TA27 (Tier 3) Articulated Dumptruck Maintenance Manual
PURPOSE:
To advise potentially hazardous condition.

DETAIL:

It has been brought to our attention that 'Viton' material used in manufacture of oil seals and 'O' rings, produces a highly corrosive acid (Hydrofluoric) when subjected to temperatures above 315° C.

The resulting contamination can have extreme consequences on human tissue since it is almost impossible to remove after contact.

We therefore recommend the following procedure when it is necessary to inspect any equipment that has been subjected to a high temperature i.e. fire.

a. Visually inspect for any gaskets or seals which have suffered from heat; they will appear black and sticky.

b. If this is affirmed - Do Not Touch

c. Make enquiries to ascertain the material composition. Any Fluoro-elastomer (Viton, Fluorel or Tecmoflon) should be considered dangerous but natural rubber and nitrile are non-hazardous.

d. If Fluoro-elastomer seals have been used, then the affected area MUST be decontaminated before undertaking further work.

e. Disposable Heavy Duty Gloves (Neoprene) MUST be worn and the affected area decontaminated by washing thoroughly with Limewater (Calcium Hydroxide solution).

f. Any cloths, residue and gloves used MUST be safely discarded after use.

Note: Burning of the discarded items is NOT RECOMMENDED, except in an approved incineration process where the gaseous products are treated by alkaline scrubbing.
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Proper service and repair is important to the safe, reliable operation of all motor vehicles. The service procedures recommended and described in this publication, are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when, and as recommended.

It is important to note that this publication contains various WARNINGS and NOTES which should be carefully read in order to minimize the risk of personal injury to personnel, or the possibility that improper service methods will be followed which may damage the vehicle or render it unsafe. It is also important to understand these WARNINGS and NOTES are not exhaustive. It is not possible to know, evaluate and advise the service trade of ALL conceivable ways in which service might be carried out, or, of the possible hazardous consequences of each way. Consequently, no such broad evaluation has been undertaken. Accordingly, anyone who uses a service procedure, or tool, which is not recommended, must first satisfy themselves thoroughly that neither their safety, nor vehicle safety, will be jeopardized by the service method he/she selects.

Two types of heading are used in this manual to attract your attention.

1. **WARNING** - This symbol is used when an operating procedure, practice, etc., which, if not correctly followed could result in personal injury or loss of life. Look for this symbol to point out important safety precautions. It means - **ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!**

2. **Note** - This is used when an operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

**WARNING**

Never use parts which are altered, modified, or weakened in operation. This can seriously jeopardize the integrity of the machine and could result in property damage or serious personal injury.
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ENGINE

Make/Model .............................................. Cummins QSM11
Type ......................... Four cycle diesel, turbocharged with air-to-air
charge cooling, water-cooled. Electronic management.

Gross power at 2 100 rev/min .......... 250 kW (335 hp, 335 PS)
Net power at 2 100 rev/min .......... 234 kW (314 hp, 318 PS)

Note: Gross power rated to SAE J1995 Jun 90. Engine
emission meets USA EPA/CARB Tier III and EU NRMM
(non-road mobile machinery) Tier III directive.

Maximum Torque .... 1 647 Nm (1 235 lbf ft) at 1 400 rev/min
Number of cylinders/configuration ................... 6, in line
Bore x Stroke .................................. 125 x 147 mm (4.92 x 5.79 in)
Piston Displacement ......................... 10.8 litres (661 in³)
Air cleaner ......................... Dry type, double element
Starting ............................................ Electric
Maximum Speed (No load) .................. 2 350 rev/min
Maximum Speed (Full load) .......... 2 100 rev/min
Idle Speed ................................... 750 rev/min
Safe Operating Angle ....................... 43°/94% Grade

TRANSMISSION

Make/Model .............................................. ZF 6WG 260 Automatic
with manual override. The transmission assembly consists
of a torque converter close-coupled to a countershaft-type
gearbox with integral output transfer gearing. Automatic
shifting throughout the range, with kickdown feature. Lockup
action in all forward gears. A torque proportioning output
differential transmits drive permanently to front and rear
axles. This differential may be locked by the driver for use in
difficult traction conditions. Optional integral hydraulic
retarder which automatically operates should the engine
overspeed. Blocked filter indicator and filter bypass system
provide valve block with additional protection from unfiltered
oil.

Pressures:
Main .................................................. 16 + 2 bar (232 + 30 lbf/in²)
Lockup (Wk) ...................................... 14 ± 1 bar (190 ± 15 lbf/in²)
Converter 'IN' .............................. 10.5 bar (152 lbf/in²) at 2 300 rev/min
Converter 'OUT' .......................... 4.8 bar (70 lbf/in²) at 2 300 rev/min
Converter Relief Valve ......................... 8.5 bar (123 lbf/in²)
Retarder ............................................ 5.5 bar (80 lbf/in²)

Temperatures:
Normal .................................. 80° - 110° C (176° - 230° F)
Maximum (Retarder Mode) ............... 145° C (293° F)
Stall Speed .......................... 1 718 ± 50 rev/min

Ratios:
Torque Converter ................................. 1.84:1
Transmission .................................. Refer to table below

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<td>5.4</td>
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<td>mile/h</td>
<td>3.7</td>
<td>8.8</td>
<td>20.1</td>
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### AXLES

Three axles in permanent all-wheel drive with differential coupling between each axle to prevent driveline wind-up. Heavy duty axles with fully-floating axle shafts and outboard planetary reduction gearing.

Automatic limited slip differentials in each axle. Centre axle incorporates a through-drive differential to transmit drive to the rear axle. Locking of this differential is actuated simultaneously with the transmission output differential lock.

**Ratios:**
- Differential .......................................................... 3.44:1
- Planetary ................................................................. 6.35:1
- Total Reduction ..................................................... 21.85:1

### SUSPENSION

**Front:** Axle is carried on the leading arms of a sub-frame which pivots on the main frame. Suspension is by rubber elements with four heavy duty hydraulic dampers.

**Rear:** Each axle is coupled to the frame by three rubber-bushed links with lateral restraint by a transverse link. Pivoting inter-axle balance beams equalise load on each axle. Suspension movement is cushioned by rubber/metal laminated compression units between each axle and underside of balance beam ends. Pivot points on rear suspension linkages are rubber-bushed and maintenance-free.

### WHEELS AND TYRES

Wheels: 5-piece earthmover rims with 12 stud fixing

**Size:**
- Standard .................................................. 25 x 19.50 in for 23.5 R25** tyres
- Optional ...................................................... 25 x 22.00 in for 750/65 R25** tyres

**Tyres:**
- Standard .................................................. 23.5 R25**
- Optional ...................................................... 750/65 R25**

**Inflation Pressures (Bridgestone):**

- Front: 23.5 R25** ........ 4.35 bar (63 lbf/in²) 4.35 bar (63 lbf/in²)
- Rear: 750/65 R25** .... 3 bar (44 lbf/in²) 3 bar (44 lbf/in²)

**Inflation Pressures (Michelin):**

- Front: 23.5 R25** ........ 3.5 bar (51 lbf/in²) 3.5 bar (51 lbf/in²)
- Rear: 750/65 R25** .. 2.75 bar (40 lbf/in²) 2.75 bar (40 lbf/in²)

**Inflation Pressures (Pirelli):**

- Front: 23.5 R25** ...... 4.3 bar (62 lbf/in²) 4.3 bar (62 lbf/in²)
- Rear: 750/65 R25** .... 4.25 bar (62 lbf/in²) 4.25 bar (62 lbf/in²)

**Inflation Pressures (Continental):**

- Front: 23.5 R25** .... 4.25 bar (62 lbf/in²) 4.25 bar (62 lbf/in²)
- Rear: 750/65 R25** .... 3.0 bar (43 lbf/in²) 3.0 bar (43 lbf/in²)

**Note:** Tyre pressures should be regarded as nominal only. It is recommended that for tyres both listed and unlisted, the user should consult the tyre manufacturer and evaluate all job conditions in order to make the proper selection.

### HYDRAULIC SYSTEM

Braking, steering and body hoist systems are controlled by a main hydraulic valve mounted on frame. Systems are supplied with oil from a common tank by the main hydraulic pump, driven from power takeoff on transmission. System components are protected by full flow filtration on the return line.

**Pump:**
- Type ............................................................... Piston
- Capacity at 2 100 rev/min ........ 4.9 litre/s (77.4 US gal/min)

### Brakes

All hydraulic braking system with dry disc on each wheel with two heavy-duty callipers per disc. Independent circuits for front and rear brake systems. Warning lights and audible alarm indicate low brake system pressure. Brake system conforms to ISO 3450, SAE J1473.

**Actuating Pressure ......................... 103 bar (1 500 lbf/in²)**

**Discs:**
- Diameter .................................................. 477 mm (18.8 in)
- Thickness .................................................. 16 mm (0.63 in)

**Parking:** Spring-applied, hydraulic-released disc on rear driveline.

**Emergency:** Automatic application of driveline brake should pressure fall in main brake hydraulic system. Service brakes may also be applied using the parking-emergency brake control.

**Retardation:** Exhaust brake or optional hydraulic retarder integral with transmission.

### Steering

Hydrostatic power steering by two single-stage, double-acting, cushioned steering cylinders. Emergency steering pressure is provided by a ground driven pump mounted on the rear of the transmission. An audible alarm and warning light indicates should the emergency system activate. Conforms to ISO 5010, SAE J53.

**System Pressure ...................... 241 bar (3 500 lbf/in²)**

**Steering Angle to either side .................. 45°**

**Lock to Lock Turns, steering wheel ............... 4**

### Body Hoist

Two single-stage, double-acting hoist rams, cushioned at both ends of stroke. Electro servo assisted hoist control.

**System Pressure ...................... 220 bar (3 200 lbf/in²)**

**Control Valve ....................... Pilot Operated, Closed Centre**

**Body Raise Time (loaded) .............. 12 sec**

**Body Lower Time (power down) .................. 7.5 sec**

### ELECTRICAL SYSTEM

**Type .............................................. 24 volt, Negative Ground**

**Battery ................................................. Two, 12 Volt, 143 Ah each**

**Accessories ........................................ Two, 12 Volt, 143 Ah each**

**Alternator ........................................... 70 Amp**
BODY

Of all welded construction, fabricated from high hardness (min. 360 BHN) 1,000 MPa (145,000 lbf/in²) yield strength steel. 25° tail chute angle provides good load retention without tailgate.

PlateThicknesses:
  Floor and Tailchute ................. 14 mm (0.55 in)
  Sides ........................................ 12 mm (0.47 in)
  Front ........................................ 8 mm (0.31 in)

Volume:
  Struck (SAE) ................................. 12.5 m³ (16.4 yd³)
  Heaped 2:1 (SAE) ......................... 15.5 m³ (20.3 yd³)

SERVICE CAPACITIES

Fuel tank ...................................... 390 litres (103 US gal)
Hydraulic System .......................... 202 litres (53.4 US gal)
Engine Crankcase and filters ........... 34 litres (9.0 US gal)
Cooling System ............................. 55 litres (14.5 US gal)
Transmission (including cooler) .... 63 litres (16.6 US gal)
Differentials - Front & Rear (each) ... 17 litres (4.5 US gal)
Differential - Centre ..................... 18.5 litres (4.9 US gal)
Planetary (each) ........................... 3 litres (0.8 US gal)
Hand Pump Tank ............................ 1 litres (0.26 US gal)
Air Conditioning Compressor ....... 0.125 litres (0.033 US gal)

TYPICAL NOISE LEVELS

Operator Ear (ISO 6394) ...................... 78 dB A
*Exterior Sound Rating (ISO 6395) ................. 110 dB A
* - The above result is for the mode giving the highest exterior sound level when measured and operated as per the prescribed procedures of the standard. Results shown are for the vehicle in base configuration.

Note: Noise Level Exposure to the operator and bystander personnel may be higher depending upon proximity to buildings, rock piles, machinery etc.. The actual job site Noise Level Exposure must be measured and applicable regulations complied with in respect to Employee Hearing Protection.

** ** **
WARNING
Before any welding is done on a machine equipped with any electronic systems, disconnect the following (if applicable) in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables and electrical connections at the engine ECM, transmission ECU, body control lever, hydraulics ECU and cab bulkhead to avoid damage to electrical components. Turn off battery master switch to isolate the batteries before disconnecting any components. After welding connect all of the above in the reverse order.

WARNING
Before any welding is done ensure all paint has been removed from the area to be welded. Failure to do so may result in hazardous fumes being given off from the paint.

Note: Always fasten the welding machines ground cable to the piece/frame being welded if possible.

Electric arc welding is recommended for all welded frame repairs. Since the nature and extent of damage to the frame cannot be predetermined, no definite repair procedure can be established. As a general rule however, if parts are twisted, bent or pulled apart, or a frame is bent or out of alignment, no welding should be done until the parts are straightened or realigned.

Successfully welded repairs will depend to a great extent upon the use of the proper equipment, materials and the ability of the welder. The Customer Support Department can be consulted regarding the feasibility of welding repairs.

Note: The current from the welding rod always follows the path of least resistance. If, for example, the ground clamp is attached to the rear frame when welding is performed on the front frame, the current must pass a frame connection to return to the welding machine. Since the pivot coupling offers the least resistance but not a sound electrical connection, small electric arcs may be set up across the moving parts which may cause welding blotches on their wearing surfaces and increase the wear rate of these components.

General Welding Procedure
The following general procedure should be used for the repair of defects outwith the vicinity of alloy steel castings.

1. Completely ARC-AIR gouge or grind out the crack until sound metal is reached. If ARC-AIR method is employed, pre-heat area to 100°C (212°F), measure 3 - 4" either side of repair prior to gouging. On completion of gouging grind to remove thin carbon layer.

2. Apply dye-penetrant check to ensure crack has been completely removed.
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3. Pre-heat area to 100° C (212° F), measured 3 - 4” either side of repair. Avoid local overheating.

4. Weld completely using E-7016 electrodes. Care must be taken to ensure electrodes are protected from moisture pick-ups at all times.

5. Allow repair weld to cool slowly.

6. Grind and blend repair to original contour. Paint heat damaged areas.

The following general procedure should be used for the repair of defects in alloy steel castings and in the welds joining steel castings.

1. Completely ARC-AIR gouge or grind out the crack until sound metal is reached. If ARC-AIR method is employed, pre-heat area to 200° C (392° F), measure 3 - 4” either side of repair prior to gouging. On completion of gouging grind to remove thin carbon layer.

2. Apply dye-penetrant check to ensure crack has been completely removed.

3. Pre-heat area to 200° C (392° F), measured 3 - 4” either side of repair. Avoid local overheating.

4. Weld completely using E-7016 electrodes. Care must be taken to ensure electrodes are protected from moisture pick-ups at all times.

5. On completion of welding, post-heat repair area to 400° C (752° F), measure 3 - 4” either side of repair.

6. If welding has to be interrupted for any reason, e.g. overnight, post-heat immediately as in Step 5.

* * * *
DESCRIPTION
The chassis consists of two separate frame assemblies which provide the articulation of the unit. The front and rear frames are constructed of all welded high-grade steel fabrications with rectangular box section beams forming main, side and cross members.

The front frame is fabricated to form a rigid structure which carries the cab, power train and suspension system.

The rear frame is fabricated to form a rigid structure which carries the body, body hydraulics, suspension and rear drive axles.

Steering is by frame articulation to 45° either side by two widely spaced vertical pivot pins in taper roller bearings. Oscillation between the front and rear frames is provided by a large diameter cylindrical coupling carried on nylon bushes located in the rear frame. Longitudinal shocks are absorbed by the thrust faces of the nylon bushes. A large thrust nut, which is threaded to the end of the coupling and locked to the frame, secures the coupling in position. Wear on the thrust faces of the bushes is compensated by tightening this thrust nut.

INSPECTION AND MAINTENANCE

Inspection
Inspect the frames and attached parts at intervals not exceeding 250 hours for cracked or broken welds and bending of the frame. Any defects found should be repaired before they progress into major failures.

Straightening
Hydraulic straightening or aligning equipment should be used to straighten bent or twisted frames whenever possible. However, if heat must be applied, never heat the metal beyond a dull, cherry red colour, as too much heat will weaken the metal. When it is necessary to heat the metal, apply heat uniformly over the area to be straightened and protect the heated surface from sudden cooling. Frame parts that cannot be straightened should be renewed.
WARNINGS

Before any welding is done on a machine equipped with the Quantum Electronic Fuel System, disconnect the following in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables, body hydraulics joystick and electrical connections at the engine ECM, transmission ECU and hydraulics ECU to avoid damage to electrical components. Turn off battery master switch to isolate the batteries before disconnecting any components. After welding connect all of the above in the reverse order.

Before any welding is done ensure all paint has been removed from the area to be welded. Failure to do so may result in hazardous fumes being given off from the paint.

Note: Always fasten the welding machines ground cable to the piece/frame being welded if possible.

Electric arc welding is recommended for all welded frame repairs. Since the nature and extent of damage to the frame cannot be predetermined, no definite repair procedure can be established. As a general rule however, if parts are twisted, bent or pulled apart, or a frame is bent or out of alignment, no welding should be done until the parts are straightened or realigned.

Successfully welded repairs will depend to a great extent upon the use of the proper equipment, materials and the ability of the welder. The Customer Support Department can be consulted regarding the feasibility of welding repairs.

WARNING

Welding and flame cutting cadmium plated metals produce odourless fumes which are toxic. Recommended industrial hygiene practice for protection of the welding operator from the cadmium fumes and metallic oxides requires enclosure ventilation specifically designed for the welding process. A respiratory protective device such as the M.S.A. 'Gasfoe' respirator with G.M.A. cartridge will provide protection against cadmium, fumes and metallic oxides. The 'Gasfoe' respirator has been approved by the U.S. Bureau of Mines: Approval number 23B-10, and is designed to protect against gases, vapours, and/or metal fumes.

Note: The current from the welding rod always follows the path of least resistance. If, for example, the ground clamp is attached to the rear frame when welding is performed on the front frame, the current must pass a frame connection to return to the welding machine. Since the pivot coupling offers the least resistance but not a sound electrical connection, small electric arcs may be set up across the moving parts which may cause welding blotches on their wearing surfaces and increase the wear rate of these components.

Reinforcement

Frame reinforcement can be made with channel or angle or flat structural stock. Whenever possible, the reinforcement should extend well beyond the bent, broken or cracked area. The reinforcement stock thickness should not exceed that of the frame stock and the material should be of the same tensile strength.

Painting

A check of the condition of the paint should be made approximately twice a year and chassis repainted if necessary.
**WARNING**
Welding, burning, heating or dressing surfaces previously painted using polyurethane paint produces fumes which are toxic. Surfaces must be prepared using paint stripper prior to area being reworked. Recommended Industrial Hygiene and Safety Rules should be followed for protection of the welding operator from the fumes.

To keep rust and corrosion to a minimum, periodic painting of abrasions and other exposed metal areas on the frames is highly recommended.

If painting of a frame is required, thoroughly clean the areas to be painted. Apply a primer coat of polyurethane red oxide and then a finish coat of polyurethane enamel.
DESCRIPTION AND OPERATION

The articulation and oscillation pivot allows the front and rear frames to rotate horizontally (articulation) and tilt laterally (oscillation) with respect to each other. It is also the main load bearing coupling between the two frames. The pivot assembly houses the driveshaft connecting the drive between the front and rear frames.

Articulation bearings, oscillation bushes, pivot driveshaft bearing and associated parts can be removed, inspected and replaced or renewed by following the procedures outlined in this section.
THRU-DRIVE DRIVESHAFT

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: The following procedures assume that only thru-drive components require repair.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

WARNING
When necessary to drive out or drive on components during disassembly/assembly, be sure to use a soft drift to prevent property damage and personal injury.

Removal and Disassembly
1. Position the vehicle on a level work area and apply parking brake.

2. Raise body and install body safety prop to secure body in partially raised position.

3. Shut down engine and block all wheels securely.

4. Identify the relationship of the driveline caps to the transmission yoke and front yoke (17). Remove capscrews and remove driveline from vehicle.

Note: Take extra care when handling drivelines as any deformity on a rotating mass creates vibration and excessive wear during any operation.

5. Remove wheel blocks, start engine and steer vehicle into a full left-hand lock. Shut down engine and block all wheels securely.

6. Remove Lockplate (16), 2 off Front bolts (19) & Front thrust collar (50).

7. Remove and discard ‘O’ rings (29 & 51) from Thrust collar (50).

8. Place a suitable container under the front of the pivot and pull front yoke (17) from driveshaft (14).

9. Disconnect mounting hardware securing protective guard (if fitted), from beneath the parking brake disc, to the rear frame.

10. Release the parking brake by turning the hex-head on the parking brake actuator fully anticlockwise.

WARNING
Tensioned spring on adjuster.

11. Remove mounting hardware securing parking brake assembly to mounting bracket on frame, then secure parking brake assembly clear of brake disc.

12. Identify the relationship of the driveline caps to brake yoke (18). Remove capscrews, disconnect driveline and secure clear of brake yoke.

13. Withdraw driveshaft assembly (14) from housing by pulling rearwards on parking brake disc/brake yoke assembly (18). If necessary, tap front end of driveshaft (14) to ease removal, take care to avoid damaging threads. Place driveshaft (14) assembly on work bench for further disassembly.

14. Prise out and discard seal (15) from front of the housing.

15. Lift out front bearing assembly cup (8) from front of the housing.

16. If bearing replacement is required, use a suitable puller to remove front and rear bearing assembly cups (8) from the housing.

Note: If either bearing assembly cup or cone (8 or 9) need replacing, they must be replaced as a set.

17. If retaining rings (31) need replacing, use a suitable drift or puller to remove them from the housing.

18. Temporarily install front yoke (17) fully onto front of driveshaft (14) and suitably restrain to resist rotation.

19. Remove mounting hardware securing parking brake disc to brake yoke (18) and remove brake disc.

20. Remove Lockplate (16), 2 off Rear bolts (19), Rear Thrust collar (63) & Brake yoke (18) from driveshaft (14). Identify front and rear ends of driveshaft (14).

21. Remove and discard ‘O’ rings (29 & 51) from Rear Thrust collar (63).
22. Remove and discard seal (15) from driveshaft (14).

23. If bearing replacement is required, use a suitable puller or drift to remove rear bearing assembly cone (9) from driveshaft (14).

**Inspection**

1. Clean all parts with a suitable solvent and let dry. DO NOT spin bearings with compressed air. Place bearings on a clean surface, cover with a lint free cloth and allow to dry.

2. Check bearing assemblies cups and cones (8 & 9) for wear or damage. Renew as necessary.

**Note:** If either bearing assembly cup or cone (8 or 9) need replacing, they must be replaced as a set.

3. Inspect splines of driveshaft (14) and yokes (17 & 18) for nicks, burrs or excessive wear. Replace if wear is excessive or splines are nicked. Burrs may be removed with a fine file or medium India stone.

4. Check yokes (17 & 18) for damage in region polished by oil seal lip; even slight damage in this area can cause leakage. Very slight marks may be polished out with fine emery cloth but it is essential that polishing marks are parallel to the seal lip.

5. Replace all seals and 'O' rings with new parts.

**Assembly and Installation**

1. If removed, use a suitable driver and install retaining rings (31) into housing, ensuring that they butt hard against abutment shoulders.

2. Using a suitable driver, install front bearing cup (8) into tractor end of pivot casing. Ensure it is firmly seated & that a 0.05mm (0.002") feeler gauge **cannot** be inserted between cup and mating face.

3. Check rear bearing cup (8) is firmly seated in the body end of the pivot casing, again ensuring 0.05mm (0.002") feeler gauge **cannot** be inserted between cup and mating face.

4. Lightly oil both bearing assembly cones (9) with SAE 80W - 90 E. P. gear oil (24).

5. Support driveshaft (14) in a suitable fixture & tap one Bearing assembly cone (9) onto driveshaft (14) using a tubular mandrel.

6. Refer to Fig. 2, Maintain end face of cone approximately 55mm from end of spline face.

7. Insert driveshaft (14) into truck end of pivot casing until bearing assembly cone (9) seats firmly in the bearing assembly cup (8).

8. Apply loctite (3) to new seal (15) and fit over the driveshaft (14) with seal 'Lip' to bearing side.Press seal home using a mandrel.

9. Apply grease to splines of Front yoke (17) and slide onto the drive shaft (14).

10. Fit new 'O'-rings (29 & 51) to Front thrust collar (50) and fit collar over stub end of driveshaft (14) (align mating holes). Fit 2 off front bolts (19).

11. Tighten Front bolts (19) ; alternately 1/4 - 1/2 turns, drawing driveshaft (14) hard against the inner face of Front thrust collar (50). Shaft will be visible through inspection hole on the collar.

12. Lock Front yoke (17) from rotation by a suitable method / bar acting on the ground. Torque front bolts (19) to 54Nm/39 lbf ft.

13. Using special mandrel (15270104) home locking plate (16) onto Bolts (19). Remove the clamping bar.

14. Slide Rear bearing assembly cone (9) onto rear end of drive shaft (14) until it seats in bearing assembly cup (8).

15. Position clamping bar assembly and screw central bolt hard against bolts (19) of front thrust collar (50), enabling body end bearing to be fully seated home.

16. Using mandrel and heavy hammer, drive Rear bearing assembly cone, fully into cup. Now remove clamp bar assembly from front end.
17. Take remaining seal (15), apply loctite (3) and fit over drive shaft with seal 'Lip' to bearing side. Press seal home using a mandrel.

18. Apply grease to splines of brake yoke (18) and slide onto drive shaft (14). Ensure milled slots of driving flanges are aligned with those of brake yoke.

**Note**: For Measurement letters- refer to fig. 3, unless otherwise stated.

19. Before fitting of Rear Thrust collar (63) record Measurements as stated:

i) Measure total width 'A' of Rear thrust collar (63)

ii) Using Depth micrometer, measure inner bore depth 'B' of collar (63) and record value.

iii) Subtract 'B' from 'A' to determine recess dimension 'C'.

20. Fit Rear thrust collar (63) without 'O'-rings onto Drive shaft (14) and tighten Rear bolts (19) to a nominal torque of 15Nm/11lbf ft.

**Note**: a gap should be visible between end of shaft and inner face of collar.

21. Using a Depth micrometer, measure distance 'D' from collar (63) outer face to end face of drive shaft (14) via the hole in the collar and record the value.

22. The actual free air space 'E' to be shimmed between end of drive shaft (14) and compression face of Thrust collar (63) equals:

\[ E = D' - C' \]

23. Now add 0.6mm (0.024") to dimension 'E' to allow for oversize shims. This value is dimension 'F' (End float will be determined by subtraction).

