaust pipe clamp at the vehicle muffler with a suitable penetrating oil and loosen the bolt and nut (refer to EMEI Veh D 393 Group 3 - Exhaust).

e. Lower the exhaust pipe away from the engine exhaust brake manifold.

**NOTE**

The engine exhaust brake throttle valve should not foul the valve housing in the fully closed position.

f. Inspect the engine exhaust brake throttle valve to ensure the valve is fully opened and the stop lever rests against the stop (Fig 59).

![Figure 59 - Engine Exhaust Brake Throttle Valve - Fully Open](image)

**NOTE**

If the engine exhaust brake fails any of the checks in sub-paras f to j, the engine exhaust brake needs to be repaired, see para 37.

h. Measure the axial clearance of the engine exhaust brake spindle between the bearing bushings (0.3 to 0.5 mm) (Fig 60).

i. Measure the radial clearance of engine exhaust brake throttle valve spindle. The clearance is not to exceed 0.3 mm.

j. Check that the engine exhaust brake throttle valve is not resting against the engine exhaust brake housing in the closed position.
k. Carefully raise the engine exhaust pipe until the engine exhaust pipe flange mates with the engine exhaust brake manifold.

l. Fit the exhaust pipe to the engine exhaust brake manifold and secure with the three bolts and nuts. Torque the bolts to 45 Nm.

m. Operate the battery isolation switch so that the batteries are connected to the vehicle.

n. Start the engine, engage the engine exhaust brake and visually inspect the operation of the engine exhaust brake and actuating cylinder. Check for leaks and rectify as required.

o. Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

**NOTE**

The engine exhaust brake efficiency can only be tested with the engine under load on a road test.

p. Test drive the vehicle. Check the operation of the engine exhaust brake, inspect for leaks and repair as required.
1. Nut  
2. Bushing  
3. Air line  
4. Spacer  
5. Stud  
6. Actuating cylinder mounting bracket  
7. Bolt  
8. Bush  
9. Engine exhaust brake manifold housing  
10. Throttle valve spindle  
11. Nut  
12. Bolt  
13. Throttle valve butterfly  
14. Nut  
15. Nut  
16. Washer  
17. Heat shield  
18. Bolt  
19. Ball  
20. Ball joint socket  
21. Retaining clip  
22. Nut  
23. Nut  
24. Throttle valve lever  
25. Actuating cylinder  
26. Bolt  

Figure 61 - Engine Exhaust Brake - Exploded View

### Repair

a. Remove the engine exhaust brake manifold from the vehicle, see para 31.

b. Remove the bolt and nut securing the throttle valve lever (Fig 61(24)) to the throttle valve spindle (Fig 61(10)) and remove the lever.

c. Remove the nut and bolt (Fig 61(11) and (12)) securing the throttle valve butterfly (Fig 61(13)) to the throttle valve spindle (Fig 61(10)).

d. Remove the throttle valve butterfly (Fig 61(13)) and the throttle valve spindle (Fig 61(10)) from the engine exhaust brake manifold.

e. Inspect the engine exhaust brake manifold housing, throttle valve butterfly and throttle valve spindle for wear, replace if required.

f. Knock out the throttle valve spindle bushes (Fig 61(8)).
g. Install new throttle valve spindle bushes. Knock each bush in until the inside edge of the bush is flush with the inside of the housing (Fig 62). Coat the bearing surfaces of the bushes with a high temperature grease.

**Figure 62 - Shaft Bush - Installation**

h. Install the throttle valve butterfly (Fig 61(13)).

i. Install the throttle valve spindle (Fig 61(10)) so that the stop on the body is located between the two stop levers on the spindle.

j. Fit the throttle valve butterfly retaining bolt (Fig 61(12)) and a new nut (Fig 61(11)). Do not tighten fully at this stage.

k. Measure the axial and the radial clearances of the engine exhaust brake throttle valve assembly, see para 36.

l. Tighten the throttle valve butterfly retaining bolt (Fig 61(12)) (fitted with a new nut (Fig 61(11)) securing the throttle valve butterfly to the throttle valve spindle and recheck the clearances.

m. Connect the engine exhaust brake actuating cylinder to the engine exhaust brake manifold and install the engine exhaust brake manifold on the vehicle, see para 33.

n. Adjust the engine exhaust brake manifold, see para 38.

38. **Adjustment (On Vehicle)**

a. Raise and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

b. Operate the battery isolation switch so that the batteries are isolated from the vehicle.

c. Detach the locking pin securing the engine exhaust brake actuating cylinder ball socket (Fig 61(20)) to the throttle valve lever ball (Fig 61(19)).

d. Unlock the adjusting nut and adjust the cylinder so that the distance “A” (Fig 63) from the centre of the hexagon nut to the centre of the ball head is 170 mm.

**Figure 63 - Engine Exhaust Brake Actuating Cylinder - Adjustment**

e. Loosen the throttle valve lever locking bolt and nut (Fig 61(26) and (23)) and slide the throttle valve lever (Fig 61(24)) off the engine exhaust brake throttle valve spindle (Fig 61(10)).

f. Fully open the engine exhaust brake throttle valve butterfly so that the stop lever rests against the stop (Fig 64).

**Figure 64 - Engine Exhaust Brake Throttle Valve**

g. Refit the throttle valve lever (Fig 61(24)) onto the serrations of the engine exhaust brake throttle valve spindle (Fig 61(10)) so that the engine exhaust brake actuating cylinder has a pre-load dimension of 2 to 4 mm (Fig 65 “B”).
**Figure 65 - Engine Exhaust Brake Actuating Cylinder - Pre-load**

**h.** Tighten the throttle valve lever locking bolt and nut (Fig 61(26) and (23)) ensuring the preload between the spindle and the actuating cylinder is maintained.

**i.** Coat the inside of the actuating cylinder ball socket (Fig 61(20)) with high temperature grease and fit the socket onto the throttle valve lever ball joint (Fig 61(19)) ensuring the locking pin has locked the ball joint to the throttle valve lever.

**j.** Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

**k.** Operate the battery isolation switch so that the batteries are connected to the vehicle.

**NOTE**

The engine exhaust brake efficiency can only be tested with the engine under load on a road test.

**l.** Road test the vehicle and check the operation of the engine exhaust brake. Inspect for leaks; repair as required.

**Timing Case Seal**

**39. Removal**

**a.** Remove the front engine mount and bearer (refer to EMEI Veh D 393 Group 1 - Engine).

**DO NOT USE AN IMPACT TOOL WHEN REMOVING THE CRANKSHAFT PULLEY CENTRE BOLT. DAMAGE TO THE CRANKSHAFT AND BIG END BEARINGS COULD OCCUR.**

**b.** Engage top gear and remove the centre bolt (Fig 66(1)) using the ring spanner (Table 2, Item 10).

**Figure 66 - Crankshaft Pulley**

**c.** Remove the crankshaft pulley from the crankshaft.

**CAUTION**

THE CRANKSHAFT VIBRATION DAMPER IS NOT REPAIRABLE IF DAMAGED; DO NOT DROP OR STRIKE THE DAMPER WHEN REMOVING IT FROM OR FITTING IT TO THE CRANKSHAFT.

**d.** Remove the vibration damper (Fig 67(1)) from the crankshaft spigot using the puller (Table 2, Item 4) (Fig 67(2)).

**Figure 67 - Engine Vibration Damper - Removal**

**e.** Remove the Woodruff key from the crankshaft.

**f.** Remove the six retaining bolts (Fig 68(1)) from the coolant pump pulley and remove the pulley.
1. Retaining bolt

*Figure 68 - Coolant Pump Drive Pulley*

**NOTE**

The thirteen M6 bolts that secure the timing case cover to the timing gear case are in three lengths. Note the location of the different length bolts when they are removed (Fig 69).

*Figure 69 - Timing Case Cover Bolts - Location*

- g. Remove the 13 bolts with washers securing the timing case cover to the timing gear case then remove the cover and gasket.

- h. Remove the wear ring (Fig 70(1)) from the crankshaft and discard it.

1. Wear ring

*Figure 70 - Wear Ring - Removal*

- i. Mount the timing case cover in the special tool with the spacer fitted and remove the timing case seal (Fig 71) with the remover/replacer tool (Table 2, Item 5).

*Figure 71 - Timing Case Seal - Removal*

40. **Cleaning and Inspection**

- a. Clean the sealing surfaces on the timing gear case and the timing case cover. Ensure all gasket material residue is removed.

- b. Inspect the timing gear case sealing surface for irregularities and the timing case cover and Woodruff key for damage, repair or replace as required.