24. Remove Rear bolts (19) and Rear thrust collar (63) from pivot body end and chap drive shaft (14) to free bearing.

25. Calculate the nominal combination of minimum number if shims (64) to achieve the size nearest to dimension 'F'. Record the appropriate part numbers and total nominal thickness value.

26. Select the shims (64) and measure the total actual thickness of the combination. Record this value.

27. Place the shim pack (64) in the rear thrust collar (63), lock off the Brake yoke (18) from rotation by suitable method / bar on ground. Torque bolts (19) to full torque.

28. Remove the clamp and spin the yoke (18) to ensure driveshaft (14) free rotation.

29. Take a magnetic clock gauge located on the flange of pivot casing, needle acting on rear thrust collar (63)
end face. Check Brake yoke (18) float movement.

30. Take reading obtained and subtract a figure sufficient to give an end float in the range 0.05mm - 0.15mm (0.002” - 0.006”), reduce shim pack (64) accordingly.

31. Remove Rear thrust collar (63) and shims (64) and re-assemble with the appropriate shims. Ensure ‘O’-rings (29 & 51) are now fitted.

32. Lock Brake yoke (18) flange as before, applying alternate 1/4 -1/2 turns on bolts (19). Torque to 54 Nm (39 lbf ft).

33. Remove the locking bar and confirm that the driveshaft (14) end float is in the range 0.05mm - 0.15mm (0.002” - 0.006”) by moving the brake yoke (18) for and aft against the clock gauge.

34. Adjust and refit the shim pack (63) as necessary.

35. Float set correctly; Drive home locking plate (16) using a mandrel (15270104). Re-check the end float.

36. Install parking brake disc on brake yoke (18) and secure with bolts and washers. Tighten bolts to a torque of 73 Nm (54 lbf ft).

37. Install parking brake assembly to mounting brackets and secure with bolts, washers and nuts. Refer to Section 170-0010, PARKING BRAKE AND MOUNTING.

38. Apply parking brake by turning the hex-head on the parking brake actuator fully clockwise.

39. Apply Loctite 638 to the threads of capscrews used to mount driveline to brake yoke (18). Align match marks and install driveline. Tighten capscrews to a torque of 153 Nm (113 lbf ft).

40. Apply Loctite 638 to the threads of capscrews used to mount driveline between transmission yoke and front yoke (17). Align match marks and install driveline. Tighten capscrews to a torque of 153 Nm (113 lbf ft).

41. Remove bolts (7), washers (20), gasket (5) and cover plate (6) from side of oscillation hub to gain access to filler/level hole plug (25) on pivot assembly (1). Remove filler/level plug (25).

42. Add SAE 80W - 90 E. P. gear oil (24) through filler/level hole in pivot assembly (1) until the oil is level with the bottom of filler/level hole.

43. Remove plug (25) from underside of oscillation hub to drain the cavity between the oscillation hub and pivot assembly (1) of any oil that entered while filling the driveshaft bearing housing.

44. Install plug (25) into filler/level hole on pivot assembly (1). Install gasket (5) and cover plate (6) on side of oscillation hub, secure with bolts (7) and washers (20).

45. Install plug (25) into cavity drain port on underside of oscillation hub.

46. Install parking brake disc protective guard (if fitted) and secure with bolts, washers and nuts. Tighten nuts to a torque of 73 Nm (54 lbf ft).

47. Start engine, raise body, lower body safety prop and lower body.

48. Remove wheel blocks.

ARTICULATION COMPONENTS

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: The following procedures assume that only components associated with articulation require repair.

Note: It is essential that the grease used for articulation components is Extreme Pressure Lithium Complex No. 2 (23), as specified in Section 300-0020, LUBRICATION SYSTEM.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

WARNINGs

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

When necessary to drive out or drive on components during disassembly/assembly, be sure to use a soft drift to prevent property damage and personal injury.
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Chassis - Articulation and Oscillation Pivot

Disconnecting Front and Rear Frames

Note: The front and rear frames can be separated sufficiently to permit disassembly/assembly of the articulation components without disconnecting hydraulic lines or electrical wiring.

1. Position the vehicle on a level work area and apply parking brake.
2. Raise body and install body safety prop to secure body in partially raised position.
3. Shut down engine and block all wheels securely.
4. Identify the relationship of the driveline caps to the transmission yoke and front yoke (17). Remove capscrews and remove driveline from vehicle.
5. Support tractor frame at front and rear with suitably placed stands or timbers so the frame will remain level during and after pin removal.
6. Remove bolts, washers and pins securing steering cylinders to pivot. Secure steering cylinders clear of pivot.
7. Release the parking brake by turning the hex-head on the parking brake actuator fully anticlockwise.

8. Attach suitable lifting equipment to pivot/rear frame assembly. Lifting equipment must prevent pivot from oscillating after separation, and, be capable of pulling pivot/rear frame assembly clear of front frame. Raise lifting equipment to support pivot/rear frame assembly.
9. Remove bolt (62), washer (61), large nut (42) and washer (41) securing upper pin (40).
10. Remove upper pin (40). If necessary tap upper pin (40) to ease removal taking care to avoid damaging the threads.

Note: It may be necessary to relieve binding between the pin and pin bores by raising or lowering the pivot/rear frame assembly.

11. Remove bolt (48) and hardened washer (44) securing lower pin (43).
12. Remove lower pin (43). If necessary tap lower pin (43) to ease removal taking care to avoid damaging the pin.

Note: Only separate the frames sufficiently to permit removal of the articulation bearings or damage to hydraulic and electrical connections could result.

13. Remove blocks from rear wheels and use lifting equipment to pull pivot/rear frame assembly clear of the front frame. After moving, block pivot/rear frame assembly and block the wheels.
14. Remove spacer (39) noting orientation to ensure correct installation.

Disassembly

1. Identify seal housings (32, 33, 34 & 35) to ensure correct location on assembly/installation.

Note: Seal housings (32, 33, 34 & 35) are not interchangeable.

2. Remove bolts (46 & 47), washers (45), seal housings (32, 33, 34 & 35) and upper and lower shims (38).
3. Prise out and discard seals (36 & 37) from the housings.
4. Remove and tag all bearing assemblies (30) with spacers to ensure correct assembly/installation.

Note: Bearing assemblies (30) and spacers are a matched set, never interchange cups, cones or spacers between sets.

Inspection

1. Clean all parts with a suitable solvent and let dry. DO NOT spin bearings with compressed air. Place bearings on a clean surface, cover with a lint free cloth.
and allow to dry.

2. Check bearing assemblies (30) and spacers, and pins (40 & 43) for wear or damage. Renew as necessary.

**Note:** Bearing assemblies (30) and spacers must be renewed as a matched set.

3. Replace all seals with new parts.

**Assembly**

1. Apply Loctite 243 (49) sparingly to bore of seal housings (32, 33, 34 & 35).

2. Using a suitable driver, install seals (36 & 37) into seal housings (32, 33, 34 & 35) ensuring that the metal ring on inside of the seals are not disturbed, and, that they are located towards the inside of seal housing.

3. Apply Loctite 243 (49) to threads of outer seal housing bolts (46).

4. Place outer seal housings (32 & 34) in position ensuring that grease relief hole in seal housings are directly opposite bearing grease port on pivot. Secure with bolts (46) and washers (45). Tighten bolts (46) to a torque of 94 Nm (68 lbf ft).

**Note:** Bearing assemblies (30) and spacers are a matched set, never interchange cups, cones or spacers between sets.

5. Using Extreme Pressure Lithium Complex No. 2 grease (23), pack bearing assemblies (30), including end faces, and install bearings.

6. Place inner seal housings (33 & 35) temporarily in position and secure with bolts (47) and washers (45). Tighten bolts (47) to a torque of 16 Nm (12 lbf ft).

7. Using feeler gauges, as shown in Fig. 4, measure the dimension between the inner pivot faces and seal housings (33 & 35). Measure at 3 positions equally spaced around seal housings and determine average dimension, this is the size of shims (38) required.

8. Remove bolts (47), washers (45) and inner seal housings (33 & 35).

9. Install shims (38) as calculated at Step 7, reinstall inner seal housings (33 & 35) and secure with bolts (47) and washers (45). Tighten bolts (47) to a torque of 94 Nm (68 lbf ft).

**Connecting Front and Rear Frames**

1. Install spacer (39) in upper outer seal housing (32), as noted on removal.

2. Smear bearing and pin bores with Extreme Pressure Lithium Complex No. 2 grease (23).

3. Attach suitable lifting equipment to pivot/rear frame assembly. Lifting equipment must prevent pivot from oscillating and be capable of pulling pivot/rear frame assembly to align pivot bearing bores and front frame pin bores. Raise lifting equipment to support pivot/rear frame assembly.

4. Remove blocks from rear wheels and blocking from pivot/rear frame assembly. Using lifting equipment, pull pivot/rear frame assembly to align pivot bearing bores and front frame pin bores. Block wheels and block pivot/rear frame assembly to remain level and stationary.

5. Freeze upper and lower pins (40 & 43) to ease installation.

6. Smear lower pin (43) with Extreme Pressure Lithium Complex No. 2 grease (23) and install through front frame and bearing bores.

**Note:** It may be necessary to relieve binding between the pin and pin bores by raising or lowering pivot/rear frame assembly.

7. Apply Loctite 243 (49) to threads of bolt (48) and secure lower pin (43) with bolt (48) and hardened washer (44). Tighten bolt (48) to a torque of 73 Nm (54 lbf ft).

8. Smear upper pin (40) with Extreme Pressure Lithium Complex No. 2 grease (23) and install through front frame and bearing bores.

9. Apply Loctite 243 (49) to threads of bolt (62). Secure upper pin (40) with bolt (62), washer (61), large nut (42) and washer (41). Tighten nut (42) to a torque of 1 425 Nm (1 050 lbf ft).

**Final Assembly**

1. Apply parking brake by turning the hex-head on the parking brake actuator fully clockwise.

2. Remove lifting equipment from pivot/rear frame assembly.

3. Remove stands or timbers from front frame.
4. Apply Loctite 270 to the threads of capscrews used to mount driveline between transmission yoke and front yoke (17). Align match marks and install driveline. Tighten capscrews to a torque of 153 Nm (113 lbf ft).

5. Align steering cylinder bores and mounting pin bores on pivot, install pins and secure with bolts and washers. Tighten bolts to a torque of 73 Nm (54 lbf ft).

6. Remove plugs (28) from articulation bearing, grease ports and replace with lube fittings (27).

Note: Lube fittings (27) are stored on pad on side of pivot assembly (1).

7. Fill bearing housings with Extreme Pressure Lithium Complex No. 2 grease (23), through lube fittings (27), until excess grease starts to escape from seal housings (32 & 34).

8. Remove lube fittings (27) and reinstall plugs (28). Store lube fittings (27) on pad on side of pivot assembly (1).

9. Start engine, raise body, lower body safety prop and lower body.

10. Remove wheel blocks.

Oscillation Components
Numbers in parentheses refer to Fig. 1.

Note: The following procedure assumes that only components associated with oscillation require repair.

Note: It is necessary to disconnect the front and rear frames at the articulation point to service the oscillation components.

Note: It is essential that the grease used for oscillation components is Extreme Pressure Multipurpose Grease (26), as specified in Section 300-0020, LUBRICATION SYSTEM.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠️ When necessary to drive out or drive on components during disassembly/assembly, be sure to use a soft drift to prevent property damage and personal injury.

⚠️ Hydraulic fluid pressure will remain within the braking system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

Disconnecting Front and Rear Frames
1. Position the vehicle on a level work area and apply parking brake.

2. Raise body and install body safety prop to secure body in partially raised position.

3. Shut down engine and block all wheels securely.

4. Depress and release brake pedal continuously to relieve the pressure in the braking system.

5. Carefully loosen brake lines at base of both accumulators to check that the pressure has released. Re-tighten brake lines.

6. Tag all hydraulic lines and electrical wiring between front and rear frames to ensure correct assembly/ installation. Disconnect all hydraulic lines and plug openings to prevent ingress of dirt. Disconnect electrical wiring and any other attachments which could be damaged on separation of front and rear frames.
7. Identify the relationship of the driveline caps to the transmission yoke and front yoke (17). Remove capscrews and remove driveline from the vehicle.

8. Support tractor frame at front and rear with suitably placed stands or timbers to keep the frame level during and after pin removal.


10. Release the parking brake by turning the hex-head on the parking brake actuator fully anticlockwise.

**WARNING**

Tensioned spring on adjuster.

11. Attach suitable lifting equipment to pivot/rear frame assembly. Lifting equipment must prevent pivot from oscillating after separation, and, be capable of pulling pivot/rear assembly clear of front frame. Raise lifting equipment to support pivot/rear frame assembly.

12. Remove bolt, washer, large nut (42) and washer (41) securing upper pin (40).

13. Remove upper pin (40). If necessary tap upper pin (40) to ease removal taking care to avoid damaging the threads.

**Note:** It may be necessary to relieve binding between the pin and pin bores by raising or lowering the pivot/ rear frame assembly.

14. Remove bolt (48) and hardened washer (44) securing lower pin (43).

15. Remove lower pin (43). If necessary tap lower pin (43) to ease removal taking care to avoid damaging the pin.

16. Remove blocks from rear wheels and use lifting equipment to pull pivot/rear frame assembly clear of the front frame. After moving, block pivot/rear frame assembly and block the wheels.

17. Remove spacer (39) noting orientation to ensure correct installation. Cover articulation bearings to prevent ingress of dirt.

**Disassembly**

1. Remove protective guard (if fitted) from beneath parking brake disc by removing mounting hardware securing guard to the rear frame. Refer to Section 170-0010, PARKING BRAKE AND MOUNTING.

2. Remove mounting hardware securing parking brake assembly to mounting bracket on frame. Remove and secure parking brake assembly clear of brake disc.

3. Identify the relationship of the driveline caps to brake yoke (18). Remove capscrews, disconnect driveline and secure clear of brake yoke (18).

4. Remove mounting hardware securing parking brake disc to brake yoke (18) and remove brake disc.

5. Place a suitable container under rear brake yoke (18) to catch oil released when pulling brake yoke (18) from driveshaft (14).

6. Remove Rear bolts (19), Lockplate (16) & Rear thrust collar (63). Pull brake yoke (18) from driveshaft (14)

7. Remove adaptor (57), connector (58), elbow (59) and pipe assembly (60) from oscillation hub.

8. Remove bolts (22) and washers (21) securing locking plate (12). Remove locking plate (12).

9. Restrain pivot assembly (1) to prevent it oscillating, by placing a heavy bar between the steering cylinder mountings. Lock the bar in position using suitable trestles or stands. See Fig. 5.

10. Using a suitable tool, remove thrust nut (11). If wear area of thrust nut (11) is damaged, replace thrust nut (11).

11. Insert an M20 eyebolt into tapped pad provided on top of pivot assembly (1) and attach suitable lifting equipment.

12. Remove pivot restraining bar.

13. Using lifting equipment, carefully pull pivot assembly (1) clear of oscillation hub. Place pivot assembly (1) in a suitable work area for further disassembly.

14. Note position of front 'V' ring (10) to aid in 'Installation'. Remove and discard 'V' ring (10).

15. Inspect nylon oscillation bushes (2) as described in 'Inspection'. If bushes are to be renewed, proceed with step 16.

16. Remove nylon oscillation bushes (2) with hammer and chisel.
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Note: The suggested method is to make an axial cut along the bush then to lever the bush in order to collapse it upon itself.

Inspection

1. Clean nylon oscillation bushes with a suitable solvent and allow to dry.

2. Inspect nylon oscillation bushes for wear, scoring, erosion and 'out of round'. Pay particular attention to the thrust faces of the bushes which should also be inspected for cracking/splitting. Renew if required.

3. Replace all seals with new parts.

Assembly

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

WARNING

To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Wipe bush housing clean using a suitable solvent and allow to dry.

2. Apply Loctite 648 (3) and Loc Quick Primer (4) and align new bushes (2) to housing with grease holes aligned vertically and identification 'PAINT DOT' at Top Dead Centre. Refer to Fig. 6. Drift bushes (2) into housing using hammer with soft packing for protection.

3. Install plug (25) in filler/level hole on pivot assembly (1). Install gasket (5) and cover plate (6) on side of oscillation hub and secure with bolts (7) and washers (20).

4. Install plug (25) in cavity drain port on underside of oscillation hub.

5. Install plugs (28) into oscillation bearing grease ports.

6. Lightly coat 'V' ring (10) and machined surfaces of pivot with Extreme Pressure Multipurpose Grease (26) and, install 'V' ring (10), with lip towards rear, on front of oscillation hub.

7. Using suitable lifting equipment, and taking care to prevent damaging bushes (2) or pivot threads, install pivot assembly (1) into rear frame.

8. Lightly coat 'V' ring (10) and machined surfaces of pivot with Extreme Pressure Multipurpose Grease (26) and, install 'V' ring (10), with lip towards front, on rear of oscillation hub.

9. a) Restrain pivot assembly (1) to prevent it oscillating, by placing a heavy bar between the steering cylinder mountings. Lock the bar in position using suitable trestles or stands. See Fig. 5.

   b) Secure a suitable tool to pivot thrust nut (11) and tighten thrust nut (11) until there is no end float/clearance at thrust face of either bush. Slacken thrust nut (11) until pin of the locking plate (12) can be inserted in the first available hole in the thrust nut (11).

   c) Secure locking plate (12) with bolts (22) and lockwashers (21). Torque tighten bolts (22) to 94 Nm (69 lbf ft).

10. Install adaptor (57), connector (58), elbow (59) and pipe assembly (60) to oscillation hub.

11. Install brake yoke (18) on driveshaft (14) until it butts against bearing assembly cup and cone (8 & 9).

12. Install parking brake disc on brake yoke (18) and secure with bolts, washers and nuts. Tighten bolts to a torque of 73 Nm (54 lbf ft).

13. Install rear of driveshaft (14).

14. Install Brake yoke (18), Rear thrust collar (63) ensuring 'O'-rings (29& 51) are in place, shim pack (64) and bolts (19).
15. Lock off Brake yoke flange as before (18) with suitable clamping method. Torque bolts (19) to 73 Nm (lbf ft)

16. Take a magnetic clock gauge located on the flange of pivot casing, needle acting on Rear thrust collar (63) end face. Check Brake yoke (18) float movement. Ensure still within range 0.05mm - 0.15mm (0.002" - 0.006")
17. If float is incorrect, alter arrangement of shim pack (64) to bring within size.
18. Using special mandrel (15270104) home locking plate (16) onto bolts (19). Remove clamping bar.

Connecting Front and Rear Frames
1. Install spacer (39) in upper bearing assembly (30) as noted on removal.
2. Smear bearing assembly (30) and pin bores with Extreme Pressure Lithium Complex No. 2 grease (23).
3. Attach suitable lifting equipment to pivot/rear frame assembly. Lifting equipment must prevent pivot from oscillating and be capable of pulling pivot/rear frame assembly to align pivot bearing bores and front frame pin bores. Raise lifting equipment to support pivot/rear frame assembly.
4. Remove blocks from rear wheels and blocking from pivot/rear frame assembly. Using lifting equipment, pull pivot/rear frame assembly to align pivot bearing bores and front frame pin bores. Block wheels and block pivot/rear frame assembly to remain level and stationary.
5. Freeze upper and lower pins (40 & 43) to ease installation.

Note: It may be necessary to relieve binding between the pin and pin bores by raising or lowering pivot/rear frame assembly.
6. Smear lower pin (43) with Extreme Pressure Lithium Complex No. 2 grease (23) and install through front frame and bearing bores.
7. Apply Loctite 243 (49) to threads of bolt (48). Secure lower pin (43) with bolt (48) and hardened washer (44). Tighten bolt (48) to a torque of 73 Nm (54 lbf ft).

8. Smear upper pin (40) with Extreme Pressure Lithium Complex No. 2 grease (23) and install through front frame and bearing bores.
9. Apply Loctite 243 (49) to threads of bolt (62). Secure upper pin (40) with bolt (62), washer (61), washer (41) and large nut (42). Tighten nut (42) to a torque of 1 425 Nm (1 050 lbf ft).

Final Assembly
1. Install parking brake assembly to mounting brackets and secure with bolts, washers and nuts. Refer to Section 170-0010, PARKING BRAKE AND MOUNTING.
2. Apply parking brake by turning the hex-head on the parking brake actuator fully clockwise.
3. Remove lifting equipment from pivot/rear frame assembly.
4. Remove stands or timbers from front frame.
5. Apply Loctite 270 to threads of capscrews used to mount driveline between transmission yoke and front yoke (17). Align match marks and install driveline. Tighten capscrews to a torque of 153 Nm (113 lbf ft).
6. Align match marks and reconnect driveline to brake yoke (18). Tighten capscrews to a torque of 153 Nm (113 lbf ft).

Note: Take extra care when handling drivelines as chips, dents, burrs or deformity on any rotating mass creates vibration and excessive wear during any operation.
7. Align steering cylinder bores and mounting pin bores on pivot. Install pins and secure with bolts and washers. Tighten bolts to a torque of 73 Nm (54 lbf ft).
8. Connect hydraulic lines and electrical wiring as noted on disassembly.
9. Remove bolts (7), washers (20), gasket (5) and cover plate (6) from side of oscillation hub to gain access to filler/level plug (25) on pivot assembly (1). Remove filler/level plug (25).
Chassis - Articulation and Oscillation Pivot

Section 100-0020

10. Add SAE 80W - 90 E. P. gear oil (24) through filler/level hole in pivot assembly (1) until the oil is level with the bottom of filler/level hole.

11. Remove plug (25) from underside of oscillation hub to drain the cavity between the oscillation hub and pivot assembly (1) of any oil that entered while filling the driveshaft bearing housing.

12. Install plug (25) in filler/level hole on pivot assembly (1). Install gasket (5) and cover plate (6) on side of oscillation hub, secure with bolts (7) and washers (20).


14. Remove plugs (28) from articulation bearing grease ports and replace with lube fittings (27).

Note: Lube fittings (27) are stored on pad on side of pivot assembly (1).

15. Fill bearing housings with Extreme Pressure Lithium Complex No. 2 grease (23) through lube fittings (27) until excess grease starts to escape from seal housings (32 & 34).

16. Remove lube fittings (27) and reinstall plugs (28). Store grease fittings (27) on pad on side of pivot assembly (1).

17. Add Extreme Pressure Multipurpose grease (26) to oscillation bushing lube fittings (55) on top of oscillation hub. Lube until excess grease in seen.

18. Install parking brake disc protective guard (if fitted) and secure with bolts, washers and nuts. Tighten nuts to a torque of 73 Nm (54 lbf ft).

19. Start engine to charge hydraulic systems, raise body, lower body safety prop and lower the body.

20. Bleed the braking system as described in Section 165-0010, BRAKE PARTS.

21. Remove wheel blocks.

MAINTENANCE
Numbers in parentheses refer to Fig. 1.

Every 250 hours, oscillation bushes must be lubricated. Add Extreme Pressure Multipurpose grease (26) to oscillation bushing lube fittings (55) on top of oscillation hub. Lube until excess grease in seen.

**WARNING**
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

Every 250 hours, check the end float/clearance at the thrust face of the oscillation bushes. Any clearance found must be removed by adjustment of the thrust nut, as described in step 9 of ‘Assembly’ procedure.

**Note:** A practical method of establishing the effective adjustment of the thrust nut is to use movement of the machines body in the raised position. Move the body from fully raised to almost fully raised while watching the effect of this action on the frame and pivot arrangement. Any slackness between the thrust nut and thrust faces will be clearly visible movement of the frame.

Every 1 000 hours (6 months), follow the procedure given below to check the oil level in the driveshaft bearing housing, and, lubricate the articulation and oscillation bearings.

**Note:** It is essential that the grease used for articulation components is Extreme Pressure Lithium Complex No. 2 grease (23), as specified in Section 300-0020, LUBRICATION SYSTEM.

1. Position the vehicle on a level work area and apply parking brake.

2. Raise body and install body safety prop to secure body in partially raised position.

3. Shut down engine and block all wheels securely.

4. Remove protective guard (if fitted) from beneath parking brake disc by removing nuts, washers and bolts securing guard to rear frame.

5. Remove bolts (7), washers (20), gasket (5) and cover plate (6) from side of oscillation hub to gain access to filler/level plug (25) on pivot assembly (1). Remove filler/level plug (25).

6. Add SAE 80W - 90 E. P. gear oil (24) through filler/level hole in pivot assembly (1) until the oil is level with the bottom of filler/level hole.
7. Remove plug (25) from underside of oscillation hub to drain the cavity between the oscillation hub and pivot assembly (1) of any oil that entered while filling the driveshaft bearing housing.

8. Install plug (25) into filler/level hole on pivot assembly (1). Install gasket (5) and cover plate (6) on side of oscillation hub, secure with bolts (7) and washers (20).

9. Install plug (25) into cavity drain port on underside of oscillation hub.

10. Remove plugs (28) from articulation bearing grease ports and replace with lube fittings (27).

**Note:** Lube fittings (27) are stored on pad on side of pivot assembly (1).

11. Fill bearing housings with Extreme Pressure Lithium Complex No. 2 grease (23) through lube fittings (27) until excess grease starts to escape from seal housings (32 & 34).

12. Remove lube fittings (27) and reinstall plugs (28). Store grease fittings (27) on pad on side of pivot assembly (1).

13. Add Extreme Pressure Multipurpose grease (26) to oscillation bushing lube fittings (55) on top of oscillation hub. Lube until excess grease is seen.

14. Install parking brake disc protective guard (if fitted) and secure with bolts, washers and nuts. Torque tighten nuts to 73 Nm (54 lbf ft).

15. Start engine, raise body, lower body safety prop and lower body.

16. Remove wheel blocks.

**SPECIAL TOOLS**

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the thrust nut tool and general service tools and adhesives required for procedures outlined in this section. These tools and adhesives are available from your dealer.
### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. No.</th>
<th>ITEM No.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>1</td>
<td>19</td>
<td>Nut (to seat bearing only)</td>
<td>250</td>
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<td>48</td>
<td>Parking Brake Disc Bolts</td>
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<td></td>
<td></td>
<td>Parking Brake Brkt Mounting Nuts</td>
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<tr>
<td></td>
<td></td>
<td>Driveline Mounting Capscrews</td>
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<tr>
<td></td>
<td></td>
<td>Protective Guard Mounting Nuts</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steering Cylinder Pin Bolts</td>
<td>73</td>
</tr>
</tbody>
</table>

* * * *
HOOD

Removal

Numbers in parentheses refer to Fig. 1.

**WARNING**

To prevent personal injury and property damage, be sure blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the machine on a level surface, apply the parking brake and switch off the engine.