- c. Check the vibration damper for damage. Replace the damper if there is evidence of worn, cracking, chunking or deteriorated rubber between the hub and pulley or vulcanised parts are lifting of separating.
41. **Installation**

   a. Install a new seal in the timing case cover using the remover/replacer tool (Table 2, Item 5) (Fig 72). Lightly lubricate the seal with engine oil.

   b. Install the Woodruff key on the crankshaft.

   c. Attach a new gasket to the timing case cover with a sealing compound (Loctite 573) (Part No. 002 989 00 20) or equivalent).

   **NOTE**

   Coat the threads of all the through bolts that secure the timing case cover to the timing gear case with a sealing compound (Loctite 573 (Part No. 002 989 00 20) or equivalent)).

   d. Mount the timing case cover on the timing gear case and fit the 13 bolts noting the length and position of the bolts (Fig 69). Do not tighten the cover bolts at this stage.

   e. Centralise the timing case cover with the remover/replacer tool (Table 2, Item 5).

   f. Install a new wear ring on the crankshaft spigot.

   g. Torque the timing gear cover securing bolts to 8 Nm.

   h. Fit the coolant pump drive pulley to the drive shaft and secure the pulley with the six retaining bolts (Fig 68). Torque the bolts to 30 Nm.

   i. Align the slot in the vibration damper with the Woodruff key and slide the vibration damper into position on the crankshaft spigot. A puller bolt may be used to seat the vibration damper against the locating shoulder on the crankshaft.

   j. Fit the crankshaft pulley to the crankshaft and secure it with centre bolt (Fig 66(1)).

   **CAUTION**

   DO NOT USE AN IMPACT TOOL WHEN INSTALLING THE CRANKSHAFT PULLEY CENTRE BOLT. DAMAGE TO THE CRANKSHAFT AND BIG END BEARINGS COULD OCCUR.

   k. Engage top gear and torque the centre bolt (Fig 66(1)) to between 500 Nm and 550 Nm.

   l. Install the engine bearer and front engine mount (refer to EMEI Veh D 393 Group 1 - Engine).

   **CAUTION**

   WHEN THE ENGINE IS RUN, WITH THE CABIN RAISED, ENSURE THAT THE AIR CLEANER HOSE AND THE AIR COMPRESSOR INTAKE HOSE IS CONNECTED TO THE AIR CLEANER TO PREVENT THE INGRESS OF CONTAMINANTS.

   m. Run the engine, check operation and inspect for leaks.

   **CAUTION**

   WHEN THE ENGINE IS RUN WITH THE CABIN RAISED ENSURE THE HEATER HOSES AND UPPER STEERING SHAFT ARE CLEAR OF MOVING PARTS TO PREVENT DAMAGE TO COMPONENTS.

   n. Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

**Injection Timer**

42. **Removal**

   a. Remove the timing case cover, see para 39.

   b. Remove the top cover on the timing gear case to expose the injection pump drive gear.

   **NOTE**

   If the backlash exceeds specifications, inspect the crankshaft and injection pump drive gears for indications of wear.

   c. Check the backlash of the timing gears with a dial gauge (0.070 to 0.180 mm).

   d. Place the main transmission in neutral and turn the engine over until the crankshaft/camshaft gear timing marks (Fig 73(2)) are aligned.
e. Mark the position of the injection pump drive gear (Fig 73(1)).

1. Injection pump drive gear timing mark
2. Crankshaft/camshaft gear timing mark

**Figure 73 - Timing Gears**

f. Remove the waisted bolt securing the camshaft gear with injection timer to the camshaft.

g. Remove the camshaft gear with injection timer from the camshaft with the puller (Table 2, Item 4).

h. Clamp the camshaft gear (Fig 74(5)) in a vice fitted with soft jaws.

i. Lever the injection timer gear (Fig 74(1)) off the camshaft gear.

j. Remove the springs (Fig 74(4)), pins (Fig 74(3)) and balance weights (Fig 74(2)) from the camshaft gear.