2. Block all road wheels and place the battery master switch in the 'Off' position.

3. Remove bolts, washers, lockwashers and nuts securing grille (27) to grille subframe. Secure grille (27) clear of hood (1).

4. Pull cable assembly (16), handle inside battery box, to release hood catch and lift up hood (1). Secure hood (1) in raised position using suitable lifting equipment.

5. Carefully remove bolts, washers and nuts securing hood retaining straps (14) and gas struts (15).
Chassis - Hood and Mounting

Remove fasteners, hood retaining straps (14) and gas struts (15) from hood (1).

6. Remove bolts (39), washers (13) and nuts (17) securing hinge assemblies (2) to frame. Carefully lift hood (1) assembly from the machine.

7. If required, remove mounting hardware securing grille subframe to hood (1). Secure grille subframe clear of hood (1).

8. If required, remove bolts (10) and washers (11) securing handles (9) to hood (1). Secure handles (9) clear of hood (1).

Installation

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

GOALPOST SUPPORT ASSEMBLY

Removal

Numbers in parentheses refer to Fig. 1.

1. Position the machine on a level surface, apply the parking brake and switch off the engine.

2. Block all road wheels and place the battery master switch in the off position.

3. Pull cable assembly (16), handle inside battery box, to release hood catch and lift up hood (1). Secure hood (1) in raised position.

4. Remove mounting hardware securing washer bottle to mounting bracket on the left hand side of goalpost support assembly (18). Secure washer bottle clear of goalpost support assembly (18).

5. Remove plate and mounting hardware securing transmission oil cooler to goalpost support assembly (18). If required, disconnect transmission oil cooler hoses.

6. Remove mounting hardware securing air cleaner intake tube to goalpost support assembly (18).

7. With a suitable container available to catch leakage, remove drain plug from radiator header tank and drain coolant. Apply Loctite 225 to drain plug and reinstall in header tank.

8. Ensure all cooling lines connected to header tank are identified for ease of installation and with suitable containers available to catch leakage, disconnect cooling lines. Fit blanking caps to all open lines.

9. Disconnect electrical harness from coolant level sensor in header tank. Note routing of all hoses and harnesses attached to and through goalpost support assembly (18) and disconnect.

10. Disconnect hood cable (16) ball joint from cam plate assembly (33) and secure cable (16) clear of hood catch mechanism.

11. Check to make certain that all necessary line and
cable disconnections have been made, before lifting goalpost support assembly (18).

12. Attach suitable lifting equipment to goalpost support assembly (18). Remove bolts (23), washers (24 & 25) and locknuts (26) securing goalpost support assembly (18) to its mounting. Lift goalpost support assembly (18) from the machine.

13. If required, remove locknuts (22), bolts (19), hood stops (20) and springs (21) from goalpost support assembly (18).

14. If required, remove bolts (30), washers (31) and nuts (29) securing hood catch mechanism (28 - 38) to goalpost support assembly (18). Remove hood catch mechanism (28 - 38).

Installation

Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. If removed, secure hood catch mechanism (28 - 38) to goalpost support assembly (18) with mounting hardware as removed at 'Removal'.

2. If removed, secure hood stops (20) and springs (21) to goalpost support assembly (18) with bolts (19) and locknuts (22).

3. Using suitable lifting equipment, lift and position goalpost support assembly (18) on the machine. Secure goalpost support assembly (18) to its mounting with bolts (23), washers (24 & 25) and locknuts (26).

4. Remove lifting equipment.

5. Connect hood cable (16) ball joint to cam plate assembly (33) and secure cable (16) using clips removed during 'Removal'.

6. Fit plate and mounting hardware securing transmission oil cooler to goalpost support assembly (18) as removed during 'Removal'. If necessary, reconnect transmission oil cooler hoses. Ensure transmission oil cooler contains sufficient oil. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

7. Install washer bottle to mounting bracket on the left hand side of goalpost support assembly (18) and secure using mounting hardware as removed during 'Removal'.

8. Secure air cleaner intake tube to goalpost support assembly (18) using mounting hardware as removed during 'Removal'.

9. Remove blanking caps from all cooling lines and connect cooling lines to radiator header tank as tagged at 'Removal'.

10. Connect electrical harness to coolant level sensor in header tank. Secure all hoses and harnesses to and through goalpost support assembly (18) following routing as noted at 'Removal'.

11. Fill radiator header tank with coolant as specified in Section 210-0000, COOLING SYSTEM.

12. Lubricate hood catch mechanism. Use grease as specified in Section 300-0020, LUBRICATION SYSTEM.

13. Lower hood assembly and check for correct alignment between hood (1) and goalpost support assembly (18) and for operation of hood catch mechanism.

14. Remove wheel blocks.

**MAINTENANCE**

Periodically check bolts (39), washers (13) and locknuts (17) and tighten when necessary.

Periodically check condition of hood catch mechanism and adjust and lubricate when necessary.

**SPECIAL TOOLS**

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools and adhesives are available from your dealer.
Fig. 1 - Engine and Mounting

1 - Engine
2 - Alternator Belt
3 - Oil Filter
4 - Fuel Filter
5 - Coolant Filter
6 - Fan Belt
7 - Rear Mount
8 - Front Mounting Bracket
9 - Bolt
10 - Lockwasher
11 - Bolt
12 - Washer
13 - Bolt
14 - Isolation Mount
15 - Snubbing Washer
16 - Bolt
17 - Locknut
18 - Bolt
19 - Lockwasher
20 - Flywheel Guard
21 - Bolt
22 - Bracket
23 - Engine Coupling
24 - Bolt
25 - Nut
26 - Bracket Assembly
27 - Fan Clutch
28 - Fan
29 - Nut
30 - Washer
31 - Bracket
32 - Hose Assembly
33 - Elbow
34 - Elbow
35 - Hose Assembly
36 - Bolt
37 - Lockwasher
38 - Snubbing Washer
39 - P.Clip
40 - Washer
41 - Bolt
42 - Lockwasher
43 - Washer
44 - Earth Cable
45 - P.Clip
46 - Nut
47 - "L" Bracket
48 - Bolt
49 - Nut
50 - Lockwasher
51 - Washer
52 - P.Clip
53 - Bolt
54 - Bracket
55 - Clip - Rubber
56 - Clip - Rubber
57 - Washer
58 - Lockwasher
59 - Bolt
60 - Bracket Assembly
61 - Lockwasher
62 - Bolt
63 - Bolt
64 - Nut-Stacking
65 - Bushing Split
66 - Bushing Split
67 - Clamp
68 - Reducer
69 - Elbow
70 - Bolt
71 - Locknut
72 - Clip
73 - Bolt
74 - Locknut
75 - Clip
76 - Elbow
77 - Plug
78 - Connector Kit
79 - Washer
80 - Clamp
81 - Bolt
82 - Nut
**DESCRIPTION**

Numbers in parentheses refer to Fig. 1.

For engine make, model and specification, refer to Section 000-0000, GENERAL INFORMATION. For engine servicing and repair data refer to the engine manufacturers service manual.

The engine is mounted to the tractor frame at three points by a mounting bracket at the front of engine (8) and two rear mounts (7). Rubber isolation mounts (14) through engine mounts provide sufficient flexibility to absorb varying engine vibration and torsional loads.

Lube oil filter (3) and fuel filter (4) are remote mounted in the battery box on the left hand side of machine. The filters are of the throw away, spin-on type. Oil supplied by the engine oil pump passes through oil filter (3) before reaching the various moving parts of engine (1). Fuel drawn from the fuel tank passes through fuel filter (4) before reaching the fuel pump.

Engine coolant filter (5) is a replaceable spin-on type element mounted on the left hand side of engine (1). Refer to Section 210-0000, COOLING SYSTEM.

**QUANTUM ELECTRONIC FUEL SYSTEM**

Description

Refer to Fig. 2.

---

**WARNING**

Before any welding is done on a machine equipped with the Quantum Electronic Fuel System, disconnect the following in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables and electrical connections at the engine ECM, transmission ECU, body control lever, hydraulics ECU and cab bulwark to avoid damage to electrical components. Turn off battery master switch to isolate the batteries before disconnecting any components.

After welding connect all of the above in the reverse order.

---

The engine is equipped with Quantum Electronic Fuel System which controls the timing and amount of fuel injection by the electronic fuel system injectors. The system also monitors several engine functions using electrical sensors which send electrical signals to the electronic control module (ECM). The ECM then computes the incoming data and determines the correct fuel output and timing for optimum power, fuel economy and emissions.

The Quantum Electronic Fuel System also takes action to prevent damage to the engine and, provides the serviceman with diagnostic capabilities so that problems can be corrected quickly and easily.

1. **Electronic Control Module (ECM)** - Receives electronic inputs from the driver as well as from mounted sensors that provide information electronically, such as oil pressure and temperature and intake manifold pressure. This information is used to control both the quantity of fuel injected and injection timing.

2. **Programmable Read Only Memory (PROM)** - Located in the ECM and encoded with the operating software. Additional information is programmed into the EEPROM. This information controls the horsepower rating, torque curve, maximum engine speed and engine protection devices. The ECM processes this information and sends electronic signals to the Electronic Fuel System Injectors where the precise amount of fuel is injected into the engine.

3. **Electronic Fuel System Injectors** - The injector is a lightweight, compact unit that injects diesel fuel directly into the combustion chamber. The amount of fuel injected and the beginning of injection timing is determined by the ECM. The ECM sends a command pulse which activates the injector solenoid.

The injector performs four functions:

a - Creates the high fuel pressure required for efficient injection.

b - Meters and injects the exact amount of fuel required to handle the load.

c - Atomizes the fuel for mixing with the air in the combustion chamber.

d - Permits continuous fuel flow for component cooling.

Electronic fuel system injectors are self compensating and virtually eliminate engine tune-ups.

**Note:** Never apply 12 V directly to terminals on the injector as it will burn out. Before removing injectors, the fuel passages must be blown out to prevent fuel flow from entering the cylinder head.

4. **Batteries** - Two 12 volt maintenance free batteries supply the machine with electrical power to operate all electrical components.
5. **Electronic Foot Pedal** - The electronic foot pedal provides an electrical signal to the engine's fuel control system in proportion to the degree of pedal actuation.

**Note:** The engine MUST be started with foot 'OFF' the electronic foot pedal.

Do not place engine under full load at full speed immediately after starting. Always allow the engine to fully circulate lubricant and warm up gradually before operating at full speed and full load. Operate engine at top rated speed when maximum power is needed for the load.

6. **Check Engine Light** - When the 'Check Engine' light comes on, the computer has detected a fault in the engine. The fault should be diagnosed and corrected at the earliest opportunity.

7. **Stop Engine Light** - When the 'Stop Engine' light comes on, the computer has detected a major malfunction in the engine that requires immediate attention. It is the operators responsibility to shut down the engine to avoid serious damage.

8. **Diagnostic Test Point** - Plug in connector for diagnostic data reader (DDR).

9. **Maintenance Light** - The maintenance light will illuminate when it is time to change the engine oil. The maintenance monitor continuously monitors the time the engine has been operating and the amount of fuel burned to determine when it is time to change oil.

**Note:** Whenever an electrical fault has occurred, the maintenance monitor data can be inaccurate.

10. **Engine Diagnostic Switch** - To check for active codes:

   a. turn the ignition key switch to the 'OFF' ('0') position.
   b. press the diagnostic switch to the 'ON' position.
   c. turn the ignition key switch to position ‘1’.

If no active codes are recorded, both the 'Stop' and 'Check' lights will illuminate and stay on.

If active codes are recorded the 'Stop' and 'Check'
lights will illuminate momentarily. The amber 'Check' and red 'Stop' lights will begin to flash the code of the recorded fault.

11. Engine Diagnostic Request Switch - When the engine is in diagnostic mode this switch is used to search through a list of fault codes, i.e. pressing the top of the switch momentarily will advance to the next active fault code, pressing the bottom of the will go back to the previous code. If only one code is active, the system will continuously display the same fault code.

Operation
Numbers in parentheses refer to Fig. 2.

When the 'Stop' light on the dash panel illuminates, the ECM (1) has detected a major malfunction in the engine that requires immediate attention. It is the operator's responsibility to shut down the engine to avoid serious damage.

The machine is equipped with an engine protection derate system, which records fault codes and illuminates appropriate warning lights when an out-of-range condition associated with any of the following sensors is found:

• Coolant temperature
• Coolant level
• Intake manifold temperature
• Oil pressure
• Oil temperature

The engine power and speed will be gradually reduced depending on the level of severity of the out-of-range condition. The operator MUST shut down the engine to avoid serious damage.

The engine should not be restarted after it has been shut down after activation of the engine protection derate system unless the problem has been diagnosed and corrected.

Whenever the 'Stop' (7) or 'Check' (6) light comes on, the Electronic Fuel System computer will determine where the problem is and will store this information in its memory. If the malfunction is intermittent, the lights will come on and go off as the computer senses the changing engine condition.

A special diagnostic data reader (INSITE) is available that can be plugged into the engine computer memory via the diagnostic test point (8). The reader is used to extract information related to the cause of the problem. Once the malfunction has been corrected, the Electronic Fuel System will return the engine to normal operation. The data reader can now distinguish between active codes and those stored in the historic code memory (inactive codes). Inactive codes can only be viewed using the data reader. The fault code recorded in the ECM memory will remain until it is erased by a technician.

**WARNING**

The operator of a Quantum-equipped vehicle must not attempt to use or read a data reader of any kind while the vehicle is operating. Doing so can result in loss of control, which may cause vehicle damage and may result in personal injury.

The operator can check for active faults by turning the ignition key switch to the 'OFF' position, switching the diagnostic switch (10) 'ON' and then turning the ignition key switch to position '1'.

If no active fault codes are recorded, both 'Stop' (7) and 'Check' (6) lights will come on and stay on. If active codes are recorded, both lights will come on momentarily. The amber 'Check' (6) and red 'Stop' (7) lights will begin to flash the code of the recorded fault. The fault codes flash in the following sequence: the amber light flashes once, then there is a pause where both lights are off. Then the numbers of the recorded fault code flash in red. There is a pause between each number. When the number is done, the amber light flashes again. e.g. amber flashes once - pause - red flashes twice - pause - red flashes three times - pause - red flashes five times - pause - amber flashes once, indicates fault code 235. The number will repeat in the same sequence until the system is advanced to the next active fault code by diagnostic request switch (11), or the diagnostic switch (10) is switched to the 'OFF' position. Refer to 'Electronic Fuel System Diagnostic Codes' table for fault code descriptions.
## ELECTRONIC FUEL SYSTEM DIAGNOSTIC CODES

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<th>Description</th>
<th>Fault Lamp</th>
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<td>111</td>
<td>ECM Hardware Internal Failure - Mission disabling</td>
<td>Red</td>
</tr>
<tr>
<td>115</td>
<td>Engine Speed Sensor - Both signals lost</td>
<td>Red</td>
</tr>
<tr>
<td>121</td>
<td>Engine Speed Sensor - One signal lost</td>
<td>Amber</td>
</tr>
<tr>
<td>122</td>
<td>Boost Pressure Sensor - Component shorted high</td>
<td>Amber</td>
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<tr>
<td>123</td>
<td>Boost Pressure Sensor - Component shorted low</td>
<td>Amber</td>
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<td>131</td>
<td>Throttle Position Sensor - Component shorted high</td>
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<td>135</td>
<td>Oil Pressure Sensor - Component shorted high</td>
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<td>Oil Pressure Sensor - Component shorted low</td>
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<td>143</td>
<td>Oil Pressure Sensor - Data below normal range</td>
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<td>144</td>
<td>Engine Coolant Temperature Sensor - Component shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>145</td>
<td>Engine Coolant Temperature Sensor - Component shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>147</td>
<td>Throttle Position Sensor - Circuit low frequency</td>
<td>Red</td>
</tr>
<tr>
<td>148</td>
<td>Throttle Position Sensor - Circuit high frequency</td>
<td>Red</td>
</tr>
<tr>
<td>151</td>
<td>Engine Coolant Temperature Sensor - Data above normal range</td>
<td>Amber</td>
</tr>
<tr>
<td>153</td>
<td>Intake Manifold Temperature Sensor - Component shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>154</td>
<td>Intake Manifold Temperature Sensor - Component shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>155</td>
<td>Intake Manifold Temperature Sensor - Data above normal range</td>
<td>Amber</td>
</tr>
<tr>
<td>187</td>
<td>Sensor Supply Voltage #2 - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>211</td>
<td>Additional OEM/Vehicle Diagnostic Codes have been logged</td>
<td>None</td>
</tr>
<tr>
<td>212</td>
<td>Oil Temperature Sensor - Component shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>213</td>
<td>Oil Temperature Sensor - Component shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>214</td>
<td>Oil Temperature - Data above normal range</td>
<td>Red</td>
</tr>
<tr>
<td>219</td>
<td>Low Oil Level in Make up tank</td>
<td>Maint.</td>
</tr>
<tr>
<td>221</td>
<td>Ambient Air Pressure Sensor - Component shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>222</td>
<td>Ambient Air Pressure Sensor - Component shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>223</td>
<td>Engine Oil Burn Valve Solenoid - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>227</td>
<td>Sensor Supply Voltage #2 - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>234</td>
<td>Engine Speed - Data above normal range</td>
<td>Red</td>
</tr>
<tr>
<td>235</td>
<td>Engine Coolant Level - Data below normal range</td>
<td>Amber</td>
</tr>
<tr>
<td>237</td>
<td>External Speed Input (Multiple Unit Synchronization) - Data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>241</td>
<td>Vehicle Speed Sensor Circuit - Data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>242</td>
<td>Vehicle Speed Sensor Circuit - Tampering has been detected</td>
<td>Amber</td>
</tr>
<tr>
<td>245</td>
<td>Fan Clutch - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>254</td>
<td>Fuel Shutoff Value - Component shorted low</td>
<td>Red</td>
</tr>
<tr>
<td>255</td>
<td>Fuel Shutoff Value - Component shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>285</td>
<td>SAE J1939 Multiplexing PGN timeout error</td>
<td>Amber</td>
</tr>
<tr>
<td>286</td>
<td>SAE J1939 Multiplexing configuration error</td>
<td>Amber</td>
</tr>
<tr>
<td>287</td>
<td>SAE J1939 Multiplexing accelerator pedal sensor system error</td>
<td>Red</td>
</tr>
<tr>
<td>288</td>
<td>SAE J1939 Multiplexing Remote throttle data error</td>
<td>Red</td>
</tr>
<tr>
<td>293</td>
<td>Auxiliary Temperature Sensor Input #1 - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>294</td>
<td>Auxiliary Temperature Sensor Input #1 - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>295</td>
<td>Ambient Air Pressure Sensor - Circuit data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>297</td>
<td>Auxiliary Pressure Sensor Input #2 - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>298</td>
<td>Auxiliary Pressure Sensor Input #2 - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>299</td>
<td>Engine Shutdown - Commanded by J1939</td>
<td>Amber</td>
</tr>
<tr>
<td>311</td>
<td>Injector Solenoid Valve Cylinder #1 Circuit - Grounded circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>312</td>
<td>Injector Solenoid Valve Cylinder #5 Circuit - Grounded circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>313</td>
<td>Injector Solenoid Valve Cylinder #3 Circuit - Grounded circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>314</td>
<td>Injector Solenoid Valve Cylinder #6 Circuit - Grounded circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>315</td>
<td>Injector Solenoid Valve Cylinder #2 Circuit - Grounded circuit</td>
<td>Amber</td>
</tr>
</tbody>
</table>
### ELECTRONIC FUEL SYSTEM DIAGNOSTIC CODES

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
<th>Fault Lamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>319</td>
<td>Real Time Clock - Power interrupt</td>
<td>Maint</td>
</tr>
<tr>
<td>321</td>
<td>Injector Solenoid Valve Cylinder #4 Circuit - Grounded circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>322</td>
<td>Injector Solenoid Valve Cylinder #1 Circuit - Open circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>323</td>
<td>Injector Solenoid Valve Cylinder #5 Circuit - Open circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>324</td>
<td>Injector Solenoid Valve Cylinder #3 Circuit - Open circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>325</td>
<td>Injector Solenoid Valve Cylinder #6 Circuit - Open circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>331</td>
<td>Injector Solenoid Valve Cylinder #2 Circuit - Open circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>332</td>
<td>Injector Solenoid Valve Cylinder #4 Circuit - Open circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>341</td>
<td>ECM - Data lost</td>
<td>Amber</td>
</tr>
<tr>
<td>343</td>
<td>ECM - Warning internal hardware failure</td>
<td>Amber</td>
</tr>
<tr>
<td>346</td>
<td>ECM - Warning software error</td>
<td>Amber</td>
</tr>
<tr>
<td>349</td>
<td>Transmission Output Shaft Speed High - Warning</td>
<td>Amber</td>
</tr>
<tr>
<td>352</td>
<td>Sensor Supply Voltage #1 - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>381</td>
<td>Error detected in intake air heater relay circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>386</td>
<td>Sensor Supply Voltage #1 - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>387</td>
<td>Accelerator Pedal Position Sensor Supply Voltage - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>388</td>
<td>Less than 6 VDC detected at engine brake circuit 1</td>
<td>Amber</td>
</tr>
<tr>
<td>392</td>
<td>Less than 6 VDC detected at engine brake circuit 2</td>
<td>Amber</td>
</tr>
<tr>
<td>412</td>
<td>Data transmission error on J1587/J1922 datalink</td>
<td>None</td>
</tr>
<tr>
<td>414</td>
<td>Data transmission error on J1587/J1922 datalink</td>
<td>None</td>
</tr>
<tr>
<td>415</td>
<td>Oil Pressure Sensor - Data indicates very low oil pressure</td>
<td>Red</td>
</tr>
<tr>
<td>418</td>
<td>Water in Fuel Indicator High</td>
<td>Maint</td>
</tr>
<tr>
<td>419</td>
<td>Error in intake manifold pressure sensor signal detected by ECM</td>
<td>Amber</td>
</tr>
<tr>
<td>422</td>
<td>Engine Coolant Level Sensor Signals - Data invalid</td>
<td>Amber</td>
</tr>
<tr>
<td>426</td>
<td>SAE J1939 datalink - cannot transmit</td>
<td>None</td>
</tr>
<tr>
<td>427</td>
<td>Data transmission on J1939 datalink not occurring at an acceptable rate</td>
<td>None</td>
</tr>
<tr>
<td>428</td>
<td>Water in Fuel Sensor - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>429</td>
<td>Water in Fuel Sensor - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>431</td>
<td>Accelerator Pedal Idle Validation Circuit - Data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>432</td>
<td>Accelerator Pedal Idle Validation Circuit - Out of calibration</td>
<td>Red</td>
</tr>
<tr>
<td>433</td>
<td>Intake Manifold Pressure Sensor - Circuit data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>434</td>
<td>Power Lost without ignition off</td>
<td>Amber</td>
</tr>
<tr>
<td>435</td>
<td>Engine Oil Pressure Sensor - Circuit data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>441</td>
<td>Battery Voltage Low - Warning</td>
<td>Amber</td>
</tr>
<tr>
<td>442</td>
<td>Battery Voltage High - Warning</td>
<td>Amber</td>
</tr>
<tr>
<td>443</td>
<td>Accelerator Pedal Position Sensor Supply Voltage - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>465</td>
<td>High voltage detected at wastegate actuator No. 1 circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>466</td>
<td>Less than 6 VDC detected at wastegate actuator No. 1 circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>489</td>
<td>Transmission Output Shaft Speed Low - Warning</td>
<td>Amber</td>
</tr>
<tr>
<td>491</td>
<td>High voltage detected at wastegate actuator No. 2 circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>492</td>
<td>Less than 6 VDC detected at actuator No. 2 circuit</td>
<td>Amber</td>
</tr>
<tr>
<td>497</td>
<td>Error detected in multiple unit synch control sw. input pins 34 &amp; 32 of OEM harness</td>
<td>Amber</td>
</tr>
<tr>
<td>527</td>
<td>Auxiliary Input/Output #2 - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>528</td>
<td>OEM Alternate Torque Validation Switch - Data incorrect</td>
<td>Amber</td>
</tr>
<tr>
<td>529</td>
<td>Auxiliary Input/Output #3 - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>551</td>
<td>Accelerator Pedal Idle Validation Circuit - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>581</td>
<td>Fuel Supply Pump Inlet Pressure Sensor - Circuit shorted high</td>
<td>Amber</td>
</tr>
<tr>
<td>582</td>
<td>Fuel Supply Pump Inlet Pressure Sensor - Circuit shorted low</td>
<td>Amber</td>
</tr>
<tr>
<td>583</td>
<td>Fuel Supply Pump Inlet Pressure Low - Warning level</td>
<td>Amber</td>
</tr>
<tr>
<td>596</td>
<td>Electrical Charging System Voltage High - Warning level</td>
<td>Amber</td>
</tr>
<tr>
<td>597</td>
<td>Electrical Charging System Voltage Low - Warning level</td>
<td>Amber</td>
</tr>
<tr>
<td>598</td>
<td>Electrical Charging System Voltage Low - Critical level</td>
<td>Red</td>
</tr>
<tr>
<td>611</td>
<td>Engine Hot Shutdown</td>
<td>None</td>
</tr>
<tr>
<td>951</td>
<td>Cylinder Power Imbalance between cylinders</td>
<td>None</td>
</tr>
</tbody>
</table>
Maintenance Monitor
The maintenance monitor uses data received from the ECM to determine the amount of fuel burned and the time the engine has been operating to determine when it is time to change the oil. The operator must still be alert for any indications that the engine needs other service.

Note: Maintenance monitor is designed to alert the operator of the need for a routine maintenance stop. Maintenance records must still be maintained for historical purposes.

Note: Whenever an electrical fault has occurred, the maintenance monitor data can be inaccurate.

'Severe' oil drain interval duty cycle is the default setting for the maintenance monitor, however this can be adjusted by using diagnostic tools, to suit duty cycle and oil type used. Engine oil drain intervals are dependant on working environment and oil type used. Refer to 'Engine oil drain intervals by duty cycle (Hours)' table below. Refer to Section 300-0020, LUBRICATION SYSTEM for recommended oil type.

The maintenance monitor will alert the operator of the need to change oil by flashing the maintenance light for approximately 12 seconds after key-on. The flashing sequence will be three quick flashes, followed by a pause. This flash sequence will go through five cycles in the 12 second period. This sequence will occur at every key-on until the maintenance monitor has been reset.

Note: The diagnostic switch must be OFF for the flashing sequence to occur.

Resetting the Maintenance Monitor - There are two ways to reset the maintenance monitor, depending on the engine ECU calibration.

1. Park machine on level ground, block road wheels, apply parking brake and switch off engine.
2. Turn key to position ‘1’.
3. Press engine diagnostic switch on/off quickly, twice (less than 1 second per cycle).
4. Press engine diagnostic switch on for a minimum of 3 seconds, then switch off.
5. Press engine diagnostic switch on for a minimum of 3 seconds, then switch off.
6. Press throttle pedal 100% on then off quickly, twice.
7. The maintenance light will flash three times. This means the maintenance monitor is reset. Note: If the maintenance light does not flash as described, the reset sequence must be performed again.
8. Press engine diagnostic switch off.
9. Turn key to position ‘0’.
10. Remove blocks from road wheels.

### ENGINE OIL DRAIN INTERVALS BY DUTY CYCLE (HOURS)

<table>
<thead>
<tr>
<th>Fuel Consumption</th>
<th>Severe</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>API CF-4</td>
<td>&gt; 13 gal/hr</td>
<td>10 to 13 gal/hr</td>
<td>8.5 to 10 gal/hr</td>
<td>&lt; 8.5 gal/hr</td>
</tr>
<tr>
<td>API CG-4</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>API CH-4 or ACEA E5</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>CES20076 or CES20077</td>
<td>300</td>
<td>350</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>400</td>
<td>550</td>
<td>700</td>
</tr>
</tbody>
</table>
Engine - Engine and Mounting

Section 110-0030

REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Tag all cables, harnesses, lines and pipes disconnected during removal to aid in installation.

⚠️ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

High electrical current can cause sparks and personal injury from burns. Turn battery master switch to the ‘Off’ position before removing any components. Remove battery ground cable first, and reconnect last, to avoid damaging electrical components.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering circuit.

2. Block all road wheels and place the battery master switch in the ‘Off’ position.

3. Disconnect battery cables from terminal posts (earth cable first).

4. Pull on handle, inside battery box, to release hood catch and lift up hood.

5. Using hydraulic hand pump inside battery box, tilt cab and secure. Refer to Section 260-0010, CAB AND MOUNTING.

6. Remove mounting hardware securing air cleaner intake tube to goalpost assembly. Remove mounting hardware securing air cleaner to battery box. Slacken mounting clamp at air cleaner intake tube and draw air cleaner away from intake pipe. Cover open ends to prevent entry of dirt.

7. Carefully remove filler cap from header tank. With a suitable container in position, remove plug and open shut-off valve on the radiator assembly and drain the coolant.

8. Remove hood and goalpost from the vehicle. Refer to Section 100-0040, HOOD AND MOUNTING.

Note: Radiator header tank will be removed as part of the goalpost assembly.

9. With a suitable container in position, remove drain valve on the cooler and drain the oil. Remove transmission oil cooler from the vehicle. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

10. Support engine sump guard with suitable blocking and remove mounting hardware securing sump guard to the frame. Remove sump guard from the frame.

11. Support guard plate under the engine (1) at the front of the frame with suitable blocking and remove mounting hardware securing guard plate to the frame. Remove guard plate from the frame.

12. Place a suitable container under the engine drain port, remove drain plug and drain the oil. After draining, reinstall drain plug in engine sump and tighten securely.

⚠️ WARNING
Before disconnecting any air conditioner lines, refer to Section 260-0130, AIR CONDITIONING. Refrigerant will rapidly freeze all objects with which it comes into contact. It can cause serious and permanent damage to the eyes and skin.

13. Evacuate air conditioning system and disconnect air conditioner lines at the engine compressor. Refer to Section 260-0130, AIR CONDITIONING.

14. Remove the radiator assembly from the vehicle. Refer to Section 210-0040, RADIATOR AND MOUNTING.

15. Remove charge air cooler pipes from engine turbocharger and engine inlet manifold.

16. Disconnect exhaust piping from the engine turbocharger.

17. Disconnect air cleaner intake pipe from engine turbocharger and remove from the engine (1).

18. Identify heater lines for ease of installation and with a suitable container in position, disconnect heater lines from the engine (1). Cap open line ends and fittings.

19. Identify fuel lines for ease of installation and with a suitable container in position, disconnect fuel lines from the engine (1). Cap open line ends and fittings.

20. Identify all electrical harnesses and cables for ease
of installation and disconnect from the engine (1).

21. Disconnect clips securing items to the engine (1) that cannot be removed with the engine.

22. Remove guard from flywheel housing and disconnect drive from the engine coupling and secure clear of the engine (1). Refer to Section 130-0010, FRONT DRIVELINES.

23. Attach suitable lifting equipment to the lifting brackets on the engine and raise lifting equipment to take up the slack.

24. Remove locknuts (17), snubbing washers (15) and bolts (16) securing engine (1) to the frame through front mounting bracket (8) and rear mounting brackets (7).

25. Check to make certain that all necessary line and electrical disconnections have been made before lifting engine (1).

26. Carefully lift engine (1) clear of the frame, remove to a suitable work area and mount securely on a work stand.

DISASSEMBLY
Numbers in parentheses refer to Fig. 1.

1. Remove bolts (11 & 13) and washers (12) securing front mounting bracket (8) to engine (1). Remove front mounting bracket (8).

2. Remove bolts (9) and washers (10) securing rear mounts to engine (1). Remove mounts (7).

3. If required, remove rubber isolation mounts (14) from rear mounts (7) and front mounting bracket (8).

4. Loosen air conditioner compressor drive belt and remove compressor from engine (1). Refer to Section 260-0130, AIR CONDITIONING.

5. Loosen alternator adjusting screw locknut (1, Fig. 3).

6. Loosen the adjustment link locking capscrew (2, Fig. 3).

7. Loosen the alternator mounting capscrew (3, Fig. 3).

8. Turn the adjusting screw (4, Fig. 3) anticlockwise to release tension. Remove alternator belt (2).

9. Remove alternator mounting capscrew (3, Fig. 3) and adjustment link locking capscrew (2, Fig. 3). Remove alternator.

10. Disconnect the electrical connector (78) harness to fan clutch (27).

11. Remove nut (29), washers (30) and studs (38) securing fan (28) and clutch (27) to engine (1) fan hub.

12. Remove both fan (28) and clutch (27) together from the engine (1).

13. Loosen fan idler pulley shaft locknut. Loosen the adjusting link to slacken the fan belt (6). Remove fan belt (6).

14. Remove bracket supporting hoses from top of flywheel housing.

15. Remove bolts (21) and washers (19) securing flywheel guard (20) to flywheel housing, then remove flywheel guard (20) from engine (1).

16. Remove bolts (18) and washers (19) securing engine coupling (23) at rear of engine (1) then remove engine coupling (23).

17. Remove and discard filters (3, 4 & 5) from engine (1), as described in 'Maintenance'. Cover engine inlet ports to prevent entry of dirt.

18. Refer to ‘Engine Manufacturers Service Manual’ if engine service or repair is required.
Engine - Engine and Mounting

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INSPECTION
Numbers in parentheses refer to Fig. 1.

1. Inspect rubber isolation mounts (14) for damage and replace if required.

2. Check mounting brackets (7 & 8) and mounting brackets on the front frame for cracks and/or damage. Repair or replace as necessary.

3. Inspect engine coupling (23) for damage and repair or replace as required.

ASSEMBLY
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Remove covers from engine filter ports and install new filters (3, 4 & 5) on engine (1), as described in 'Maintenance'.

2. Install engine coupling (23) to rear of engine (1) and secure with bolts (18) and washers (19). Tighten bolts (18) to a torque of 31 Nm (23 lbf ft).

3. Install flywheel guard (20) to flywheel housing and secure with bolts (21) and washers (19).

4. Install bracket supporting hoses to top of flywheel housing.

5. Fit fan belt (6) and tighten adjusting link to tighten fan belt (6). Refer to Engine Operation and Maintenance Manual for correct fan belt (6) tension.

6. Tighten the fan idler pulley shaft locknut to 140 lbf ft (190 Nm). Check the belt tension again after the locknut is tightened.

7. Install fan (28) and clutch (27) to fan hub and secure with studs (38), nuts (29) and washers (30). Tighten nut (29) to a torque of 31 Nm (23 lbf ft).

8. Connect electrical connector (78) harness to fan clutch (27).

9. Install alternator on engine (1) and secure with adjustment link locking capscrew (2, Fig. 3) and alternator mounting capscrew (3, Fig. 3).

10. Fit alternator belt (2) between alternator pulley and accessory drive pulley. Turn adjusting screw (4, Fig. 3) clockwise to increase belt tension; anticlockwise to decrease belt tension. Refer to Engine Operation and Maintenance Manual for correct alternator belt (2) tension.

11. Tighten the adjusting screw locknut (1, Fig. 3) against the retainer. Tighten the adjustment link locking capscrew (2, Fig. 3) to 59 lbf ft (80 Nm).

12. Tighten the alternator mounting capscrew (3, Fig. 3) to 35 lbf ft (47 Nm).

13. Install air conditioning compressor and compressor drive belt on engine (1). Refer to Section 260-0130, AIR CONDITIONING.

14. If removed, install rubber isolation mounts (14) to rear mounts (7) and front mounting bracket (8).

15. Install rear mounts (7) to engine (1) and secure with bolts (9) and washers (10).

16. Install front mounting bracket (8) to engine (1) and secure with bolts (11 & 13) and washers (12).

INSTALLATION
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Attach suitable lifting equipment to engine (1) lifting brackets and carefully position engine (1) assembly in the tractor frame.

2. Secure engine (1) assembly to frame mounting brackets with bolts (16), snubbing washers (15) bolt (9) and locknuts (10) as shown in Fig. 1. Tighten bolts (16) to a torque of 298 Nm (220 lbf ft).

3. Connect driveline to the engine coupling (23). Install guard to flywheel housing. Refer to Section 130-0010, FRONT DRIVELINES.
Ensure no lines are chaffing on sharp edges or resting against areas where heat will be evident.

18. Ensure shut-off valve at the bottom of the radiator assembly and any drain cocks on engine (1) water jacket are securely closed. Ensure shut off cocks at coolant filter (5) are open to allow flow through the filter.

19. Fill the cooling system with coolant. Refer to Section 210-0000, COOLING SYSTEM.

20. Fill the engine with lubricant through oil filler to the top mark on dipstick. Refer to Section 300-0020, LUBRICATION SYSTEM for oil specification.

21. Fill transmission oil cooler with oil. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

22. Check all line and pipe connections for leaks prior to starting the vehicle. Tighten as required.

23. Install hood assembly on the vehicle. Refer to Section 100-0040, HOOD AND MOUNTING.

24. Using hydraulic hand pump inside battery box, lower cab and secure. Refer to Section 260-0010, CAB AND MOUNTING.

25. Switch the battery master switch to the ‘On’ position, start up the engine and check for leaks. Tighten lines, pipes and fittings and top up all systems as required.

26. Using suitable lifting equipment position front guard plate under the engine and secure to the frame with mounting hardware removed during removal.

27. Using suitable lifting equipment position engine sump guard under the engine and secure to the frame with mounting hardware removed during removal.

28. Remove wheel blocks from all road wheels.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

Note: Carry out the following maintenance procedures in conjunction with additional procedures listed in Section 300-0020, LUBRICATION SYSTEM.

Every 10 Hours (Daily)

Engine (1) - Visually check engine for damage, loose or frayed belts and listen for any unusual noises. Check coolant level and air cleaner restriction. Check
Engine - Engine and Mounting

Section 110-0030

charge air piping for damage.

**Engine (1) Oil Level Check** - Position the vehicle on a level work area, apply the parking brake, shut off the engine and wait at least five minutes (to allow oil to drain to the oil pan) before checking the oil level. The oil level should be between the low (L) and high (H) marks on the dipstick. Add oil if low. Refer to Section 300-0020, LUBRICATION SYSTEM for oil specification.

**Note:** Never operate the engine with oil level below the low (L) or above the high (H) mark on the dipstick.

**Fuel Filter/Water Separator (4)** - Drain the water and sediment from the separator daily. Position the vehicle on a level work area, apply the parking brake, shut off the engine and, with a suitable container below the drain valve to catch spillage, open the drain valve by hand. Turn the valve anticlockwise approximately 1.5 - 2 turns until draining occurs. Drain the filter sump until clear fuel is visible. Turn the valve clockwise to close the drain valve.

**Note:** Do not overtighten the drain valve as overtightening can damage the threads.

**Cooling Fan (28)** - Visually inspect the fan for cracks or damaged blades. Check the fan to make sure that mounting bolts (29) are secure. Tighten bolts as required. Replace any fan that is damaged.

**WARNING**

Personal injury can result from a fan blade failure. Never pull or pry on the fan as this can damage the blades and lead to fan failure.

**Drive Belts** - Visually inspect all drive belts daily. Replace belts that are cracked or frayed and adjust belts that have a glazed or shiny surface which indicates belt slippage. Correctly installed and tensioned belts will show even pulley and belt wear.

**Engine (1) Crankcase Breather** - Check and clean the crankcase breather hose. Remove the breather hose and check internally for obstructions or sludge buildup. Clean or replace breather hose as necessary, to prevent excess crankcase pressure buildup.

**Every 250 Hours**

**Engine Oil and Lube Oil Filter (3)** - Replace the lubricating oil and oil filter (3).

**WARNING**

Avoid direct contact of hot oil with your skin. Hot oil can cause serious personal injury.

Operate the engine until the water temperature reaches 60° C (140° F). Position the vehicle on a level work area, apply the parking brake and switch off the engine. Position a suitable container under the engine oil drain plug and drain the oil immediately to make sure all the oil and suspended contaminants are removed from the engine.

Clean the area around the lube oil filter head and, using strap type filter wrench, remove lube oil filter (3). Discard lube oil filter (3) if it is not required for a failure analysis. Clean the gasket sealing surface of the filter head.

**Note:** The 'O' ring can stick on the filter head. Make sure the 'O' ring is removed and discarded.

**Note:** Fill the filter with clean lubricating oil prior to installation. The lack of lubrication during the delay until the filter is pumped full of oil is harmful to the engine.

Apply a light film of clean lubricating oil to the gasket surface of the new filter and install the filter on the filter head. Turn the filter until the gasket contacts the filter head surface. Tighten the filter an additional 1/2 to 3/4 of a turn, or as specified by the filter manufacturer.

**Note:** Mechanical tightening of the filter is not recommended and may result in seal and/or cartridge damage. Tighten filter by hand only.

Check and clean the engine oil drain plug threads and the seal surface. Replace plug if damaged. Install and tighten the drain plug to a torque of 88 Nm (65 lbf ft). Fill the engine with clean lubricating oil specified in Section 300-0020, LUBRICATION SYSTEM. The oil level should be between the low (L) and high (H) marks on the dipstick.

Engine oil pressure must be indicated on the gauge within 15 seconds after starting engine. If oil pressure is not reached within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level in the oil pan.
Start the engine and operate at idle speed to inspect for leaks at the filter and oil drain plug. Shut off the engine, wait approximately ten minutes to let the oil drain back to the sump and check the oil level again. Add oil as necessary to bring the level to the high (H) mark on the dipstick. Do not overfill the engine with oil.

**Fuel Filter (4)** - Clean the area around the fuel filter head and replace the fuel filter.

Position the vehicle on a level work area, apply the parking brake and switch off the engine. Using a strap type filter wrench, remove fuel filter (4) and discard the thread adaptor sealing ring. Clean the gasket surface of the filter head.

Install the new thread adaptor sealing ring (supplied with new filter) and apply a film of clean engine oil to lubricate the filter seal. Fill the new filter with clean fuel specified in Section 300-0020, LUBRICATION SYSTEM.

Install new fuel filter (6) on the filter head and tighten by hand until the gasket contacts the filter head surface. Tighten fuel filter (6) per filter manufacturer’s instructions.

**Note:** Mechanical tightening of the filter is not recommended and may result in seal and/or cartridge damage. Tighten filter by hand only.

**Every 500 Hours**

**Coolant Filter (5)** - Replace coolant filter (5) as follows:

**Note:** There is a shut off valve at the coolant inlet and outlet lines of coolant filter (5). Closing these valves will enable coolant filter (5) to be replaced without an excessive loss of coolant.

**WARNING**

Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C (120°F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

1. Remove the cooling system pressure cap from header tank.

2. Close shut off valves at coolant filter (5) inlet and outlet lines and, using filter wrench, remove and discard coolant filter (5) from engine (1).

3. Clean the filter adaptor with a clean, lint free cloth.

4. Lightly coat new coolant filter (5) seal with clean engine oil as specified in Section 300-0020, LUBRICATION SYSTEM.

5. Start coolant filter (5) on the filter adaptor and tighten it by hand until the seal touches the adaptor filter head. Tighten an additional 1/2 to 3/4 of a turn after contact, or as specified by the filter manufacturer.

**Note:** Mechanical tightening of coolant filter (5) is not necessary and will distort or crack the adaptor. Tighten coolant filter by hand only.

6. Open shut off valves at coolant filter (5) inlet and outlet lines, and install pressure cap on header tank.

7. Start the engine and check for leaks. If any leaks are noted, have them corrected. Add coolant as required. Refer to Section 210-0000, COOLING SYSTEM.

**Every 1 500 Hours**

**Engine Mounting Bolts (16)** - Check torque on engine mounting bolts (16). If required, tighten to 298 Nm (220 lbf ft).

**Engine (1)** - Steam clean.

**Engine (1) Overhead Set** - Adjust the valves and injectors. Refer to Engine Operation and Maintenance Manual for details.

**Engine (1) Water Pump** - Inspect water pump weep hole and ensure it is not blocked.

**Engine (1) Turbocharger Mounting Nuts** - Tighten nuts to 65 Nm (50 lbf ft).

**SPECIAL TOOLS**

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of service tools which should be used in conjunction with procedures outlined in the engine manufacturers service manual, and, general service tools required. These tools are available from your dealer.
### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>Nm</th>
<th>lbf ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
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</tr>
<tr>
<td>1</td>
<td>29</td>
<td>Nut</td>
<td>31</td>
<td>23</td>
</tr>
</tbody>
</table>
DESCRIPTION AND OPERATION

Numbers in parentheses refer to Fig. 1.

**Note:** The rate of fan (4) speed change and maximum fan speed is preset to the cooling needs of the engine.

The electronic sensing technology (EST) fan (5) drive system uses a pulse width modulated signal from the engine electronic control module (6) to provide the appropriate fan speed necessary to satisfy any cooling demand.

At a pre-determined engine coolant temperature or engine air intake temperature, variable current signals from the ECM (6) give an increased fan speed. Any further rises in coolant/air intake temperature results in increased fan speed. The fan speed increases proportionally with the increase in temperature until the fan is fully engaged.

**Note:** The fan is fully engaged when the air conditioning is switched on.

When the temperature drops, so the fan speed reduces proportionally until the idle speed is reached.

The EST fan drive (5) has a failsafe feature, ie. if the electrical current to the fan drops to zero, the fan will be automatically engaged.
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Section 110-0040

REMOVAL
Numbers in parentheses refer to Fig. 1.

⚠️ WARNING
To prevent personal injury and property damage, make sure blocking or lifting equipment is properly secured and of adequate capacity to do the job safely.

⚠️ Personal injury can result from a fan blade failure. Never pull or pry on the fan as this can damage the blades and lead to fan failure.

1. Position the machine on a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Operate the steering several times to discharge the steering system.

2. Block all road wheels and place the battery master switch in the off position.

3. If required, remove mounting hardware securing hood assembly to the machine and, using suitable lifting equipment, remove hood assembly. Refer to Section 100-0040, HOOD AND MOUNTING.

4. Remove mounting hardware securing fan guards to the fan shroud. Remove fan guards from the machine. If required remove radiator from the machine. Refer to Section 210-0040, RADIATOR, HEADER TANK AND MOUNTING.

5. Disconnect harness (7) at the connector on the fan drive (5) braided cable.

6. Support fan (4) assembly with suitable lifting equipment and remove bolts (1) securing fan (4) assembly to the engine. Remove fan (4) assembly from the machine.

7. Remove nuts (3) and lockwashers (2) securing EST fan drive (5) to fan (4) mounting surface of housing. Remove EST fan drive (5) from housing.

INSTALLATION
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified, to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

⚠️ WARNING
To prevent personal injury and property damage, make sure blocking or lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Install EST fan drive (5) on fan (4) mounting surface of housing and secure in place with lockwashers (2) and nuts (3).

2. Using suitable lifting equipment, position fan (4) assembly on the machine and secure to engine with bolts (1). Torque tighten bolts (1) to 31 Nm (23 lbf ft).

Note: Ensure there is even clearance, all the way round, between fan (4) and the fan shroud.

3. Connect harness (7) at the connector on the fan drive (5) braided cable.

4. If removed, install radiator on machine. Refer to Section 210-0040, RADIATOR, HEADER TANK AND MOUNTING. Install fan guards to the fan shroud and secure with mounting hardware, as removed at ‘Removal’.

5. If removed, position the hood assembly on the machine using a suitable lifting device. Secure hood assembly on the machine with mounting hardware, as removed at ’Removal’. Refer to Section 100-0040, HOOD AND MOUNTING.

6. Start the engine and check for correct operation of the fan. Refer to ‘Testing’ procedures contained in this section.

7. Remove wheel blocks.

TESTING

Static Test
Note: This test will only determine if the fan drive has seized or is very close to seizure.

With the engine stopped, the fan should turn smoothly with resistance (viscous) without scraping, scratching or grating noise.

Note: Rotation without resistance indicates a fault.

Basic Dynamic Test - Cut In/Cut Out
Note: This test is carried out with the machine static and secured at rest.
After the machine has stood for approximately 30 minutes with the engine stopped, start the engine and increase engine speed to 2 100 rev/min.

Initially the fan noise should be loud (cut in), but before a further minute has elapsed, the fan noise should significantly reduce (cut out).

**Basic Dynamic Test - Fan Drive Operation**

*Note:* This test is carried out with the machine static and secured at rest.

1. Place a cardboard, or alternative material, sheet over the radiator front with an approximate 100 mm (4 in) diameter hole in the sheet, in line with the centre of the fan drive.

2. Start the engine and increase engine speed to 2 100 rev/min.

3. Fan noise should initially be loud and reduce significantly before 1 minute has elapsed.

4. Maintain engine speed at 2 100 rev/min. Fan drive should 'cut in' (engage) before coolant temperature gauge indicates excessive coolant temperature.

5. Return engine speed to idle, quickly remove the sheet in front of the radiator and bring engine speed back up to 2 100 rev/min. Fan speed should 'cut out' (disengage) within 1 minute.

**Failsafe Check**

*Note:* This test is carried out with the machine static and secured at rest. Hood should be raised and secured.

1. Start the engine and increase engine speed to 2 100 rev/min.

2. Maintain engine speed at 2 100 rev/min and disconnect harness at the connector on the fan drive braided cable. Fan should automatically engage to full flow speed.

**MAINTENANCE**

**Every 10 Hours/Daily**

Check the fan for cracks or damaged blades. Clean or replace as required.

*Note:* This DST fan is a non-serviceable component. However, the following instructions must be strictly adhered to:

1. DO NOT clean around fan drive with steam or high pressure jet.

2. DO NOT tamper with modulation control mechanism for ANY reason.

3. DO NOT add any fluids or lubricants to the drive.

4. DO NOT restrict fan rotation during engine operation for ANY reason.

5. DO NOT operate a machine with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.

6. DO NOT disassemble ANY fan assembly or associated parts that are still within the warranty coverage period.

7. IMMEDIATELY investigate and correct ANY operator complaint involving drive or cooling system performance.

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Bolt</td>
<td>31</td>
</tr>
</tbody>
</table>

**SPECIAL TORQUE SPECIFICATIONS**

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* * * *
DESCRIPTION AND OPERATION
Numbers in parentheses refer to Fig. 1.

The dual dry element air cleaner is remote mounted horizontally on the left hand side of the machine. The air cleaner prolongs engine life by removing grit, dust and water from the air as it enters the engine. Grit and dust, combined with engine oil, forms a highly abrasive compound which can destroy the engine in a comparatively short period of time.

A rubber vacuator valve (4) attached to end cover (6) in a downward position, ejects grit, dust and water while the engine is running. Vacuator valve (4) minimizes the need for daily servicing. Even though vacuator valve (4) is normally under a slight vacuum when the engine is running, pulsing of the vacuum opens and closes the rubber valve, expelling dust and water as they collect. When the engine is stopped, vacuator valve (4) opens and expels any accumulated grit, dust or water.

A mechanical air restriction gauge (2, Fig. 2) is mounted on the air cleaner body and shows when the system air flow is being restricted. A red band gradually rises in the gauge window as air restriction increases. The red band is locked when maximum allowable restriction is reached. When the red band locks at the top of the gauge window, primary filter element (2) should be serviced. Air restriction gauge (2, Fig. 2) should be reset by pushing the button on the gauge, holding it for several seconds and then releasing it.

While air restriction gauge (2, Fig. 2) indicates the need for servicing, it does not give as precise a measurement as a water manometer or vacuum gauge. Refer to 'Measuring Air Restriction'.

Secondary (safety) element (3) is installed in air cleaner body (1) inside of primary element (2). This element increases the reliability of the air cleaner's
protection of the engine from airborne dirt. It protects the engine from dirt admitted by a damaged primary element (2), or dirt that might be dropped into air cleaner assembly while changing primary element (2).

**AIR CLEANER**

**Removal**
Numbers in parentheses refer to Fig. 2.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Pull on handle to release hood catch and lift up the hood.

4. Remove bolts (16), washers (13) and nuts (25) securing coupling (24) to air intake tube (1).

5. Slacken clamps (8 & 23) securing elbow (7).

6. Remove bolts (3), washers (4), lockwashers (5) and nuts (6) securing air cleaner to bracket (21). Using suitable lifting equipment, support the air cleaner assembly and draw air cleaner assembly away from elbow (7).
b. Check that air cleaner mounting bracket (21) is secure and that air cleaner is mounted securely.

**MAINTENANCE**

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

**WARNING**

Always shutdown the engine before servicing air cleaner.

Check air restriction gauge (2, Fig. 2) daily (every 10 hours). The air cleaner elements should be serviced only when the maximum allowable restriction has been reached, as indicated by air cleaner restriction gauge (2, Fig. 2). The elements should not be serviced on the basis of visual observation as this would lead to over service. When restriction readings finally indicate a change, remove primary element (2) carefully and clean/replace as required. Refer to 'Primary Element'.

Never attempt to clean safety element (3). Change safety element (3) after every third primary element (2) service.