**43. Cleaning and Inspection**

**WARNING**

ENSURE THE SAFETY REQUIREMENTS FOR USE OF COMPRESSED AIR ARE STRICTLY ADHERED TO. INADVERTANT USE OF COMPRESSED AIR EQUIPMENT MAY RESULT IN INJURY TO PERSONNEL.

a. Clean all parts with an appropriate cleaning agent and blow dry with compressed air.

b. Clean the sealing surfaces on the timing gear case, timing case cover and top cover of all gasket material residue.

c. Visually inspect the injection timing device components for wear and damage.

d. Inspect the timing gear case, timing case cover and top cover sealing surfaces for irregularities, repair or replace as required.

**44. Installation**

a. Fit the injection timer gear (Fig 74(1)) to the camshaft gear (Fig 74(5)) and at the same time insert the pins (Fig 74(3)) and springs (Fig 74(4)).

b. Clamp the camshaft gear in a vice fitted with soft jaws.

c. Lift and rotate the injection timer gear slightly and at the same time insert the balance weights (Fig 74(2)).

**NOTE**

Ensure there is no free play between the mating surfaces of the balance weights and the ramps the weights run on and, no radial movement exists between the camshaft gear and the injection timer gear.

d. Coat the surfaces of the balance weights and bearing surfaces with grease (Molykote (Part No. 000 989 63 51) or equivalent)).

e. Align the timing marks (Fig 73(1)) on the fuel injection pump drive gear and the timing gear case housing and the timing marks (Fig 73(2)) on the crankshaft and the camshaft gear.
f. Install the injection timer on the camshaft ensuring that the Woodruff key on the camshaft aligns with the slot in the camshaft gear.
g. Place the main transmission in top gear.
h. Install the waisted bolt securing the camshaft gear with injection timer to the camshaft and torque the bolt to 300 Nm.

NOTE

If the backlash exceeds specifications, inspect the crankshaft and injection pump drive gears for indication of wear.

i. Check the backlash between the injection timer gear and the fuel pump drive gear (0.070 to 0.180 mm). If the backlash exceeds the specification replace the camshaft gear with injection timer.

j. Attach a new gasket to the timing gear case top cover with a sealing compound (Loctite 573 (Part No. 002 989 00 20) or equivalent).

k. Install the timing gear case top cover and secure with the three M6 bolts. Torque the bolts to 9 Nm. Coat the threads of the bolts with a sealing compound (Loctite 573 (Part No. 002 989 00 20) or equivalent) prior to assembly.

l. Attach a new timing case cover gasket to the timing gear case with a sealing compound (Loctite 573 (Part No. 002 989 00 20) or equivalent).

m. Install the timing case cover, see para 41.

n. Run the engine, check operation and inspect for leaks.

Speed Limiter Actuator

CAUTION

GOVERNMENT LEGISLATION PROHIBITS UNAUTHORISED REPAIRS AND ADJUSTMENT TO SPEED LIMITERS. REPAIRS AND ADJUSTMENTS ARE ONLY TO BE CARRIED OUT BY AN AUTHORISED AND ACCREDITED REPAIRER USING SPECIALISED TEST EQUIPMENT.

45. Removal

a. Raise and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).
46. Cleaning and Inspection

THE SPEED LIMITER ACTUATOR MUST BE PROTECTED AGAINST HIGH PRESSURE WATER JETS AND IMMERSION WHEN CLEANING.

a. Wipe down the speed limiter actuator and mounting surfaces with an appropriate cleaning agent. Do not immerse the actuator.

**NOTE**
To protect the speed limiter actuator from temperature variations and to allow the speed limiter actuator to “breathe” the Teflon (P.T.F.E) diaphragm (Fig 76(1)) must be free of contamination (e.g. dirt, moisture, grease and paint).

b. Inspect the speed limiter actuator body, operating cable, dust boot and wiring loom for wear, damage and irregularities. Ensure the wiring loom is protected from sharp edges.

c. Inspect the Teflon (P.T.F.E) breather diaphragm (Fig 76(1)) for cleanliness and the actuator shaft seal for serviceability. Clean the breather diaphragm if required.