Make sure vacuator valve (4) is not damaged or plugged and that the joint with cover assembly (6) is not broken. If vacuator valve (4) is lost or damaged, replace it to maintain pre-cleaner efficiency and normal filter element service life.

Check condition of clamps (8 & 23, Fig. 2), elbow (7, Fig. 2) and air intake tubes (1 & 9, Fig. 2). Tighten/replace as necessary.

**Primary Element**

Numbers in parentheses refer to Fig. 1.

Although a paper primary element (2) is used, it is possible to remove excess dirt by tapping element.

1. Release latches on cover assembly (6) and remove cover assembly from air cleaner body (1).

2. Remove primary element (2) from air cleaner body (1) and clean/replace. It is advised to replace the element rather than attempt to clean thoroughly.

3. Using a damp cloth and a suitable solvent, wipe out all excess dust from air cleaner body (1) and allow to dry.

4. Install primary element (2) in air cleaner body (1).
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5. Install cover assembly (6) on air cleaner body (1) and secure with latches.

Secondary Element
Numbers in parentheses refer to Fig. 1.

Since safety element (3) is protected from contamination by primary element (2), it needs no periodic cleaning and should be replaced only after every third primary element (2) service.

1. With primary element (2) removed from air cleaner body (1), remove safety element (3).

2. Remove any dust dislodged into air cleaner body (1) outlet and, using a damp cloth and a suitable solvent, wipe out all excess dust from air cleaner body (1) and allow to dry.

3. Install new safety element (3) followed by primary element (2) in air cleaner body (1).

4. Install cover assembly (6) on air cleaner body (1) and secure with latches.

Recommendations
Numbers in parentheses refer to Fig. 2.

1. Under no condition should the vehicle be operated without both filter elements in each air cleaner assembly.

2. It is very important that elbow (7) and air intake tube (9) from the air cleaner assembly to the engine be airtight or the purpose of the air cleaner will be completely defeated. All clamps (8 & 23) (and those supplied with the engine) should be checked frequently and tightened to prevent leaks.

3. Keep new or cleaned filter elements on hand for replacement to prevent unnecessary downtime of the vehicle.

MEASURING AIR RESTRICTION
Numbers in parentheses refer to Fig. 2.

As a dry air cleaner element becomes loaded with dust, the vacuum on the engine side of the air cleaner (air cleaner outlet) increases. This vacuum is generally measured as ‘restriction in mm (inches) of water’.

The recommended maximum allowable intake restrictions at rated speed and load are as follows:

a. 380 mm-H₂O (15 in-H₂O) with clean filter elements.

b. 635 mm-H₂O (25 in-H₂O) with dirty filter elements.

While the air restriction gauge sends a signal to indicate the need for servicing, it does not give as precise a measurement as a water manometer or vacuum gauge.

Water Manometer
a. Remove air restriction gauge (2) from port in air cleaner assembly.

b. Hold water manometer vertically and fill both legs approximately half full of water. Connect one of the upper ends to port by means of a flexible hose.

c. With the manometer held vertically and the engine drawing maximum air, the difference in height of the water columns in the two legs is measured as the air cleaner restriction.

d. If the restriction exceeds the levels indicated, engine performance will be affected. Primary filter element should be cleaned or replaced.

Vacuum Gauge
a. Remove air restriction gauge (2) from port in air cleaner assembly.

b. Connect the hose from the vacuum gauge to port and, with the engine drawing maximum air, take a note of the reading on the gauge.

c. If the restriction exceeds the levels indicated, engine performance will be affected. Primary filter element should be cleaned or replaced.

SERVICE TOOLS
Refer to Section 300-0070, SERVICE TOOLS for part numbers of service tools referenced in this section and general service tools required. These tools are available from your dealer.

* * * *
DESCRIPTION

Numbers in parentheses refer to Fig. 1.

For transmission make, model and specification, refer to Section 000-0000, GENERAL INFORMATION. For transmission servicing and repair data refer to transmission manufacturers service manual.

The transmission is supported by front plate (5), LH bracket (12) and RH bracket (13) which are bolted to the transmission and attached to front frame mounting brackets through centre bonded mount (6) and isolation mounts (16). Mounts (6 & 16) provide sufficient flexibility to absorb varying transmission vibration and torsional loads.

The transmission assembly consists of a torque converter close-coupled to a 6 speed gearbox with integral output transfer gearing. Automatic shifting in gear ranges 1 to 6, with kickdown feature. Lockup in all forward gears. A wear-resistant hydrodynamic retarder is integral of the transmission.

An engine dependent power takeoff at the rear of the transmission provides the drive for the main hydraulic pump which supplies the braking, steering and body hoist systems. A ground driven emergency steering pump is attached at the lower rear left hand side of the transmission.

Mounted off bracket assembly on top of transmission is the diff-lock/retarder valve which houses the retarder solenoid, axle differential lock solenoid and pressure reducing valve (refer to Figs. 4 & 5).
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SWITCHES AND SENSORS
Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Transmission Oil Temperature
Oil temperature sender (1) sends a signal to indicate transmission oil temperature on the transmission oil temperature gauge in the cab. The gauge should read between 80° C (176° F) and 120° C (248° F) during normal operation and may reach 145° C (293° F) during retarder operation. If the needle remains at high temperatures for extended periods, the machine should be brought to a stop, transmission shifted to neutral and engine speed increased to 1 200 - 1 500 rev/min. Under this condition, oil temperature should drop to normal values in about 2 - 3 minutes. If oil temperature does not drop, the cause should be investigated.

The transmission oil temperature is also monitored by temperature sensors in the main control valve, which sends a signal to illuminate the transmission STOP warning light. The light will illuminate to indicate any of the following conditions:

- High retarder temperature
- High transmission sump temperature
- Engine overspeed

If the light illuminates during normal operation, a fault code will also register on the display unit (See EST-37 Trouble Shooting tables). Bring the machine to a stop and investigate the cause.

Temperature sensor (9) sends a signal to the hydraulic ECU to operate the transmission cooler fan drive at a speed proportional to transmission oil temperature.
Lockup Clutch (Wk)
The transmission lockup clutch is automatically engaged. Engine speed is picked up by turbine speed sensor (8) which sends a signal to energise lockup solenoid (3, Fig. 3) when turbine speed reaches a predetermined level. Energising lockup solenoid (3, Fig. 3) will move lockup valve (4, Fig. 3) across, allowing oil to flow through the valve to engage lockup.

Gear Selection
The transmission can be engaged and disengaged under load by means of hydraulically controlled multi-disc clutches. All gears run in antifriction bearings and are constantly meshed. The gears, bearings and clutches are lubricated with cooled oil.

The transmission is equipped with six multi-disc clutches. These clutches are controlled via the six proportional valves (6, Fig. 3). Each proportional valve (6, Fig. 3) is composed of a pressure regulator (Y1 to Y6, Fig.3), follow-on slide (5, Fig. 3) and vibration damper (7, Fig. 3).

The control pressure of 9 bar for the actuation of the follow-on slides (5, Fig. 3) is created by the pressure reduction valve (2, Fig. 3). The pressure oil (16+2 bar) is directed via the follow-on slide (5, Fig. 3) to the respective clutch.

Due to the direct proportional control with separate pressure modulation for each clutch, the pressures to the clutches, which are taking place in the gear change, are controlled. In this way, a hydraulic intersection of the clutches to be engaged and disengaged becomes possible. This creates fast
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shiftings without traction force interruption.

**Speedometer Sensor**

Speedometer sensor, within the ECU, sends a signal to the speedometer, via the speedometer frequency divider, to indicate travel speed in kilometres per hour and miles per hour.

**Differential Pressure Switch**

The differential pressure switch is located in the transmission filter head. The switch will close and record a fault code when the filters become blocked, indicating a filter change is required.

**Note:** The differential pressure switch is not operational when oil temperature is below 50° C (122° F) or when transmission output speed is greater than 2000 rev/min.

**Differential Locks**

**Note:** The transmission differential lock requires hydraulic pressure to hold it 'Off', whereas, the centre axle differential lock requires pressure to hold it 'On'.

When the engine is started, hydraulic pressure is applied to the transmission differential lock to ensure the differential lock is released. On activation of the differential lock switch, the transmission differential lock solenoid is de-energised and hydraulic pressure is released at the transmission differential lock and applied at the centre axle differential lock. In this condition, the differential locks are engaged.

**Note:** The differential locks can be preselected when the machine is moving however, they will only engage on the move when the vehicle speed is below 20 km/hr. Warning light will illuminate when differential locks are selected, NOT attained.

**Note:** Before driving in soft or slippery conditions, stop and engage the differential locks. Spinning wheels can result in damage to the transmission and axle differentials.

**Note:** Disengage differential locks when driving on firm ground.

**Retarder Control**

The hydro dynamic retarder is arranged between the engine and torque converter so that a good braking effect is obtained in all speeds. The retarder is a wear resistant hydrodynamic brake with speed dependent action.

Retarder solenoid (4, Figs. 4 & 5) is energised on application of the retarder switch, located on the right hand switch bank, provided that the lockup clutch is engaged and the transmission 'Stop' warning light is OUT. Energising retarder solenoid will shift retarder solenoid valve and allow oil to flow through the valve to engage the retarder. Pressure reducing valve (2, Figs. 4 & 5) reduces the inlet pressure from 16 bar (232 lbf/in²) to 5.5 bar (80 lbf/in²).

Pressing the retarder switch OFF will de-energise retarder solenoid and retarder solenoid valve will shift back to disengage the retarder.

**Note:** Irrespective of speed, the retarder will automatically disengage when the transmission oil temperature reaches 150° C (302° F).
TRANSMISSION - Transmission and Mounting

**Section 120-0010**

**Schedule of Measuring Points**

Measurements to be carried out with oil at normal operating temperature of 80°C and operating at full speed.

**Measuring Points for Pressure Oil and Temperature:**

- **51** = Before the Converter - Opening Pressure 8.5 bar
- **52** = Behind the Converter - Opening Pressure 5 bar
- **53** = Clutch forward 16+2 bar KV
- **55** = Clutch reverse 16+2 bar KR
- **56** = Clutch 16+2 bar K1
- **57** = Clutch 16+2 bar K2
- **58** = Clutch 16+2 bar K3
- **60** = Clutch 16+2 bar K4
- **63** = Temperature 100°C behind the retarder (short time 150°C)
- **65** = System pressure 16-2
- **66** = Temperature 100°C behind the converter (short time 120°C)
- **67** = WK-Control pressure 13±1 bar

**Fig. 6 - Typical Schedule of Measuring Points and Gear Pattern**
Fig. 7 - Oil Circulation Diagram for Typical Transmission with Lockup Clutch and Retarder
OPERATION

EST-37 Automatic Shift Control

The EST-37 transmission is equipped with an electronic control unit (ECU) which continually monitors the transmission and shift system electrical components and warns the operator when a problem develops. It also takes action to prevent damage to the transmission, and provides the serviceman with diagnostic capabilities so that problems can be corrected quickly and easily.

When a fault occurs, a two digit error code will be displayed on the LCD display on the dash panel. The error code is also recorded in the transmission ECU, and can be accessed by the serviceman by plugging in a data reader to extract information relating to the fault. The error code recorded in the ECU memory will remain until it is erased by a technician.

If a major fault is detected, it is the operators responsibility to shut down the machine as soon as it is safe to do so. The machine should not be restarted until the fault has been diagnosed and corrected.

Refer to 'EST-37 Trouble Shooting' table for a list of fault codes and checks.

The EST-37 transmission control has been designed to provide the driver with maximum operational flexibility by allowing the choice of automatic or manual gear selection to optimize vehicle performance under all operating conditions.

The rotational pressure compensated (RPC) system gives improved shift quality due to more accurate clutch filling, in addition to reduced clutch filling time.

The transmission provides six forward gears, three reverse gears and a neutral position. The gear positions are indicated on the LCD display located on the dash panel. The transmission will only operate in the gear selected by the operator in the manual range, or, when the lever is in the automatic range, shifts will occur automatically between 1st and 6th gear, depending on operating requirements. The reverse gears 1st through 3rd are manual mode only.

WARNING

Before any welding is done on a machine equipped with an EST-37 shift system, disconnect the following in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables and electrical connections at the engine ECM, transmission ECU, body control lever, hydraulics ECU and cab bulkhead to avoid damage to electrical components. Turn off battery master switch to isolate the batteries before disconnecting any components. After welding connect all of the above in the reverse order.

VTS-3 Shift Controller - Operation:
The shift controller has 3 positions the lever can rest in, Forward, Neutral and Reverse. Within each of these positions, the gear can be changed by pushing the lever to the right (+) to upshift or to the left (-) to downshift. In the Neutral position, this can be used to preselect the starting gear (the default being 2nd gear).

The shift controller has a 'Function' button on the top of the lever which is used to switch between automatic and manual modes. Press the function button from 'NEUTRAL' and move the lever forward to select automatic mode, when driving normal upshifting and downshifting will occur. If required, a gear can be held in manual mode by pressing the function button once, to resume full automatic mode the function button should be pressed again. Manual gears can also be selected by pushing the lever to the left for lower gears or to the right for higher gears, again by pressing the function button once automatic mode will be resumed.

Note: The transmission will only allow gearshifting when the predetermined values have been reached.

Note: There is no shift inhibitor in the gear shift control, therefore, no resistance would be felt while moving through the gear ranges.

The gear lever housing sends a signal to the electronic control unit, which in turn will only allow the engine to be started when the gear lever is in the 'NEUTRAL' position. The gear shift lever must always be placed in 'NEUTRAL' and the parking brake applied when starting the engine, or whenever the machine is left unattended.

When shifting from 'NEUTRAL' to start from a standstill, or to reverse direction, decelerate the engine to idle speed before selecting the proper gear. When 'REVERSE' is selected, the 'Reverse Alarm' sounds and the 'Reverse Light' illuminates to warn personnel to...
the rear of the machine that reverse gear has been selected.

During reversing operations it is recommended to reduce engine speed, use only 1st or 2nd gear and never exceed 10 km/h (6.2 mile/h).

The electronic control system distinguishes between the throttle position (or load ranges) depending on the governor position (injection pump). On a light throttle opening, the transmission will give earlier upshifts and later downshifts than when operating at full throttle.

A kickdown facility (See Fig. 8), which can be used when automatic mode is selected, allows for the possibility of selecting a lower gear by pressing down fully on the throttle pedal and holding. This can be used to provide a downshift on demand provided that the vehicle speed is within the range allowable. That is, the vehicle is not travelling at a speed that would result in the engine overspeeding in the lower gear.

When driving with kickdown, the transmission will give earlier downshifts and later upshifts. To disengage the transmission kickdown, release the throttle pedal and allow it to return to a light throttle position.

When operating in automatic range with the display indicating that the transmission has downshifted to 2nd gear, there are two options for providing a further downshift as conditions indicate.

1. 1st gear can be manually selected by pushing the shift lever to the left.

2. Kickdown can be selected from 2nd automatic, when the transmission will downshift to 1st gear, depending upon vehicle speed.

When the kickdown is released the transmission will upshift to 2nd automatic, provided that the forward speed has increased sufficiently to allow this to happen, and that the shift lever is in the automatic mode.

A dashboard display is provided which indicates gear selected and driving direction as follows (See Fig. 9):

**Manual Mode** - When driving with shift selector in manual range, the bars only are shown in position 1, and, driving direction and gear selected are indicated in positions 2 and 3.

**Automatic Mode** - When driving with shift selector in automatic range, a full display of bars and arrows are shown in position 1, and, driving direction and gear selected are indicated in positions 2 and 3.

Under certain conditions the transmission may start to 'hunt' between gears when in automatic mode. The transmission changes up and down between two gears at short intervals because there is not sufficient power to sustain driving in the higher gear, but is sufficient for upshifting from the lower gear. By using the shift display, it can be established which gears are involved and in these circumstances the lower gear should be selected using the shift control lever. Automatic mode should be reselected at the earliest opportunity.

During machine operation, watch for wide deviations from normal readings on the transmission oil temperature gauge. If the gauge shows the oil temperature rising above 120° C (248° F) during normal operation, or above 145° C (293° F) during retarder operation, the machine must be stopped and inspected for external oil leakage. If no leaks are found, shift to 'NEUTRAL' and operate the engine at 1 200 - 1 500 rev/ min. If the transmission oil temperature does not decrease into the normal zone within 2 or 3 minutes, the cause of the overheating should be corrected.
before the machine is operated further.

**Note:** In cold weather, the transmission oil should be warmed up by running the engine at idle speed with the gear selector in neutral, since the system will not operate satisfactorily if the oil is too cold.

When temporarily stopped, such as for yielding the right-of-way to a loaded machine, the transmission can be left in gear and the machine held stationary with the service brakes.

When stopped for a more extended period with the engine left running, shift to 'NEUTRAL' to avoid unnecessary heat buildup, and apply the parking brake.

⚠️ **WARNING**
 Always select the correct drive direction and gear before releasing the parking brake.

**WARNINGS**

Never allow the machine to coast with the transmission in 'NEUTRAL'.

When running down a gradient the engine speed should not be allowed to drop below 1 200 rev/min, at which point, lockup would disengage preventing retarder operation.

In the event of a loss of electric power to the gear shift control, the transmission will automatically shift to 'NEUTRAL'. If this occurs, stop the machine using the service brakes and apply the parking brake. Do not operate until the fault has been repaired.

Always select 'NEUTRAL' and apply the parking brake before leaving the operators seat.

The retarder will automatically disengage when the oil temperature reaches 150° C (302° F), irrespective of engine speed.

### Display during operation

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F, 1R</td>
<td>Actual gear and direction. Left digit shows actual gear, right digit shows actual direction</td>
<td></td>
</tr>
<tr>
<td>2F, 2R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3F, 3R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF, LR</td>
<td>limp home gear</td>
<td></td>
</tr>
<tr>
<td>F or R, no gear</td>
<td>Clutch Cutoff</td>
<td></td>
</tr>
<tr>
<td>F or R flashing</td>
<td>only 6WG: direction F or R selected while turbine speed is too high, CAUTION gear will engage if turbine speed drops</td>
<td></td>
</tr>
<tr>
<td>NN</td>
<td>not neutral, waiting for neutral after power up or a severe fault to F or R position</td>
<td>go engage a gear, first move shift selector to neutral position and again</td>
</tr>
<tr>
<td>**</td>
<td>oil temperature too low, no gear available</td>
<td>warm up engine / transmission</td>
</tr>
<tr>
<td>*N</td>
<td>oil temperature low, only one gear available</td>
<td>warm up engine / transmission</td>
</tr>
<tr>
<td>1 bar (special symbol)</td>
<td>manual mode 1. gear</td>
<td></td>
</tr>
<tr>
<td>2 bars</td>
<td>manual mode 2. gear</td>
<td></td>
</tr>
<tr>
<td>3 bars</td>
<td>manual mode 3. gear</td>
<td></td>
</tr>
<tr>
<td>4 bars</td>
<td>manual mode 4. gear</td>
<td></td>
</tr>
<tr>
<td>4 bars and 2 arrows</td>
<td>automatic mode</td>
<td></td>
</tr>
<tr>
<td>bars flashing</td>
<td>6 WG: converter lockup clutch open</td>
<td>difference of engine and turbine speed above a certain limit and lockup clutch not activated</td>
</tr>
<tr>
<td>spanner</td>
<td>at least one fault active</td>
<td>select neutral to get fault code displayed</td>
</tr>
<tr>
<td>fault code</td>
<td>see faultcode list</td>
<td></td>
</tr>
</tbody>
</table>
The AEB-Starter is a tool to start the AEB (automatic filling parameter adjustment) of ergopower transmissions with ease. Connect AEB-Starter to plug X25 located below dash adjacent to TCU.

### Display during operation - Continued

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS</td>
<td>warning sump temperature</td>
<td>changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)</td>
</tr>
<tr>
<td>WR</td>
<td>warning retarder temperature</td>
<td>changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)</td>
</tr>
<tr>
<td>WT</td>
<td>warning torque converter temperature</td>
<td>changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)</td>
</tr>
<tr>
<td>WE</td>
<td>warning high engine speed</td>
<td>changes between actual gear/direction while driving, in neutral only displayed if no fault is detected (spanner)</td>
</tr>
<tr>
<td>PN</td>
<td>direction F or R selected while parking brake engaged</td>
<td>transmission in neutral until parking brake is released CAUTION: vehicle starts to move after release of parking brake</td>
</tr>
<tr>
<td>F or R flashing</td>
<td>direction F or R selected while turbine speed is too high, CAUTION gear will engage if turbine speed drops</td>
<td></td>
</tr>
<tr>
<td>EE flashing</td>
<td>no communication with display</td>
<td>checked wiring from TCU to display</td>
</tr>
</tbody>
</table>

### Display during AEB-Mode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL</td>
<td>AEB - Starter is plugged at the diagnostic plug</td>
<td></td>
</tr>
<tr>
<td>ST</td>
<td>AEB-Starter-button is pressed</td>
<td></td>
</tr>
<tr>
<td>K1..K4,KV,KR</td>
<td>calibrating clutch K1..K4,KV,KR</td>
<td></td>
</tr>
<tr>
<td>_ and Kx</td>
<td>wait for start, initialization of clutch Kx, x: 1, 2, 3, 4, V, R</td>
<td></td>
</tr>
<tr>
<td>≡ and Kx</td>
<td>fast fill time determination of clutch Kx</td>
<td></td>
</tr>
<tr>
<td>= and Kx</td>
<td>compensating pressure determination of clutch Kx</td>
<td></td>
</tr>
<tr>
<td>OK</td>
<td>calibration for all clutches finished</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on) after removing AEB-Starter</td>
</tr>
<tr>
<td>STOP</td>
<td>AEB cancelled (activation stopped)</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>STOP and Kx</td>
<td>AEB stopped, clutch Kx can’t be calibrated</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>Spanner and Kx</td>
<td>Kx couldn’t be calibrated, AEB finished</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>† E</td>
<td>engine speed too low, -&gt; raise engine speed</td>
<td></td>
</tr>
<tr>
<td>‡ E</td>
<td>engine speed too high, -&gt; lower engine speed</td>
<td></td>
</tr>
<tr>
<td>† T</td>
<td>transmission oil temperature too low, -&gt; heat up transmission</td>
<td></td>
</tr>
</tbody>
</table>
### Display during AEB-Mode - Continued

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Transmission oil temperature too high -&gt; cool down transmission</td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td>Transmission temperature not in defined range during calibration</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>FB</td>
<td>Operating mode not NORMAL or transmission temperature sensor defective or storing of Calibrated values to EEPROM has failed.</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>FO</td>
<td>Outputspeed_not_zero</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>FN</td>
<td>Shift lever not in Neutral position</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>FP</td>
<td>Parkbrake_not_applied</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
<tr>
<td>STOP</td>
<td>AEB - Starter was used incorrect or is defective</td>
<td>Transmission stays in neutral, you have to restart the TCU (ignition off/on)</td>
</tr>
</tbody>
</table>

### TABLE OF FAULT CODES

<table>
<thead>
<tr>
<th>Fault Code (hex)</th>
<th>MEANING OF CODE: possible reason for fault detection</th>
<th>TCU reaction</th>
<th>Checks</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>LOGICAL ERROR AT GEAR-RANGE SIGNAL: TCU detected a wrong signal combination for the gear range • cable from shift lever to TCU is broken • cable is defective and is connected to battery voltage or vehicle ground • shift lever is defective</td>
<td>TCU shifts transmission to neutral OP-Mode: transmission shutdown</td>
<td>check cables from TCU to shift lever • check signal combinations of shift lever positions for gear range</td>
<td>Failure cannot be detected in systems with DW2/DW3 shift lever</td>
</tr>
<tr>
<td>12</td>
<td>LOGICAL ERROR AT DIRECTION SELECT SIGNAL: TCU detected a wrong signal combination for the direction • cable from shift lever to TCU is broken • cable is defective and is connected to battery voltage or vehicle ground • shift lever is defective</td>
<td>TCU shifts transmission to neutral OP-Mode: transmission shutdown</td>
<td>check cables from TCU to shift lever • check signal combinations of shift lever positions F-N-R</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>LOGICAL ERROR AT ENGINE DERATING DEVICE: TCU detected no reaction of engine while derating device active</td>
<td>after selecting neutral, TCU changes to</td>
<td>check engine derating device</td>
<td>This fault is reset after power up of TCU</td>
</tr>
<tr>
<td>15</td>
<td>LOGICAL ERROR AT DIRECTION SELECT SIGNAL 2 SHIFTER: TCU detected a wrong signal combination for the direction • cable from shift lever 2 to TCU is broken • cable is defective and is connected to battery voltage or vehicle ground • shift lever is defective</td>
<td>TCU shifts transmission to neutral if selector active OP-Mode: transmission shutdown if selector active</td>
<td>check cables from TCU to shift lever 2 • check signal combinations of shift lever positions F-N-R</td>
<td>Fault is taken back if TCU detects a valid neutral signal for the direction at the shift lever</td>
</tr>
<tr>
<td>16</td>
<td>LOGICAL ERROR AT AXLE CONNECTION: Feedback axle connection measured by TCU and output signal axle connection don't fit • axle can't be connected/disconnected due to mechanical problem • one of the cables from feedback axle connection - switch to TCU is broken</td>
<td>OP-Mode: normal</td>
<td>check cables from TCU to feedback axle connection switch • check signals of the feedback axle connection</td>
<td></td>
</tr>
<tr>
<td>Fault Code (hex)</td>
<td>MEANING OF CODE possible reason for fault detection</td>
<td>TCU reaction</td>
<td>Checks</td>
<td>Remarks</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------</td>
<td>--------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>17</td>
<td>S.C. TO GROUND AT TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground • cable is defective and is contacted to vehicle ground • device has an internal defect • connector pin is contacted to vehicle ground</td>
<td>customer specific</td>
<td>• check cables from TCU to device • check connectors from TCU to device • check the resistance of device</td>
<td>See figure 10</td>
</tr>
<tr>
<td>18</td>
<td>S.C. TO BATTERY VOLTAGE AT ADM4 TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage • cable is defective and is contacted to battery voltage • relay has an internal defect • connector pin is contacted to battery voltage</td>
<td>no reaction</td>
<td>• check cables from TCU to relay • check connectors from TCU to relay • check the resistance of relay</td>
<td>See figure 10</td>
</tr>
<tr>
<td>19</td>
<td>O.C. AT ADM4 TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin • cable is defective and has no connection to TCU • relay has an internal defect • connector has no connection to TCU</td>
<td>no reaction</td>
<td>• check cable from TCU to sensor • check connectors • check temperature sensor</td>
<td>See figure 10</td>
</tr>
<tr>
<td>25</td>
<td>S.C. TO BATTERY VOLTAGE OR O.C. AT TRANSMISSION SUMP TEMPERATURE SENSOR INPUT the measured voltage is too high: • cable is defective and is contacted to battery voltage • cable has no connection to TCU • temperature sensor has an internal defect • connector pin is contacted to battery voltage or is broken</td>
<td>no reaction, TCU uses default temp. OP-Mode: normal</td>
<td>• check cable from TCU to sensor • check connectors • check temperature sensor</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>S.C. TO GROUND AT TRANSMISSION SUMP TEMPERATURE SENSOR INPUT the measured voltage is too low: • cable is defective and is contacted to vehicle ground • temperature sensor has an internal defect • connector pin is contacted to vehicle ground</td>
<td>no reaction, TCU uses default temp. OP-Mode: normal</td>
<td>• check cable from TCU to sensor • check connectors • check temperature sensor</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>S.C. TO BATTERY VOLTAGE OR O.C. AT RETARDER TEMPERATURE SENSOR INPUT the measured voltage is too high: • cable is defective and is contacted to battery voltage • cable has no connection to TCU • temperature sensor has an internal defect • connector pin is contacted to battery voltage or is broken</td>
<td>no reaction, TCU uses default temp. OP-Mode: normal</td>
<td>• check cable from TCU to sensor • check connectors • check temperature sensor</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>S.C. TO GROUND AT RETARDER TEMPERATURE SENSOR INPUT the measured voltage is too low: • cable is defective and is contacted to vehicle ground • temperature sensor has an internal defect • connector pin is contacted to vehicle ground</td>
<td>no reaction, TCU uses default temp. OP-Mode: normal</td>
<td>• check cable from TCU to sensor • check connectors • check temperature sensor</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>S.C. TO BATTERY VOLTAGE OR O.C. AT ENGINE SPEED INPUT TCU measures a voltage higher than 7.00 V at speed input pin • cable is defective and is contacted to battery voltage • cable has no connection to TCU • speed sensor has an internal defect • connector pin is contacted to battery voltage or has no contact</td>
<td>OP-Mode: substitute clutch control</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td></td>
</tr>
<tr>
<td>Fault Code (hex)</td>
<td>MEANING OF CODE</td>
<td>TCU reaction</td>
<td>Checks</td>
<td>Remarks</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>--------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>32</td>
<td>S.C. TO GROUND AT ENGINE SPEED INPUT</td>
<td>OP-Mode: substitute clutch control</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCU measures a voltage less than 0.45V at speed input pin • cable/connector is defective and is contacted to vehicle ground • speed sensor has an internal defect</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>LOGICAL ERROR AT ENGINE SPEED INPUT</td>
<td>OP-Mode: substitute clutch control</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td>This fault is reset after power up to TCU</td>
</tr>
<tr>
<td></td>
<td>TCU measures a engine speed over a threshold and the next moment the measured speed is zero • cable/connector is defective and has bad contact • speed sensor has an internal defect • sensor gap has the wrong size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>S.C. TO BATTERY VOLTAGE OR O.C. AT TURBINE SPEED INPUT</td>
<td>OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCU measures a voltage higher than 7.00 V at speed input pin • cable is defective and is contacted to battery voltage • cable has no connection to TCU • speed sensor has an internal defect • connector pin is contacted to battery voltage or has no contact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>S.C. TO GROUND AT TURBINE SPEED INPUT</td>
<td>OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero • cable/connector is defective and has bad contact • speed sensor has an internal defect • sensor gap has the wrong size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>LOGICAL ERROR AT TURBINE SPEED INPUT</td>
<td>OP-Mode: substitute clutch control if a failure is existing at output speed, TCU shifts to neutral OP-Mode: limp home</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td>This fault is reset after power up of TCU</td>
</tr>
<tr>
<td></td>
<td>TCU measures a turbine speed over a threshold and at the next moment the measured speed is zero • cable/connector is defective and has bad contact • speed sensor has an internal defect • sensor gap has the wrong size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>S.C. TO BATTERY VOLTAGE OR O.C. AT INTERNAL SPEED INPUT</td>
<td>OP-Mode: substitute clutch control</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCU measures a voltage higher than 7.00 V at speed input pin • cable is defective and is contacted to battery voltage • cable has no connection to TCU • speed sensor has an internal defect • connector pin is contacted to battery voltage or has no contact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>S.C. TO GROUND AT INTERNAL SPEED INPUT</td>
<td>OP-Mode: substitute clutch control</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TCU measures a voltage less than 0.45V at speed input pin • cable/connector is defective and is contacted to vehicle ground • speed sensor has an internal defect</td>
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<td>39</td>
<td>LOGICAL ERROR AT INTERNAL SPEED INPUT</td>
<td>OP-Mode: substitute clutch control</td>
<td>• check cable from TCU to sensor • check connectors • check speed sensor • check sensor gap</td>
<td>This fault is reset after power up of TCU</td>
</tr>
<tr>
<td></td>
<td>TCU measures a internal speed over a threshold and at the next moment the measured speed is zero • cable/connector is defective and has bad contact • speed sensor has an internal defect • sensor gap has the wrong size</td>
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| 3A               | S.C. TO BATTERY VOLTAGE OR O.C. AT OUTPUT SPEED INPUT TCU measures a voltage higher than 12.5 V at speed input pin  
• cable is defective and is contacted to battery voltage  
• cable has no connection to TCU  
• speed sensor has an internal defect  
• connector pin is contacted to battery voltage or has no contact | special mode for gear selection  
OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral  
OP-Mode: limp home | • check cable from TCU to sensor  
• check connectors  
• check speed sensor | |
| 3B               | S.C. TO GROUND AT OUTPUT SPEED INPUT TCU measures a voltage less than 1.00 V at speed input pin  
• cable / connector is defective and is contacted to vehicle ground | special mode for gear selection  
OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral  
OP-Mode: limp home | • check cable from TCU to sensor  
• check connectors  
• check speed sensor | |
| 3C               | LOGICAL ERROR AT OUTPUT SPEED INPUT TCU measures a output speed over a threshold and at the next moment the measured speed is zero  
• cable / connector is defective and has bad contact  
• speed sensor has an internal defect  
• sensor gap has the wrong size | special mode for gear selection  
OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral  
OP-Mode: limp home | • check cable from TCU to sensor  
• check connectors  
• check speed sensor  
• check sensor gap | This fault is reset after power up of TCU |
| 3E               | OUTPUT SPEED ZERO DOESN'T FIT TO OTHER SPEED SIGNALS if transmission is not neutral and the shifting has finished.  
TCU measures outputspeed zero and turbine speed or internal speed not equal to zero.  
• speed sensor has an internal defect  
• sensor gap has the wrong size | special mode for gear selection  
OP-Mode: substitute clutch control if a failure is existing at turbine speed, TCU shifts to neutral  
OP-Mode: limp home | • check sensor signal of output speed sensor  
• check sensor gap of output speed sensor  
• check cable from TCU to sensor | This fault is reset after power up of TCU |
| 56               | ENGINE CONF TIMEOUT Timeout of CAN-message ENGINE CONF from engine controller  
• interference on CAN-Bus  
• CAN wire/connector is broken  
• CAN wire/connector is defective and has contact to vehicle ground or battery voltage | OP-Mode: substitute clutch control | • check engine controller  
• check wire of CAN-Bus  
• check cable to engine controller | |
| 57               | EECl TIMEOUT Timeout of CAN-message EECl from EEC controller  
• interference on CAN-Bus  
• CAN wire/connector is broken  
• CAN wire/connector is defective and has contact to vehicle ground or battery voltage | OP-Mode: substitute clutch control | • check EEC controller  
• check wire of CAN-Bus  
• check cable to EEC controller | |
| 58               | EECl3 TIMEOUT Timeout of CAN-message EECl3 from EEC controller  
• interference on CAN-Bus  
• CAN wire/connector is broken  
• CAN wire/connector is defective and has contact to vehicle ground or battery voltage | OP-Mode: substitute clutch control | • check EEC controller  
• check wire of CAN-Bus  
• check cable to EEC controller | |
| 65               | ENGINE TORQUE SIGNAL CAN signal for engine torque is defective  
• engine controller is defective  
• interference on CAN-Bus | OP-Mode: substitute clutch control | • check engine controller  
• check wire of CAN-Bus  
• check cable to engine controller | |
| 66               | KICKDOWN SIGNAL CAN signal for kickdown is defective  
• engine controller is defective  
• interference on CAN-Bus | no reaction | • check engine controller  
• check wire of CAN-Bus  
• check cable to engine controller | |
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| 69              | REFERENCE ENGINE TORQUE SIGNAL CAN signal for reference of engine torque is defective  
**engine controller is defective**  
**interference on CAN-Bus** | OP-Mode: substitute clutch control | •check engine controller  
•check wire of CAN-Bus  
•check cable to engine controller |  |
| 6A              | ACTUAL ENGINE TORQUE SIGNAL CAN signal for actual engine torque is defective  
**engine controller is defective**  
**interference on CAN-Bus** | OP-Mode: substitute clutch control | •check engine controller  
•check wire of CAN-Bus  
•check cable to engine controller |  |
| 6B              | NOM FRICTION TORQUE SIGNAL CAN signal for nominal friction torque is defective  
**engine controller is defective**  
**interference on CAN-Bus** | OP-Mode: substitute clutch control | •check engine controller  
•check wire of CAN-Bus  
•check cable to engine controller |  |
| 6E              | EEC2 TIMEOUT Timeout of CAN-message EEC2 from EEC controller  
**interference on CAN-Bus**  
**CAN wire/connector is broken**  
**CAN wire/connector is defective and has contact to vehicle ground or battery voltage** | no reaction  
TCU uses default signal accelerator pedal in idle position  
OP-Mode: normal | •check EEC controller  
•check wire of CAN-Bus  
•check cable to EEC controller | if this signal is not transmitted via CAN, TCU uses default signal |
| 6F              | ACCELERATOR LOW IDLE SWITCH SIGNAL CAN signal for manual downshift is defective  
**EEC controller is defective**  
**interference on CAN-Bus** | no reaction  
TCU uses default signal accelerator pedal in idle position  
OP-Mode: normal | •check EEC controller  
•check wire of CAN-Bus  
•check cable to EEC controller |  |
| 71              | s.c. TO BATTERY VOLTAGE AT CLUTCH K1 the measured resistance value of the valve is out of limit, the voltage at K1 valve is too high  
**cable / connector is defective and has contact to battery voltage**  
**cable / connector is defective and has contact to another regulator output of the TCU**  
**regulator has an internal defect** | TCU shifts to neutral  
OP-Mode: limp home if failure at another clutch is pending  
TCU shifts to neutral  
OP-Mode: TCU shutdown | •check cable from TCU to gearbox  
•check connectors from TCU to gearbox  
•check regulator resistance |  |
| 72              | s.c. TO GROUND AT CLUTCH K1 the measured resistance value of the valve is out of limit, the voltage at K1 valve is too low.  
**cable / connector is defective and has contact to vehicle ground**  
**regulator has an internal defect** | TCU shifts to neutral  
OP-Mode: limp home if failure at another clutch is pending  
TCU shifts to neutral  
OP-Mode: TCU shutdown | •check cable from TCU to gearbox  
•check connectors from gearbox to TCU  
•check regulator resistance |  |
| 73              | o.c. AT CLUTCH K1 the measured resistance value of the valve is out of limit.  
**cable / connector is defective and has no contact to TCU**  
**regulator has an internal defect** | TCU shifts to neutral  
OP-Mode: limp home if failure at another clutch is pending  
TCU shifts to neutral  
OP-Mode: TCU shutdown | •check cable from TCU to gearbox  
•check connectors from gearbox to TCU  
•check regulator resistance |  |
| 74              | s.c. TO BATTERY VOLTAGE AT CLUTCH K2 the measured resistance value of the valve is out of limit, the voltage at K2 valve is too high.  
**cable / connector is defective and has contact to battery voltage**  
**cable / connector is defective and has contact to another regulator output of the TCU**  
**regulator has an internal defect** | TCU shifts to neutral  
OP-Mode: limp home if failure at another clutch is pending  
TCU shifts to neutral  
OP-Mode: TCU shutdown | •check cable from TCU to gearbox  
•check connectors from gearbox to TCU  
•check regulator resistance |  |
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<td>75</td>
<td>S.C. to Ground at Clutch K2 the measured resistance value of the valve is out of limit, the voltage at K2 valve is too low.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<td>76</td>
<td>O.C. at Clutch K2 the measured resistance value of the valve is out of limit.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<td>77</td>
<td>S.C. to Battery Voltage at Clutch K3 the measured resistance value of the valve is out of limit, the voltage at K3 valve is too high.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<td>78</td>
<td>S.C. to Ground at Clutch K3 the measured resistance value of the valve is out of limit, the voltage at K3 valve is too low.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<td>79</td>
<td>O.C. at Clutch K3 the measured resistance value of the valve is out of limit.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<td>81</td>
<td>S.C. to Battery Voltage at Clutch K4 the measured resistance value of the valve is out of limit, the voltage at K4 valve is too high.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<td>82</td>
<td>S.C. to Ground at Clutch K4 the measured resistance value of the valve is out of limit, the voltage at K4 valve is too low.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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<tr>
<td>83</td>
<td>O.C. at Clutch K4 the measured resistance value of the valve is out of limit.</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check cable from TCU to gear box • check connectors from gearbox to TCU • check regulator resistance 1) • check internal wire harness of the gearbox</td>
<td>see figure 10</td>
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| 84              | s.c. to battery voltage at clutch KV the measured resistance value of the valve is out of limit, the voltage at KV valve is too high  
                      cable / connector is defective and has contact to battery voltage  
                      cable / connector is defective and has contact to another regulator output of the TCU  
                      regulator has an internal defect | TCU shifts to neutral  
                           OP-Mode: limp home if failure at another clutch is pending  
                           TCU shifts to neutral  
                           OP-Mode: TCU shutdown | • check cable from TCU to gear box  
                               • check connectors from gearbox to TCU  
                               • check regulator resistance  
                               • check internal wire harness of the gearbox | 1) see figure 10 |
| 85              | s.c. to ground at clutch KV the measured resistance value of the valve is out of limit, the voltage at KV valve is too low  
                      cable / connector is defective and has contact to vehicle ground  
                      regulator has an internal defect | TCU shifts to neutral  
                           OP-Mode: limp home if failure at another clutch is pending  
                           TCU shifts to neutral  
                           OP-Mode: TCU shutdown | • check cable from TCU to gear box  
                               • check connectors from gearbox to TCU  
                               • check regulator resistance  
                               • check internal wire harness of the gearbox | 1) see figure 10 |
| 86              | o.c. at clutch KV the measured resistance value of the valve is out of limit  
                      cable / connector is defective and has no contact to TCU  
                      regulator has an internal defect | TCU shifts to neutral  
                           OP-Mode: limp home if failure at another clutch is pending  
                           TCU shifts to neutral  
                           OP-Mode: TCU shutdown | • check cable from TCU to gear box  
                               • check connectors from gearbox to TCU  
                               • check regulator resistance  
                               • check internal wire harness of the gearbox | 1) see figure 10 |
| 87              | s.c. to battery voltage at clutch KR the measured resistance value of the valve is out of limit, the voltage at KR valve is too high  
                      cable / connector is defective and has contact to battery voltage  
                      cable / connector is defective and has contact to another regulator output of the TCU  
                      regulator has an internal defect | TCU shifts to neutral  
                           OP-Mode: limp home if failure at another clutch is pending  
                           TCU shifts to neutral  
                           OP-Mode: TCU shutdown | • check cable from TCU to gear box  
                               • check connectors from gearbox to TCU  
                               • check regulator resistance  
                               • check internal wire harness of the gearbox | 1) see figure 10 |
| 88              | s.c. to ground at clutch KR the measured resistance value of the valve is out of limit, the voltage at KR valve is too low  
                      cable / connector is defective and has contact to vehicle ground  
                      regulator has an internal defect | TCU shifts to neutral  
                           OP-Mode: limp home if failure at another clutch is pending  
                           TCU shifts to neutral  
                           OP-Mode: TCU shutdown | • check cable from TCU to gear box  
                               • check connectors from gearbox to TCU  
                               • check regulator resistance  
                               • check internal wire harness of the gearbox | 1) see figure 10 |
| 89              | o.c. at clutch KR the measured resistance value of the valve is out of limit  
                      cable / connector is defective and has no contact to TCU  
                      regulator has an internal defect | TCU shifts to neutral  
                           OP-Mode: limp home if failure at another clutch is pending  
                           TCU shifts to neutral  
                           OP-Mode: TCU shutdown | • check cable from TCU to gear box  
                               • check connectors from gearbox to TCU  
                               • check regulator resistance  
                               • check internal wire harness of the gearbox | 1) see figure 10 |
| 91              | s.c. to ground at relay reverse warning alarm TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground  
                      cable is defective and is contacted to vehicle ground  
                      backup alarm device has an internal defect  
                      connector pin is contacted to vehicle ground | backup alarm will be on until TCU power down even if fault vanishes (loose connection)  
                           OP-Mode: normal | • check cable from TCU to backup alarm device  
                               • check connectors from backup alarm device to TCU  
                               • check resistance 1) of backup alarm device | 1) see figure 10 |
| 92              | s.c. to battery voltage at relay reverse warning alarm TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage  
                      cable is defective and is contacted to battery voltage  
                      backup alarm device has an internal defect  
                      connector pin is contacted to battery voltage | no reaction  
                           OP-Mode: normal | • check cable from TCU to backup alarm device  
                               • check connectors from backup alarm device to TCU  
                               • check resistance 1) of backup alarm device | 1) see figure 10 |
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</table>
| 93            | O.C. AT RELAY REVERSE WARNING ALARM TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin  
 cable is defective and has no connection to TCU  
 backup alarm device has an internal defect  
 connector has no connection to TCU | no reaction  
 OP-Mode: normal | • check cable from TCU to backup alarm device  
 • check connectors from backup alarm device to TCU  
 • check resistance of backup alarm device | see figure 10 |
| 9A            | S.C. TO GROUND AT CONVERTER LOCK UP CLUTCH TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground  
 cable is defective and has no connection to TCU  
 converter clutch solenoid has an internal defect  
 connector pin is contacted to vehicle ground | no reaction  
 OP-Mode: normal | • check cable from TCU to converter clutch solenoid  
 • check connectors from converter clutch solenoid to TCU  
 • check resistance of converter clutch solenoid | see figure 10 |
| 9B            | O.C. AT CONVERTER LOCK UP CLUTCH TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin  
 cable is defective and has no connection to TCU  
 converter clutch solenoid has an internal defect  
 connector has no connection to TCU | converter clutch always open, retarder not available  
 OP-Mode: normal | • check cable from TCU to converter clutch solenoid  
 • check connectors from converter clutch solenoid to TCU  
 • check resistance of converter clutch solenoid | see figure 10 |
| 9C            | S.C. TO BATTERY VOLTAGE AT CONVERTER LOCK UP CLUTCH TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage  
 cable is defective and is contacted to battery voltage  
 converter clutch solenoid has an internal defect  
 connector pin is contacted to battery voltage | no reaction  
 OP-Mode: normal | • check cable from TCU to converter clutch solenoid  
 • check connectors from converter clutch solenoid to TCU  
 • check resistance of converter clutch solenoid | see figure 10 |
| 9D            | S.C. TO GROUND AT RETARDER TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground  
 cable is defective and is contacted to vehicle ground  
 retarder solenoid has an internal defect  
 connector pin is contacted to vehicle ground | no reaction  
 OP-Mode: normal | • check cable from TCU to retarder solenoid  
 • check connectors from retarder solenoid to TCU  
 • check resistance of retarder solenoid | see figure 10 |
| 9E            | O.C. AT RETARDER TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin  
 cable is defective and has no connection to TCU  
 retarder solenoid has an internal defect  
 connector has no connection to TCU | no reaction  
 OP-Mode: normal | • check cable from TCU to retarder solenoid  
 • check connectors from retarder solenoid to TCU  
 • check resistance of retarder solenoid | see figure 10 |
| 9F            | S.C. TO BATTERY VOLTAGE AT RETARDER SOLENOID TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage  
 cable is defective and is contacted to battery voltage  
 retarder solenoid has an internal defect  
 connector pin is contacted to battery voltage | no reaction  
 OP-Mode: normal | • check cable from TCU to retarder solenoid  
 • check connectors from retarder solenoid to TCU  
 • check resistance of retarder solenoid | see figure 10 |
| A1            | S.C. TO GROUND AT DIFLOCK SOLENOID TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground  
 cable is defective and is contacted to vehicle ground  
 diflock solenoid has an internal defect  
 connector pin is contacted to vehicle ground | no reaction  
 OP-Mode: normal | • check cable from TCU to diflock solenoid  
 • check connectors from diflock solenoid to TCU  
 • check resistance of diflock solenoid | see figure 10 |
| A2            | S.C. TO BATTERY VOLTAGE AT DIFLOCK SOLENOID TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage  
 cable is defective and is contacted to battery voltage  
 diflock solenoid has an internal defect  
 connector pin is contacted to battery voltage | no reaction  
 OP-Mode: normal | • check cable from TCU to diflock solenoid  
 • check connectors from diflock solenoid to TCU  
 • check resistance of diflock solenoid | see figure 10 |
| A3            | O.C. AT DIFLOCK SOLENOID TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin  
 cable is defective and has no connection to TCU  
 diflock solenoid has an internal defect  
 connector has no connection to TCU | no reaction  
 OP-Mode: normal | • check cable from TCU to diflock solenoid  
 • check connectors from diflock solenoid to TCU  
 • check resistance of diflock solenoid | see figure 10 |
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<td>A4</td>
<td>S.C. TO GROUND AT WARNING SIGNAL OUTPUT TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground • cable is defective and is contacted to vehicle ground • warning device has an internal defect • connector pin is contacted to vehicle ground</td>
<td>no reaction OP-Mode: normal</td>
<td>• check cable from TCU to warning device • check connectors from warning device to TCU • check resistance of warning device</td>
<td>1) see figure 10</td>
</tr>
<tr>
<td>A5</td>
<td>O.C. AT WARNING SIGNAL OUTPUT TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin • cable is defective and has no connection to TCU • warning device has an internal defect • connector has no connection to TCU</td>
<td>no reaction OP-Mode: normal</td>
<td>• check cable from TCU to warning device • check connectors from warning device to TCU • check resistance of warning device</td>
<td>1) see figure 10</td>
</tr>
<tr>
<td>A6</td>
<td>S.C. TO BATTERY VOLTAGE AT WARNING SIGNAL OUTPUT TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage • cable is defective and is contacted to battery voltage • warning device has an internal defect • connector pin is contacted to battery voltage</td>
<td>no reaction OP-Mode: normal</td>
<td>• check cable from TCU to warning device • check connectors from warning device to TCU • check resistance of warning device</td>
<td>1) see figure 10</td>
</tr>
<tr>
<td>B1</td>
<td>SLIPPAGE AT CLUTCH K1 TCU calculates a differential speed at closed clutch K1. If this calculated value is out of range, TCU interprets this as slipping clutch. • low pressure at clutch K1 • low main pressure • wrong signal at internal speed sensor • wrong signal at output speed sensor • wrong size of the sensor gap • clutch is defective</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check pressure at clutch K1 • check sensor gap at internal speed sensor • check sensor gap at output speed sensor • check signal at internal speed sensor • check signal at output speed sensor • replace clutch</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>SLIPPAGE AT CLUTCH K2 TCU calculates a differential speed at closed clutch K2. If this calculated value is out of range, TCU interprets this as slipping clutch. • low pressure at clutch K2 • low main pressure • wrong signal at internal speed sensor • wrong signal at output speed sensor • wrong size of the sensor gap • clutch is defective</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check pressure at clutch K2 • check main press. in system • check sensor gap at internal speed sensor • check sensor gap at output speed sensor • check signal at internal speed sensor • check signal at output speed sensor • replace clutch</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>SLIPPAGE AT CLUTCH K3 TCU calculates a differential speed at closed clutch K3. If this calculated value is out of range, TCU interprets this as slipping clutch. • low pressure at clutch K3 • low main pressure • wrong signal at internal speed sensor • wrong signal at output speed sensor • wrong size of the sensor gap • clutch is defective</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check pressure at clutch K3 • check main press. in system • check sensor gap at internal speed sensor • check sensor gap at output speed sensor • check signal at internal speed sensor • check signal at output speed sensor • replace clutch</td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>SLIPPAGE AT CLUTCH K4 TCU calculates a differential speed at closed clutch K4. If this calculated value is out of range, TCU interprets this as slipping clutch. • low pressure at clutch K4 • low main pressure • wrong signal at internal speed sensor • wrong signal at turbine speed sensor • wrong size of the sensor gap • clutch is defective</td>
<td>TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending TCU shifts to neutral OP-Mode: TCU shutdown</td>
<td>• check pressure at clutch K4 • check main press. in system • check sensor gap at internal speed sensor • check sensor gap at turbine speed sensor • check signal at internal speed sensor • check signal at turbine speed sensor • replace clutch</td>
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<td>--------------------------------------------------</td>
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</tr>
</tbody>
</table>
| B5 SLIPAGE AT CLUTCH KV | TCU calculates a differential speed at closed clutch KV. If this calculated value is out of range, TCU interprets this as slipping clutch. 
  • low pressure at clutch KV 
  • low main pressure 
  • wrong signal at internal speed sensor 
  • wrong signal at turbine speed sensor 
  • wrong size of the sensor gap 
  • clutch is defective | TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending 
 TCU shifts to neutral OP-Mode: TCU shutdown | • check pressure at clutch KV 
 • check main press. in system 
 • check sensor gap at internal speed sensor 
 • check sensor gap at turbine speed sensor 
 • check signal at internal speed sensor 
 • check signal at turbine speed sensor 
 • replace clutch |
| B6 SLIPAGE AT CLUTCH KR | TCU calculates a differential speed at closed clutch KR. If this calculated value is out of range, TCU interprets this as slipping clutch. 
  • low pressure at clutch KR 
  • low main pressure 
  • wrong signal at internal speed sensor 
  • wrong signal at turbine speed sensor 
  • wrong size of the sensor gap 
  • clutch is defective | TCU shifts to neutral OP-Mode: limp home if failure at another clutch is pending 
 TCU shifts to neutral OP-Mode: TCU shutdown | • check pressure at clutch KR 
 • check main press. in system 
 • check sensor gap at internal speed sensor 
 • check sensor gap at turbine speed sensor 
 • check signal at internal speed sensor 
 • check signal at turbine speed sensor 
 • replace clutch |
| B7 OVERTEMP SUMP | TCU measured a temperature in the oil sump that is over the allowed threshold. | no reaction OP-Mode: normal OP-Mode: normal | • cool down machine 
 • check oil level 
 • check temperature sensor |
| B8 OVERTEMP RETARDER | TCU measured a temperature in the retarder oil that is over the allowed threshold. | TCU disables retarder OP-Mode: normal | • cool down machine 
 • check oil level 
 • check temperature sensor |
| B9 OVERSPEED ENGINE | retarder applies OP-Mode: normal | - | not used |
| BA DIFFERENTIAL PRESSURE OIL FILTER | TCU measured a voltage at differential pressure switch out of the allowed range. 
  • oil filter is polluted 
  • cable/connector is broken or cable/connector is contacted to battery voltage or vehicle ground 
  • differential pressure switch is defective | no reaction OP-Mode: normal | • check oil filter 
 • check wiring from TCU to differential pressure switch (measure resistance) |
| BB SLIPAGE AT CONVERTER LOCKUP CLUTCH | TCU calculates a differential speed at closed converter lockup clutch. If this calculated value is out of range, TCU interprets this as slipping clutch. 
  • low pressure at converter lockup clutch 
  • low main pressure 
  • wrong signal at engine speed sensor 
  • wrong signal at turbine speed sensor 
  • wrong size of the sensor gap 
  • clutch is defective | | • check pressure at converter lockup clutch 
 • check main pressure in the system 
 • check sensor gap at engine speed sensor 
 • check sensor gap at turbine speed sensor 
 • check signal at engine speed sensor 
 • check signal at turbine speed sensor 
 • replace clutch |
| BD S.C. 2G GROUND AT ENGINE BRAKE SOLENOID | TCU detected a wrong voltage at the output pin, that looks like a s.c. to vehicle ground 
  • cable is defective and is contacted to vehicle ground 
  • engine brake solenoid has an internal defect 
  • connector pin is contacted to vehicle ground | no reaction OP-mode: normal | • check cable from TCU to engine brake solenoid 
 • check connectors from engine brake solenoid to TCU 
 • check the resistance of engine brake solenoid |