47. Installation

a. Install the dust boot on the actuator shaft and screw on the inner nut until it just contacts the boot.

b. Fit the operating arm (as noted on removal), the spring washer and the outer nut that secures the operating arm on the speed limiter actuator shaft. Screw on the outer nut until the outside of the nut is flush with the end of the actuator shaft and then screw the inner nut outwards and tighten against the operating arm.

c. Install the backing plate and spacer onto the speed limiter actuator and secure with the two bolts.

d. Locate the speed limiter actuator and spacers on the three mounting bolts and secure with the self locking nuts (Fig 75(1)). Tighten the nuts securely.

e. Feed the Bowden cable through the hole in the backing plate and secure the cable retainer in the plate.

f. Install the Bowden cable socket on the ball on the operating lever and secure the socket with the retaining clip. Lubricate the inside of the socket with grease prior to assembly.

g. Connect the electrical lead connector from the speed limiter actuator to the wiring loom and secure the lead to the wiring loom with cable ties.

h. Operate the battery isolation switch to connect the batteries to the vehicle electrical system.

i. Check the adjustment of the Bowden cable, see para 48.

j. Lower and secure the cab (refer to EMEI Veh D 393 Group 01 - Access for Repair).

k. Test drive the vehicle and check the operation of the speed limiter.

48. Adjustment

ENSURE THE HANDBRAKE IS APPLIED AND THE ENGINE IS SWITCHED OFF BEFORE COMMENCING ADJUSTMENT. KEEP HANDS CLEAR OF THE SPEED LIMITER ACTUATOR OPERATING ARM WHEN THE IGNITION IS TURNED ON/OFF TO PREVENT SERIOUS INJURY TO FINGERS.

GOVERNMENT LEGISLATION PROHIBITS UNAUTHORISED REPAIRS AND ADJUSTMENT TO SPEED LIMITERS. REPAIRS AND ADJUSTMENTS ARE ONLY TO BE CARRIED OUT BY AN AUTHORISED AND ACCREDITED REPAIRER USING SPECIALISED TEST EQUIPMENT.
THE BOWDEN CABLE ADJUSTMENT IS CRITICAL FOR THE SAFE OPERATION OF THE VEHICLE. THE LIMITED SPEED OF THE VEHICLE CAN BE EXCEEDED IF THE CABLE IS ADJUSTED (INCORRECTLY) SO THAT WHEN THE SPEED LIMITER ACTUATOR IS IN THE ELECTRICAL FULL LOAD POSITION (FIG 77) THE INJECTION PUMP THROTTLE LEVER CANNOT REACH THE IDLE POSITION.

THE BOWDEN CABLE ADJUSTMENT IS CRITICAL FOR THE SAFE OPERATION OF THE SPEED LIMITER. IF THE CABLE IS ADJUSTED (INCORRECTLY) SO THAT WHEN THE FUEL INJECTION PUMP THROTTLE LEVER IS IN THE IDLE POSITION AND THE SPEED LIMITER ACTUATOR CANNOT REACH THE ELECTRICAL FULL LOAD POSITION (FIG 77), THE ACTUATOR MOTOR WILL BE OVERLOADED AND DAMAGE TO THE ACTUATOR DRIVE GEARS WILL OCCUR.

a. Turn the ignition switch to OFF.

b. Move the speed limiter actuator arm, by hand, forward until it reaches the stop.

c. When the speed limiter actuator arm is fully forward at the stop, have a second person press the accelerator pedal down to the stop (full throttle). At the same time, observe the throttle linkage to the fuel injection pump and check that the pump throttle lever does not move from the idle position (fully rearward).

d. Ensure hands are clear of the speed limiter actuator operating arm and have a second person turn the ignition switch to ON. Check that the speed limiter actuator arm moves through 90° to the electrical start position (Fig 77). Check that the actuator arm moves without obstruction throughout its range of travel to its end limit. When fully rearward (electrical start position) the front edge of the actuator arm should be aligned with the top rear corner of the actuator body.

e. While the speed limiter actuator arm is fully to the rear, have a second person press the accelerator pedal down to the stop (full throttle). At the same time, observe the throttle linkage to the fuel injection pump and check that the pump throttle lever can attain the full fuel position (fully forward).

**NOTE**

Use a spanner to hold the operating arm when tightening the ball joint nuts.

f. If the limits cannot be reached (sub-paras b. to e.), adjust the position of the ball joint (Fig 78(1)) on the operating arm to suit. Minor adjustments may be made to tension the Bowden cable by turning the adjusting nut (Fig 78(2)).

g. Road test the vehicle and check the operation of the speed limiter.

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**Figure 77 - Speed Limiter Actuator Arm Positions**

**Figure 78 - Speed Limiter Cable - Adjustment**

1. Ball joint
2. Adjusting nut