\(^{1)}\) see figure 10
<table>
<thead>
<tr>
<th>Fault Code (hex)</th>
<th>MEANING OF CODE possible reason for fault detection</th>
<th>TCU reaction</th>
<th>Checks</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| BE              | s.c. battery voltage at engine brake TCU detected a wrong voltage at the output pin, that looks like a s.c. to battery voltage  
● cable is defective and is connected to battery voltage  
● engine brake solenoid has an internal defect  
● connector pin is connected to battery voltage | no reaction  
OP-mode: normal | • check cable from TCU to engine brake solenoid  
• check connectors from engine brake solenoid to TCU  
• check the resistance 1/2 of engine brake solenoid | 1) see figure 10 |
| BF              | o.c. at engine brake TCU detected a wrong voltage at the output pin, that looks like a o.c. for this output pin  
● cable is defective and has no connection to TCU  
● engine brake solenoid has an internal defect  
● connector has no connection to TCU | no reaction  
OP-mode: normal | • check cable from TCU to engine brake solenoid  
• check connectors from engine brake solenoid to TCU  
• check the resistance 1/2 of engine brake solenoid | 1) see figure 10 |
| C3              | over-temp torq convertor output TCU measured an oil temperature at the converter output that is over the allowed threshold | no reaction  
OP-mode: normal | • cool down machine  
• check oil level  
• check temperature sensor | |
| CA              | engine retarder config timeout Timeout of CAN message ENGINE RETARDER CONFIG from EEC controller  
● interference on CAN-Bus  
● CAN wire/connector is broken  
● CAN wire/connector is defective and has contact to vehicle ground or battery voltage | OP-mode: substitute clutch control | • check EEC controller  
• check wire of CAN-Bus  
• check cable to EEC controller | |
| CB              | ETC timeout Timeout of CAN-message ETC1 from EEC controller  
● interference on CAN-Bus  
● CAN wire/connector is broken  
● CAN wire/connector is defective and has contact to vehicle ground or battery voltage | OP-mode: substitute clutch control | • check EEC controller  
• check wire of CAN-Bus  
• check cable to EEC controller | |
| D1              | s.c. to battery voltage at power supply for sensors TCU measures more than 6V at the pin AU1  
(5V sensor supply) | see fault codes no. 21 to no. 2C | • check cables and connectors to sensors, which are supplied from AU1  
• check power supply at pin AU1 (should be approx. 5V) | fault codes no. 21 to no. 2C may be a reaction of this fault |
| D2              | s.c. to ground at power supply for sensors TCU measures less than 4V at the pin AU1  
(5V sensor supply) | see fault codes no. 21 to no. 2C | • check cables and connectors to sensors, which are supplied from AU1  
• check power supply at pin AU1 (should be approx. 5V) | fault codes no. 21 to no. 2C may be a reaction of this fault |
| D3              | low power at battery measured voltage at power supply is lower than 18 V | shift to neutral  
OP-Mode: TCU shutdown | • check power supply battery  
• check cables from batteries to TCU  
• check connectors from batteries to TCU | |
| D4              | high power at battery measured voltage at power supply is higher than 32.5 V | shift to neutral  
OP-Mode: TCU shutdown | • check power supply battery  
• check cables from batteries to TCU  
• check connectors from batteries to TCU | |
### Transmission - Transmission and Mounting

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<table>
<thead>
<tr>
<th>Fault Code (hex)</th>
<th>MEANING OF CODE possible reason for fault detection</th>
<th>TCU reaction</th>
<th>Checks</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>D5</td>
<td>error at switch 1 for valve power supply VPS1 TCU switched on VPS1 and measured VPS1 is off or TCU switched off VPS1 and measured VPS1 is still on • cable or connectors are defect and are connected to battery voltage • cable or connectors are defect and are connected to vehicle ground • permanent power supply KL30 missing • TCU has an internal defect</td>
<td>shift to neutral OP-Mode: TCU shutdown</td>
<td>• check fuse • check cables from gearbox to TCU • check connectors from gearbox to TCU • replace TCU</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>error at switch 2 for valve power supply VPS2 TCU switched on VPS2 and measured VPS2 is off or TCU switched off VPS2 and measured VPS2 is still on • cable or connectors are defect and are connected to battery voltage • cable or connectors are defect and are connected to vehicle ground • permanent power supply KL30 missing • TCU has an internal defect</td>
<td>shift to neutral OP-Mode: TCU shutdown</td>
<td>• check fuse • check cables from gearbox to TCU • check connectors from gearbox to TCU • replace TCU</td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>s.c. to battery voltage at display output TCU sends data to the display and measures always a high voltage level on the connector. • cable or connectors are defect and are connected to battery voltage • display has an internal defect</td>
<td>no reaction OP-Mode: normal</td>
<td>• check cable from TCU to the display • check connectors at the display • change display</td>
<td></td>
</tr>
<tr>
<td>E4</td>
<td>s.c. to ground at display output TCU sends data to the display and measures always a high voltage level on the connector. • cable or connectors are defect and are connected to vehicle ground • display has an internal defect</td>
<td>no reaction OP-Mode: normal</td>
<td>• check cable from TCU to the display • check connectors at the display • change display</td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td>General EEPROM fault TCU cannot read non volatile memory • TCU is defective</td>
<td>no reaction OP-Mode: normal</td>
<td>• replace TCU</td>
<td>often shown together with fault code F2</td>
</tr>
<tr>
<td>F3</td>
<td>Application error something of this application is wrong</td>
<td>transmission stay neutral OP-Mode: TCU shutdown</td>
<td>• replace TCU</td>
<td>fault occurs only if a test engineer did something wrong in the application of the vehicle</td>
</tr>
<tr>
<td>F5</td>
<td>Clutch Failure AEB was not able to adjust clutch filling parameters • One of the AEB-Values is out of limit</td>
<td>transmission stay neutral OP-Mode: TCU shutdown</td>
<td>• check clutch</td>
<td>TCU shows also the affected clutch on the Display</td>
</tr>
<tr>
<td>F6</td>
<td>Clutch Adjustment Data Lost TCU was not able to read correct clutch adjustment parameters • Interference during saving data on non volatile memory • TCU is brand new or from another vehicle</td>
<td>TCU shifts to neutral OP-Mode: limp home</td>
<td>• execute AEB</td>
<td></td>
</tr>
</tbody>
</table>
8.1 Actuator:

8.2 Cable:

Retarder
The retarder is engaged when the bottom of the switch is pressed and provided that the transmission 'Stop' warning light is OUT and the transmission is in 'lockup'. To disengage retarder, press the top of the switch. The retarder will also be selected by the brake pedal. The first 5° of pedal travel engages the retarder, provided that the transmission 'Stop' warning light is OUT, the transmission is in 'lockup' and oil temperature is within operating range. Further depression of pedal applies service brakes in addition to retarder. Retarder will be disengaged when the brake pedal is released, or when any of the conditions are out of range.

The retarder is used to apply a continuous braking force to hold the truck to a safe steady speed when descending grades, to reduce the need for service brake applications, thus reducing service brake wear and preventing overheating. The retarder may be used anytime to slow down. If additional braking is required apply the service brakes. The retarder is not meant for bringing the vehicle to a halt, or for sudden deceleration - the service brakes should be employed for this purpose.

Before the vehicle starts down the grade, release accelerator, slow the vehicle with the service brakes, select the required gear, and apply the retarder. For maximum retardation, oil circulation and cooling, the vehicle downgrade speed (retarder applied) in the gear selected should be high enough to keep the engine operating at governed speed. Generally the gear used to ascend a grade is also correct for its descent. If the rate of descent is too slow, the transmission should be upshifted to the next highest gear. If the rate of descent is too fast, the service brakes should be applied and the transmission shifted into a lower gear which will allow a safe descent and efficient retarder operation.

Frequent use of the retarder will result in higher transmission oil temperatures. Therefore, the oil temperature gauge should be checked frequently. During normal operation the gauge should read between
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80°C (176°F) and 120°C (248°F). However, during retarder operation the gauge may reach 145°C (293°F). Provided the vehicle is not in an overspeed condition, the transmission 'Stop' warning light will illuminate when the transmission oil temperature reaches 140°C (284°F). The retarder will automatically disengage when the oil temperature reaches 150°C (302°F) irrespective of engine speed. The speed must be reduced by using the service brakes so that the oil is cooled down. Reduce downgrade travel speed to avoid the oil overheating and possible damage to the transmission.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Operate steering right and left several times to relieve any pressure in the steering system.

2. Operate the treadle valve continuously to discharge the accumulators, block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Disconnect the following cables and connectors in the order given, to prevent serious damage to the vehicles electrical components.
   a - Battery earth cables
   b - Battery supply cables
   c - Alternator earth cables
   d - Alternator supply cables
   e - Transmission ECU (Est-37) connector
   f - Engine ECM connectors
   g - Body control lever
   h - Hydraulics ECU

4. Place a suitable container under the transmission drain port, remove drain plug and drain oil. After draining, reinstall drain plug and tighten securely.

5. Remove blanking cap from remote drain line at the bottom of the hydraulic tank. Install a length of hose on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap.

6. Remove cab from the machine. Refer to Section 260-0010, CAB AND MOUNTING. Ensure all connections and lines connected to cab are disconnected.

7. Disconnect all drivelines connected to the transmission and secure clear of the transmission. Refer to Section 130-0010, DRIVELINES.

8. Identify and tag oil filter hose assemblies (5, 6 & 7, Fig. 11) to aid installation. Disconnect hose assemblies (5, 6 & 7, Fig. 11) and cap open ends and adaptor (8, Fig. 11) and elbows (9, 10 & 11, Fig. 11) to prevent entry of dirt.

9. Remove filter bracket (1, Fig. 11) from exhaust cradle. Remove all exhaust tubes, silencer, exhaust stack and exhaust cradle. Remove engine air intake tube if required.

10. Disconnect all electrical harnesses and connections not previously disconnected on removal of the transmission.

REMOVAL

Numbers in parentheses refer to Fig. 1.

Note: Tag all lines, cables and linkages disconnected during removal to aid in installation.

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Hydraulic oil pressure will remain within the braking system after engine shutdown. Operate the treadle valve continuously until the pressure has dissipated before removing any brake lines or serious injury could result.

High electrical current can cause sparks and personal injury from burns. Turn battery master switch to the 'Off' position before disconnecting any components.
11. Identify and tag all hydraulic lines at the hydraulic pump. Disconnect hydraulic lines and cap lines and ports to prevent entry of dirt.

**Note:** The transmission can be removed from the vehicle without removing the hydraulic pump.

12. Identify, tag and disconnect hydraulic lines at the main hydraulic valve. Cap lines and ports to prevent entry of dirt.

13. Identify, tag and disconnect transmission oil cooler lines from the transmission. Cap lines and ports to prevent entry of dirt.

14. Identify, tag and disconnect hydraulic lines (6, 7, 8, 9 & 10, Fig. 12) at the diff-lock/retarder valve. Cap lines and ports to prevent entry of dirt.

15. Identify, tag and disconnect hydraulic lines at the hydraulic tank. Cap lines and ports to prevent entry of dirt.

16. Identify and tag diagnostic hose assemblies (22 & 23, Fig. 12) to aid in installation. Disconnect hose assemblies (22 & 23, Fig. 12) and cap open ends and tee (21, Fig. 12) and adaptor (26, Fig. 12) to prevent entry of dirt.

17. Identify, tag and disconnect all remaining lines and fixtures necessary to allow removal of the transmission from the vehicle.

18. Attach suitable lifting equipment to the lifting points on transmission and raise lifting equipment to take up the slack.

19. Remove locknut (10), hardened washer (22), bolt (11) and snubbing washer (17) securing LH bracket (12) to frame mounts.

20. Remove locknut (10), hardened washer (22), bolt
(11) and snubbing washer (17) securing RH bracket (13) to frame mounts.

21. Remove locknuts (10), washers (8) and bolts (9) securing front bracket assembly to frame mounts.

22. Check to make certain that all necessary line and cable disconnections have been made before lifting the transmission.

23. Carefully raise the transmission ensuring that no lines, cables or components foul during removal. The transmission may have to be pushed forward to allow output yoke to clear rear of frame. When the transmission is clear of the frame assembly, move to a suitable work area and mount securely on a work stand.

**DISASSEMBLY**
Numbers in parentheses refer to Fig. 1, unless otherwise specified.

1. Remove bracket assembly (20, Fig. 12) complete with diff-lock/retarder valve (1, Fig. 12). Remove bolts (5, Fig. 12) securing diff-lock/retarder valve to bracket assembly and remove valve.

2. If required, pressure reducing valve (2, Fig. 12), solenoid cartridges (3, Fig. 12) and coils (4, Fig. 12) can be removed from diff-lock/retarder valve.

3. Remove bolts (14), lockwashers (15) and LH bracket (12) from the transmission. Remove isolation mount (16) from LH bracket (12) and replace if required.

4. Remove bolts (14), lockwashers (15) and RH bracket...
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(13) from the transmission. Remove isolation mount (16) from RH bracket (13) and replace if required.

5. Remove bolts (4) and lockwashers (3) securing front bracket (2) and front plate (5) to transmission.

6. Remove mounting hardware securing front plate (5) to front bracket (2). Press out centre bonded mount (6) from front plate (5) and remove sleeve (1).

7. Remove mounting hardware securing hydraulic pump to the transmission power takeoff. Refer to Section 230-0050, HYDRAULIC PUMP.

8. If required, identify and tag electrical connections to engine speed sensor, output speed sensor, central gear train sensor and turbine speed sensor (5, 6, 7 & 8, Fig. 2) and remove sensors from the transmission.

9. If required, identify and tag electrical connections to oil temperature sender (gauge) (1, Fig. 2), transmission oil cooler fan drive temperature switch (9, Fig. 2) and retarder oil temperature sender (11, Fig. 2) and remove from the top of the transmission.

10. Remove fasteners securing dipstick tube (18) support bracket. Remove bolts (20), lockwashers (21), dipstick tube (18) assembly and gasket (19) from the transmission.

11. Refer to transmission manufacturers service manual if transmission service or repair is required.

INSPECTION

Numbers in parentheses refer to Fig. 1.

1. Check front bracket assembly (1, 2, 5 - 8), LH bracket (12), RH bracket (13) and frame mounting brackets for cracks and damage. Repair or replace as required.

2. Check general condition of transmission assembly for wear and damage. Check for worn or damaged driveline flanges and excessive wear on mounting holes and isolation mounts (16).

3. Check condition of all electrical harnesses and connections and repair/replace as required. Check condition of all hydraulic lines on the transmission and replace if damaged.

ASSEMBLY

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Install new gasket (19) on dipstick tube (18) assembly and secure assembly to the transmission with bolts (20) and lockwashers (21). Secure dipstick tube (18) to support bracket with fasteners previously removed.

2. If removed, install oil temperature sender (gauge) (1, Fig. 2), transmission oil cooler fan drive temperature switch (9, Fig. 2) and retarder oil temperature sender (11, Fig. 2) in top of the transmission. Tighten electrical connections securely.

3. If removed, install engine speed sensor, output speed sensor, central gear train sensor and turbine speed sensor (5, 6, 7 & 8, Fig. 2) in the transmission as shown in Fig. 2. Tighten electrical connections securely.

4. Install hydraulic pump to the transmission power takeoff and secure using mounting hardware removed at Disassembly. Refer to Section 230-0050, MAIN HYDRAULIC PUMP.

5. Install centre bonded mount (6) and sleeve (1) to front plate (5). Secure front plate assembly to front bracket (2) with bolt (7), washer (8) and nut. Tighten bolt (7) to 920 Nm (679 lbf ft).

Note: Clean, prime and seal joint using Loctite 7063 cleaner, Loctite T primer and Loctite 648 retaining compound.

6. Secure front bracket assembly to transmission using bolts (4) and lockwashers (3). Tighten bolts (4) to 225 Nm (166 lbf ft).

7. Secure LH bracket (12) and RH bracket (13) to the transmission with bolts (14) and lockwashers (15). Tighten bolts (14) to 410 Nm (302 lbf ft).

Note: Clean, prime and seal joint using Loctite 7063 cleaner, Loctite T primer and Loctite 648 retaining compound.

8. Secure diff-lock/retarder valve (1, Fig. 12) to bracket assembly (20, Fig. 12) with mounting hardware removed during Disassembly.

9. Mount bracket assembly (20, Fig. 12) and diff-lock/retarder valve (1, Fig. 12) to transmission with fasteners removed during Disassembly.
INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Lubricate isolation mounts (16) with water or a suitable rubber lubricant and install in front frame mounts, with spigots to the underside of the mounts.

2. Attach suitable lifting equipment to transmission lifting points and carefully position the transmission assembly in the frame. Take care to avoid snagging any lines, harnesses or components attached to the transmission.

3. Secure rear mounting brackets (12 & 13) to frame mounts with bolts (11), snubbing washers (17), hardened washers (22) and locknuts (10), as shown in Fig. 1. Tighten bolts (11) to a torque of 920 Nm (679 lbf ft).

4. Secure front bracket assembly to frame mounts with bolts (9), washers (8) and locknuts (10). Tighten bolts (9) to a torque of 920 Nm (679 lbf ft).

5. Remove lifting equipment from lifting points on transmission.

6. Remove blanking caps from hose assemblies (22 & 23, Fig. 12), tee (21, Fig. 12) and adaptor (26, Fig. 12) and connect hose assembly (22, Fig. 12) to adaptor (26, Fig. 12), and hose assembly (23, Fig. 12) to tee (21, Fig. 12).

7. Remove blanking caps from hydraulic tank hose assemblies and ports, and connect hose assemblies to the hydraulic tank.

8. Remove blanking caps from hose assemblies (6, 7, 8, 9 & 10, Fig. 12) and ports at diff-lock/retarder valve. Connect hose assemblies to the diff-lock/retarder valve.

9. Remove blanking caps from transmission oil cooler lines and retarder ports and connect oil cooler lines. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

10. Remove blanking caps and connect lines to main hydraulic valve, as identified at removal.

11. Remove blanking caps and connect hydraulic lines to the hydraulic pump, as identified at removal.

12. Connect all electrical cables, harnesses and connections to the transmission, as identified at removal.

13. Install air intake tube (if removed), exhaust tubes, exhaust cradle, exhaust silencer and exhaust stack. Install filter bracket (1, Fig. 11) to cradle.

14. Connect all drivelines to the transmission and secure with mounting hardware removed during removal. Refer to Section 130-0010, DRIVELINES.

15. Prior to installing the cab, ensure that all connections to the transmission, other than cab connections, are connected securely and properly clipped.

16. Install the cab assembly on the front frame. Refer to Section 260-0010, CAB AND MOUNTING.

17. Connect all harnesses and electrical connections at front of the cab.

18. Fill hydraulic tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 230-0040, HYDRAULIC TANK for fill level and procedure.

19. Fill transmission with engine oil specified in Section 300-0020, LUBRICATION SYSTEM. Check the oil level as described under 'Oil Level Check'. Note: Transmission oil cooler should be primed when refilling transmission. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

20. Connect the following cables and connectors in the order given to prevent serious damage to the engines electrical components.

   a - Hydraulics ECU
   b - Body control lever
   c - Engine ECM connectors
d - Transmission ECU (Est-37) connector
e - Alternator supply cables
f - Alternator earth cables
g - Battery supply cables
h - Battery earth cables

21. Turn the battery master switch to the 'On' position, start the engine and make an operational check of all lines and electrical connections disconnected during removal. Check for leaks and tighten lines and fittings as required. Allow transmission to warm up and recheck all connections for leaks.

22. Ensure parking brake is applied, disconnect steering lock bar and secure in the 'Stowed' position. Remove wheel blocks from all road wheels.

23. Check for correct operation of the transmission, shift selector and warning lights.

MAINTENANCE

Periodic Inspections

For easier inspection, the transmission should be kept clean. Make periodic checks for loose mounting bolts and leaking oil lines. Check the condition of electrical harnesses and connections regularly.

Transmission breather (10, Fig. 2) should be checked on a regular basis (every 250 hours), and as frequently as necessary, depending on operating conditions. A badly corroded or plugged breather restricts proper breathing and causes a buildup of condensation and subsequent oil deterioration.

Oil Level Check

⚠️ WARNING
When checking the oil level, be sure that the parking brake is applied and all road wheels are securely blocked.

Check the transmission oil level and add oil if low, every 10 hours/daily. Use only oil specified in Section 300-0020, LUBRICATION SYSTEM.

Because the transmission oil cools, lubricates and transmits hydraulic power it is important that the proper oil level be maintained at all times. If the oil level is too low, the converter and clutches will not receive an adequate supply of oil. If the oil level is too high, the oil will aerate and the transmission will overheat. It is absolutely necessary that the oil put into the transmission is clean.

Cold Oil Level Check - Engine Off
This check is made only to determine if the transmission contains sufficient oil for safe starting. Oil level should show at least 6" (152 mm) above the hot oil maximum (MAX 80° C) mark on the dipstick. Add oil if low.

Cold Oil Level Check - Engine Running
This cold check is valid only when transmission oil temperature is below 40° C (104° F).

1. Position the vehicle on a level work area, apply the parking brake and block all road wheels securely.

2. With parking brake applied, gear selector in neutral and engine idling, check the oil level on dipstick. Oil level should be up to the 'COLD MIN' mark on the dipstick. Add oil if low.

Hot Oil Level Check - Engine Running
This hot check is valid for normal operating oil temperature of 80° C (176° F).

1. Position the vehicle on a level work area, apply the parking brake and block all road wheels securely.

2. With the transmission in neutral and the engine running, allow the machine to idle until normal operating temperature of 80° C (176° F) is achieved.

3. With parking brake applied, foot on service brake, engine idling and transmission operating at normal temperature, select each gear position in turn. Allow the transmission to remain in each gear for 5 - 10 seconds.

4. Return gear selector to neutral and, with the engine idling, check the oil level on dipstick. Oil level should be between the 'MAX 80° C' upper mark and the 'MIN 80° C' lower mark on the dipstick. Add oil if low.
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Topping Up Oil

If transmission oil level has to be topped up, according to dipstick, oil should be added through the filler on the transmission oil cooler. Bleed plug on top of transmission oil cooler should be opened while adding oil. Allow oil to drain into system then recheck level.

Oil and Filter Change

**WARNING**

When changing filter cartridges, it is imperative that new filter cartridges are the same part number and colour as the original cartridges.

The transmission oil and filter cartridges should be changed every 1 000 hours, or sooner, depending on operating conditions. Clean oil filter head when changing filter cartridges. Also, the oil must be changed whenever there are traces of dirt or evidence of high temperature indicated by discoloration or strong odour.

The internal filter and finger magnet at the lower front left hand of the sump should be removed and cleaned with mineral spirits at each oil and filter change. Metal particles in the oil (except for the minute particles normally trapped in the oil filters) indicate damage has occurred in the transmission. When these particles are found in the filters, the cause must be established and rectified immediately to prevent damage to the transmission.

At each oil change, examine the used oil for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during transmission operation. However, if there is evidence of water or engine coolant in the oil, the cause must be established and rectified immediately to prevent damage to the transmission. Oil should be added to transmission as described in 'Topping Up Oil'.

AEB Starter

The AEB Starter is an electronic tool used to calibrate the transmission to ensure optimum shift comfort. It is recommended to run the AEB Starter after the first 500 hours of transmission operation. The AEB Starter should also be run if shift quality deteriorates, or whenever the transmission, electronic control unit (ECU) or shift lever are replaced. The procedure for

### AEB Starter Procedure

<table>
<thead>
<tr>
<th>ACTION</th>
<th>DISPLAY MESSAGE</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 warm up transmission</td>
<td>normal operating messages</td>
<td></td>
</tr>
<tr>
<td>2 turn off ignition</td>
<td>nothing</td>
<td></td>
</tr>
<tr>
<td>3 plug in AEB - Starter</td>
<td></td>
<td>TCU must recognise PL for at least 2 seconds before you can press the button</td>
</tr>
</tbody>
</table>
| 4 • move shift lever to N position  
  • engage parkbrake           |                 |                                                                        |
| 5 start engine                | PL              |                                                                        |
| 6 set engine speed to idle    | PL’ if start conditions are OK | The button must not be released before TCU has started the AEB or quit with an error code (see display table) |
| 7 press button of the AEB-Starter | ST’ if start conditions are OK | TCU has started the AEB, and goes on adjusting K1, K2, ..., KR. (Button may be released) |
| 8 hold button until AEB has started | K1’ (Information about the AEB state) |                                                                       |
| 9 wait until AEB has finished | 'OK’ (AEB has been successful) |                                                                       |
| 10 turn off ignition and unplug AEB-Starter | nothing |                                                                        |
running the AEB Starter is detailed in the table on previous page. Refer to table on page 10 for typical codes displayed during AEB mode.

**Note:** Connect the AEB Starter to plug X25 located below the right hand dash panel, adjacent to the ECU.

**TROUBLESHOOTING**
Numbers in parentheses refer to Fig. 2, unless otherwise specified.

**Transmission Sensor Checks**
The engine (5), turbine (8), central gear train (7) and output (6) speed sensors can be checked by measuring their resistance at plug X8 (located below the right hand dash panel).

1. Engine speed sensor (5). Check across pins 1 & 2. Resistance should be 945 - 1 155 ohms at a temperature of 20°C (68° F).
2. Turbine speed sensor (8). Check across pins 3 & 4. Resistance should be 945 - 1 155 ohms at a temperature of 20°C (68° F).
3. Central gear train speed sensor (7). Check across pins 5 & 6. Resistance should be 945 - 1 155 ohms at a temperature of 20°C (68° F).
4. Output speed sensor (6). Check across pins 21 & 22. Resistance should be 5 mega ohms.

The installation of the speed sensors can also be checked by measuring the gap between the sensor and the gear tooth:

- Engine speed sensor (5) and turbine speed sensor (8) - gap should be 0.5 - 0.8 mm.
- Central gear train speed sensor (7) - gap should be 0.3 +/- 0.1 mm.

Output speed sensor (6) - gap should be 1.0 - 1.5 mm.

**Lock-Up Solenoid**
The solenoid can be checked at plug X9, pins 7 & 8 (located below the right hand dash panel).
- Resistance: 60 - 80 ohms
- Current: 0.25 - 0.35 A
- Voltage: 24 V

Pressure can also be checked (see Fig. 6).

**Temperature Sensors**
The sump temperature sensor, located in the main control valve (2) can be checked at plug X8, pins 14 & 15. Resistance should be 1 000 - 1 500 ohms.

The retarder temperature sensor (11) can be checked at plug X9, pins 15 & 16. Resistance should be 800 - 1 500 ohms.

The transmission oil cooler fan drive temperature sensor (9) can be checked by measuring resistance across terminals:
- At 20°C (68° F), resistance should be 1 020 - 1 280 ohms.
- At 60°C (140° F), resistance should be 219 - 261 ohms.
- At 90°C (194° F), resistance should be 82 - 96 ohms.
- At 120°C (248° F), resistance should be 36.3 - 40.7 ohms.

**Shift Controller**
To troubleshoot the shift controller, continuity checks can be easily done by removing plug X2, selecting position and measuring across following pins:
- Neutral - Pins 2 & 5
- Forward - Pins 2 & 4
- Reverse - Pins 2 & 6
- Up - Pins 2 & 7
- Down - Pins 2 & 8
- Button - Pins 2 & 10

**Measuring CAN-Bus Resistance At Plug X4 (Ignition OFF)**

<table>
<thead>
<tr>
<th>Measurement between</th>
<th>Specified Value (ohms)</th>
<th>Actual Value (ohms)</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN H (X4 pin 1) and CAN L (X4 pin 2)</td>
<td>40</td>
<td>0</td>
<td>Short circuit from CAN H to CAN L</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>60 or 120</td>
<td>Connections to one or two ends of resistors are damaged or cut off</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>Infinity</td>
<td>End resistors damaged or cut off</td>
</tr>
</tbody>
</table>
Transmission - Transmission and Mounting

Section 120-0010

Measuring CAN-Bus Voltage At Plug X4 (Ignition ON)

<table>
<thead>
<tr>
<th>Measurement between</th>
<th>Specified Value (Volts)</th>
<th>Actual Value (volts)</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN H (X4 pin 1)</td>
<td>2.4 - 2.9</td>
<td>24</td>
<td>Short circuit from CAN H to battery</td>
</tr>
<tr>
<td>and Ground</td>
<td></td>
<td>0</td>
<td>Short circuit from CAN H to ground</td>
</tr>
<tr>
<td>CAN L (X4 pin 2)</td>
<td>2.2 - 2.7</td>
<td>24</td>
<td>Short circuit from CAN L to battery</td>
</tr>
<tr>
<td>and Ground</td>
<td></td>
<td>0</td>
<td>Short circuit from CAN L to ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 - 2.1</td>
<td>Intermittent short circuit from CAN H to another component</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.8 - 24</td>
<td>Intermittent short circuit from CAN L to another component</td>
</tr>
</tbody>
</table>

Transmission To Engine CAN-Bus

The communication link between the transmission and the engine can be electrically checked by measuring resistance and voltage. Refer to tables.

Solenoid Coil Ratings

The following data should be referenced when checking solenoids:

1. Centre axle diff-lock solenoid (3, Figs. 4 & 5) (at valve on top of transmission)
   Resistance: 41 ohms
   Current: 0.6 A

2. Transmission diff-lock solenoid (at transmission output to front axle)
   Resistance: 30 ohms
   Current: 0.8 A

3. Retarder solenoid (4, Figs. 4 & 5) (at valve on top of transmission). The solenoid can be checked at plug X9, pins 9 & 10.
   Resistance: 41 ohms
   Current: 0.6 A

Pressure Checks

When oil is at operating temperature, the switch can be checked at plug X9, pins 17 & 18. With the harness connected to the switch, resistance should be 500 ohms.

SERVICE TOOLS

Refer to Section 300-0070, SERVICE TOOLS, for part number of AEB Starter and other service tools which should be used in conjunction with procedures outlined in the transmission manufacturers service manual, and, general service tools required. These tools are available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>Bolt</td>
<td>225</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>Bolt</td>
<td>920</td>
</tr>
<tr>
<td>1</td>
<td>9</td>
<td>Bolt</td>
<td>920</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>Bolt</td>
<td>920</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>Bolt</td>
<td>410</td>
</tr>
</tbody>
</table>

* * * *
DESCRIPTION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

The function of the driveline is to transmit rotating power from one point to another in a smooth and continuous action while allowing a degree of movement or misalignment of the components it connects.

The drivelines must operate through constantly changing relative angles between the components they are mounted to and must also be capable of changing length while transmitting torque.

A typical driveline consists of universal joints which allow some misalignment and permit the driveline to pivot in any direction, and, a light rigid hollow slip yoke and splined shaft assembly forming a slip joint.

The slip joint accommodates length variations generated during operation, preventing tension or compression loads from causing serious damage to the components.

Note: Extra care should be taken when handling the drivelines since chips, dents, burrs or deformity on any rotating mass creates vibration and excessive wear during any operation.

There are three driveline assemblies installed between various components in the tractor frame as follows:

Driveline assembly (1) is connected between the engine drive and transmission input drive.

Driveline assembly (4) is connected between the front axle drive flange and transmission final drive.

Driveline assembly (7) connects the rear final drive of the transmission to the articulation and oscillation pivot.
Drivelines - Front and Rear Drivelines
Section 130-0010

There are two driveline assemblies connecting the centre and rear axles to the drive supplied from the transmission, through the pivot drive arrangement, as follows:

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.
2. Block all road wheels and place the battery master switch in the 'Off' position.
   Note: Access to remove driveline assembly (1) can be obtained by tilting the cab. Refer to Section 260-0010, CAB AND MOUNTING.
3. Remove bolts (13) and washers (14) securing anti-flail guard (12) to bracket (15). Remove anti-flail guard (12).
4. Remove bracket (15) over driveline assembly (1) from engine flywheel housing.
5. Match mark universal joint (2) and their mating surfaces to ensure correct mating alignment when installing driveline assembly (1).
6. Support driveline (1) with suitable lifting equipment and remove capscrews (10) securing universal joints (2) to their mating components. Remove driveline assembly (1). If necessary tap driveline assembly (1) from its mating components with a soft faced hammer.
7. Match mark universal joints (5 & 8) and their mating surfaces to ensure correct mating alignment when installing driveline assemblies (4 & 7).
8. Remove capscrews (11) securing universal joints (5) to their mating components and remove driveline assembly (4). If necessary tap driveline assembly (4) from its mating components with a soft faced hammer.

WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

To prevent serious injury or death, DO NOT go under the vehicle when the engine is running. Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc..
Drivelines - Front and Rear Drivelines

Section 130-0010

from its mating components with a soft faced hammer.

9. Remove capscrews (10) securing universal joints (8) to their mating components and remove driveline assembly (7). If necessary tap driveline assembly (7) from its mating components with a soft faced hammer.

**Note:** Access to driveline assemblies (1 & 4, Fig. 2) can be obtained from underneath the vehicle.

10. Match mark universal joints (2 & 5, Fig. 2) and their mating surfaces to ensure correct mating alignment when installing driveline assemblies (1 & 4, Fig. 2).

11. Remove capscrews (7, Fig. 2) securing universal joints (2, Fig. 2) to their mating components and remove driveline assembly (1, Fig. 2). If necessary tap driveline assembly (1, Fig. 2) from its mating components with a soft faced hammer.

12. Remove capscrews (8, Fig. 2) securing universal joints (5, Fig. 2) to their mating components and remove driveline assembly (4, Fig. 2). If necessary tap driveline assembly (4, Fig. 2) from its mating components with a soft faced hammer.

**DISASSEMBLY**

**Universal Joint**

Numbers in parentheses refer to Fig. 1.

1. Place the yoke end of driveline assembly (1) in a soft jawed vice, clamping on the tube of shaft.

**Note:** Do not distort the tube with excessive grip.

2. Remove screws (3) and universal joints (2) from driveline assembly (1).

3. Place the shaft end of driveline assembly (1) in a soft jawed vice.

4. Remove screws (3) and universal joints (2) from driveline assembly (1).

5. Repeat steps 1 to 4 for drivelines (4 & 7) and (1 & 4, Fig. 2)

**INSPECTION**

1. Clean all metal parts in a suitable solvent, and dry all parts with compressed air.

2. Inspect splines of shaft and yoke for nicks, burrs and excessive wear. Replace if wear is excessive or splines are nicked. Burrs may be removed with a fine file or medium India stone.

3. Check the surfaces of the components that universal joints mate against for parallelism. Refer to Fig. 3.

4. Check condition of mounting capscrews and replace if required.

**ASSEMBLY**

**Universal Joint**

Numbers in parentheses refer to Fig. 1.

1. Place the yoke end of driveline assembly (1) in a soft jawed vice, clamping on the tube of shaft.

**Note:** Do not distort the tube with excessive grip.

2. Install universal joint (2) to yoke end of driveline assembly (1) and secure with screws (3).

3. Place the shaft end of driveline assembly (1) in a soft jawed vice.

4. Install universal joint (2) to shaft end of driveline assembly (1) and secure with screws (3).

5. Repeat steps 1 to 4 for drivelines (4 & 7) and (1 & 4, Fig. 2)

**INSTALLATION**

Numbers in parentheses refer to Fig. 1, unless
Drivelines - Front and Rear Drivelines

Section 130-0010

otherwise specified.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Extra care should be taken when handling drivelines since carelessness can result in premature failure of the components. Chips, dents, burrs, or any other deformity of wing bearings will prevent accurate mating. This will cause misalignment which is accompanied by vibration and excessive wear.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

To prevent serious injury or death, DO NOT go under the vehicle when the engine is running. Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc.

1. Position driveline assembly (7) on the vehicle as shown in Fig. 1 and align match marks on universal joints (8) with those on its mating surfaces.

2. Apply Loctite 648 to the threads of capscrews (10) and secure universal joints (8) to its mating surfaces with capscrews (10). Tighten capscrews (10) to a torque of 153 Nm (113 lbf ft).

3. Position driveline assembly (4) on the vehicle as shown in Fig. 1 and align match marks on universal joints (5) with those on its mating surfaces.

4. Apply Loctite 648 to the threads of capscrews (11) and secure universal joints (5) to its mating surfaces with capscrews (11). Tighten capscrews (11) to a torque of 153 Nm (113 lbf ft).

5. Position driveline assembly (1) on the vehicle as shown in Fig. 1 and align match marks on universal joints (2) with those on its mating surfaces.

6. Apply Loctite 648 to the threads of capscrews (10) and secure universal joints (2) to its mating surfaces with capscrews (10). Tighten capscrews (10) to a torque of 153 Nm (113 lbf ft).

7. Secure bracket (15) over driveline assembly (1) with mounting hardware previously removed.

8. Secure anti-flail guard (12) to bracket (15) with bolts (13) and washers (14).

9. Position driveline assembly (1, Fig. 2) on the vehicle as shown and align match marks on universal joints (2, Fig. 2) with those on its mating surfaces.

10. Apply Loctite 648 to the threads of capscrews (7, Fig. 2) and secure universal joints (2, Fig. 2) to its mating surfaces with capscrews (7, Fig. 2). Tighten capscrews (7, Fig. 2) to a torque of 153 Nm (113 lbf ft).

11. Position driveline assembly (4, Fig. 2) on the vehicle as shown and align match marks on universal joints (5, Fig. 2) with those on its mating surfaces.

12. Apply Loctite 648 to the threads of capscrews (8, Fig. 2) and secure universal joints (5, Fig. 2) to its mating surfaces with capscrews (8, Fig. 2). Tighten capscrews (8, Fig. 2) to a torque of 153 Nm (113 lbf ft).

13. Lower the cab, place the battery master switch in the ‘On’ position, ensure the parking brake is applied and start the engine. Remove wheel blocks from all road wheels.

MAINTENANCE

Every 500 hours, check the universal joints for wear and replace if required.

Every 2000 hours, check drivelines for leaks and damage, and replace if required.

Periodic Inspection

Use a small pry bar to check the companion flange yokes for looseness. If loose, drop one end of the driveline and twist the yoke to check the backlash between the splines and yokes. Replace any yoke that does not fit snugly.

With the pry bar, check the universal joints for play. If loose, replace the universal joints. Check the splines at the slip joint and replace the yoke if excessively worn.

SERVICE TOOLS

There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools and adhesives are available from your dealer.
### DRIVELINE DIAGNOSIS CHART

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>REASON</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration or noise</td>
<td>Driveline bent or out of balance</td>
<td>Clean driveline in a suitable solvent. Inspect for contact with adjacent parts. If driveline is distorted or sprung, replace. If driveline does not run smoothly, and vibration is felt, remove driveline and dynamically balance the assembly.</td>
</tr>
<tr>
<td>Driveline loose at yoke/flange</td>
<td></td>
<td>Check driveline mounting capscrews for tightness. If loose, replace capscrews and torque tighten to the proper specification.</td>
</tr>
<tr>
<td>Excessive wear of universal joints</td>
<td>Poor yoke/flange alignment and/or run-out</td>
<td>Check yoke/flange for alignment, run-out and balance. Repair or replace as required.</td>
</tr>
<tr>
<td>Driveline imbalance</td>
<td></td>
<td>Check to see if balance weights are missing or if driveline is distorted. If driveline is distorted, replace; if weights are missing, check balance of driveline dynamically and rebalance.</td>
</tr>
</tbody>
</table>

### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>Capscrew</td>
<td>153</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>Capscrew</td>
<td>153</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>Capscrew</td>
<td>153</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>Capscrew</td>
<td>153</td>
</tr>
</tbody>
</table>

* * * *
DESCRIPTION

The differential assembly is mounted to the axle housing. It comprises of a differential for the normal cross-axle drive function.

The differential is a spiral bevel ring gear type with an automatically limited slip element (See Fig. 2).

REMOVAL AND INSTALLATION

Numbers in parentheses refer to Fig. 1.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, raise the body and install the body safety prop to secure the body in the partially raised position.

2. Apply the parking brake and switch off the engine.

3. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

4. Drain the gear oil out of the axle housing and both planetaries into a suitable container.

5. Remove the planetary assemblies and axle shafts from the axle housing. Note from which side the long and short axle shafts are removed. Refer to Section 160-0030, AXLE GROUP (HUB).

6. Identify the relationship of the front and rear driveline flanges and differential flanges with punch marks.

7. Disconnect the drivelines from the differential flanges. The drivelines can be removed if it is convenient to do so.

8. Support the weight of the countershaft case assembly with suitable lifting equipment. Remove bolts (17 & 34) securing countershaft case (20) to differential housing (35) and carefully remove countershaft case (20) assembly clear of differential housing (35).

9. Support the weight of differential housing (35) assembly with suitable lifting equipment. Remove bolts (58) securing differential housing (35) to the axle housing. Thread in three puller bolts to break the seal between the differential and axle housing and to partially pull the differential assembly out of the axle housing. Carefully remove differential housing (35) assembly clear of axle housing.

INSTALLATION

Installation is the reversal of the 'Removal' procedure.

Note: Use sealing compound between the axle housing and differential housing mounting faces.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, AXLE BOLT AND NUT TORQUE SPECIFICATIONS.

Add gear oil of the type specified in Section 300-0020, LUBRICATION SYSTEM, through the differential filler/level hole until the oil is level with the bottom of the filler/level hole. Fill the planetary assemblies up to the 'Oil Level Check Line'.
Fig. 1 - Exploded View Of Centre Differential
### Centre Axle - Differential Drive Head

#### Section 150-0020

**LEGEND FOR FIG. 1.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drive Flange</td>
</tr>
<tr>
<td>2</td>
<td>Washer</td>
</tr>
<tr>
<td>3</td>
<td>Slotted Nut</td>
</tr>
<tr>
<td>4</td>
<td>Input Shaft</td>
</tr>
<tr>
<td>5</td>
<td>Dust Cover</td>
</tr>
<tr>
<td>6</td>
<td>Shaft Seal</td>
</tr>
<tr>
<td>7</td>
<td>Bearing</td>
</tr>
<tr>
<td>8</td>
<td>Screw</td>
</tr>
<tr>
<td>9</td>
<td>Bearing Flange</td>
</tr>
<tr>
<td>10</td>
<td>Spacer</td>
</tr>
<tr>
<td>11</td>
<td>Spur Gear</td>
</tr>
<tr>
<td>12</td>
<td>Screw</td>
</tr>
<tr>
<td>13</td>
<td>Cover</td>
</tr>
<tr>
<td>14</td>
<td>Nut</td>
</tr>
<tr>
<td>15</td>
<td>Ball Bearing</td>
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<tr>
<td>16</td>
<td>Roll Pin</td>
</tr>
<tr>
<td>17</td>
<td>Screw</td>
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<tr>
<td>18</td>
<td>Seal</td>
</tr>
<tr>
<td>19</td>
<td>Plug</td>
</tr>
<tr>
<td>20</td>
<td>Countershaft Case</td>
</tr>
<tr>
<td>21</td>
<td>Seal</td>
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<tr>
<td>22</td>
<td>Plug</td>
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<tr>
<td>23</td>
<td>Spacing Ring</td>
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<td>24</td>
<td>Spacing Ring</td>
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<td>25</td>
<td>Gear</td>
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<td>Bearing</td>
</tr>
<tr>
<td>27</td>
<td>Bearing Retaining Bush</td>
</tr>
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<td>28</td>
<td>Support Shim</td>
</tr>
<tr>
<td>29</td>
<td>Retaining Ring</td>
</tr>
<tr>
<td>30</td>
<td>Spacer</td>
</tr>
<tr>
<td>31</td>
<td>Shim</td>
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<td>32</td>
<td>Bearing</td>
</tr>
<tr>
<td>33</td>
<td>Pinion Gear</td>
</tr>
<tr>
<td>34</td>
<td>Screw</td>
</tr>
<tr>
<td>35</td>
<td>Differential Housing</td>
</tr>
<tr>
<td>36</td>
<td>Cotter Pin</td>
</tr>
<tr>
<td>37</td>
<td>Adjusting Nut</td>
</tr>
<tr>
<td>38</td>
<td>Bearing</td>
</tr>
<tr>
<td>39</td>
<td>Ring Gear</td>
</tr>
<tr>
<td>40</td>
<td>Differential Assembly</td>
</tr>
<tr>
<td>41</td>
<td>Lockscrew</td>
</tr>
<tr>
<td>42</td>
<td>Bolt</td>
</tr>
<tr>
<td>43</td>
<td>Washer</td>
</tr>
<tr>
<td>44</td>
<td>Bearing Cap</td>
</tr>
<tr>
<td>45</td>
<td>Bearing</td>
</tr>
<tr>
<td>46</td>
<td>Adjusting Nut</td>
</tr>
<tr>
<td>47</td>
<td>Cotter Pin</td>
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<tr>
<td>48</td>
<td>Circlip</td>
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<tr>
<td>49</td>
<td>Shim</td>
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<td>50</td>
<td>Snap Ring</td>
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<td>Ball Bearing</td>
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<td>Seal</td>
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<td>Seal Retainer</td>
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<td>Dust Cover</td>
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<td>Drive Flange Shaft</td>
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<tr>
<td>57</td>
<td>Lockwire</td>
</tr>
<tr>
<td>58</td>
<td>Bolt</td>
</tr>
</tbody>
</table>

* - See Fig. 2

---

**Fig. 2 - Exploded View of Limited Slip Cross-axle Differential**

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Centre Axle - Differential Drive Head

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DISASSEMBLY

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

1. If not done so previously, remove bolts (17 & 34) which attach countershaft case (20) to differential housing (35) and lift off the countershaft case assembly.

2. Remove cotter pins (36 & 47) and adjusting nuts (37 & 46) as shown in Fig. 3.

3. Index mark bearing cap (44) and differential housing (35). Using special tool 15269899 (220V Hot Air Blower) or 15269900 (110V Hot Air Blower) heat the area around the threaded holes, remove bolts (42), washers (43) and bearing cap (44) as shown in Fig. 4.

4. Remove the outer races of tapered bearings (38 & 45) from differential assembly (40). Remove differential assembly (40) from the differential housing (35) as shown in Fig. 5.

5. Remove both bearings (38 & 45) inner rings using special tools 15272560 (Puller) and 15275376 (grip insert) as shown in Fig. 6.

6. Index mark cover (1, Fig. 2) and housing (12, Fig. 2). Remove 12-off driving pins (9) and lift off cover.

7. Remove thrust washer (2, Fig. 2), two externally splined clutch discs (3, Fig. 2), two internally splined clutch discs (4, Fig. 2), thrust ring (5, Fig. 2) and side gear (6, Fig. 2).

8. Remove four pinion gears (7, Fig. 2) and axle (8, Fig. 2) out of housing (12, Fig. 2).

9. Remove the other side gear (6, Fig. 2), thrust ring (5, Fig. 2), two internally splined discs (4, Fig. 2), two externally splined discs (3, Fig. 2), snap ring (10) and thrust washer (11, Fig. 2) from housing (12, Fig. 2).

10. It is not necessary to remove ring gear (39) from housing (12, Fig. 2) unless ring gear (39) and pinion gear (33) are being replaced. The ring gear and pinion gear are only sold as a matched set and cannot be replaced separately. Remove lock screws (41) as shown in Fig. 7 and press the ring gear off the housing. If necessary, pull the inner races of tapered bearings (38 & 45) from the cover and housing.

11. Unlock slotted nut (3) using socket 15501489 and clamping yoke 15270120. Remove nut and washer (2) from the threaded region of input shaft (4) as shown in Fig. 8.
12. Remove bolts (12) and cover (13) from countershaft case (20). Unlock nut (14) using clamping yoke 15270120 on drive flange (1) and suitable socket on nut (14) as shown in Fig. 9. Remove nut (14) from pinion gear (33) shaft.

13. With the press set shown in Fig. 10, press pinion gear (33) out of countershaft case (20). Remove spacing ring (23) from the shaft end of pinion gear (33).

14. Drive roller bearing (15) out of its bore in countershaft case (20).

15. Press pinion gear (33) out of gear (25) and pull bearing retaining bush (27) out of countershaft case (20) as shown in Fig. 11.

16. Drive roller bearing (32) out of the bearing retaining bush and remove shim (31) and spacer (30).

17. Remove circlip (48) and shim (49) from drive flange shaft (56) and withdraw drive flange shaft from axle housing. Remove dust shield (55) from end of drive flange shaft (56).

18. Remove seal retainer (54) and pull shaft seal (53) from axle housing. Remove snap rings (50 & 52) and drive ball bearing (51) from the axle housing.

19. Carefully remove drive flange (1) from mating splines on input shaft (4). Now remove dust cover (5) from drive flange (1).

20. Remove screws (8) and bearing flange (9) from countershaft case (20). Shaft seal (6) and bearing (7) should come out with bearing flange (9).
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21. Carefully remove bearing (7) and shaft seal (6) from bearing flange.

19. Spacer (10) should now be accessible to allow removal from countershaft case (20).

20. Remove retaining ring (29) from input shaft (4) using external snap ring pliers (15270145), thus allowing removal of support shim (28). Now separate input shaft (4) and spacing ring (24) from bearing (26) and countershaft casing (20). Remove shaft and spacing ring.

21. Remove bearing (26) from countershaft casing (20).

**INSPECTION**

The importance of careful and thorough inspection cannot be overstressed. Thorough inspection and necessary replacement of parts now may eliminate costly and avoidable trouble later.

1. Clean all parts in petroleum base solvent.

2. Immediately after cleaning, dry all parts, except bearings, with compressed air, or with a soft, clean lint free wiping cloth. Compressed air has a corrosive effect on bearings, therefore, they must be wiped dry with a cloth.

3. Coat cleaned, dried parts immediately with light oil to prevent corrosion. If parts are not to be assembled immediately, treat them with a good rust preventive and wrap them with treated paper or other suitable material designed to prevent corrosion.

4. Before installing the differential assembly to the machine, clean the inside and outside of the axle housing to remove any foreign material.

5. Inspect all gears, pinions, and splines for cracked or broken teeth, excessive wear, and pitted or scored surfaces. Repair or replace as necessary.

**Note:** If either ring gear or pinion gear is defective, both gears must be replaced, because they are serviced only as a matched set. Make sure the ring gear and pinion gear have the same mating numbers.

6. Check for pitted, scored or worn thrust surfaces of differential case halves.

**ASSEMBLY**

Numbers in parentheses refer to Fig. 1 unless specified otherwise.

**Note:** Tighten all fasteners without special torques specified to torques listed in Section 300-0080, AXLE BOLT AND NUT TORQUE SPECIFICATIONS.

**Note:** During assembly and installation, make sure that mated, punch marked, or otherwise identified parts are returned to their original positions, if still serviceable.
1. The following measurements must be carried out if any of the following components; countershaft case (20), bearing retaining bush (27), bearing (32), pinion gear (33) or ring gear (39) have been exchanged during the overhaul of the unit.

2. If a new ring gear set has to be installed, ensure that the pinion gear (33) and ring gear (39) have the same numbers / are part of a set.

3. Heat bore of countershaft case (20) and install bearing retaining bush (27) firmly against the shoulder.

4. Place differential housing (35) over countershaft case (20) and screw together provisionally by means of screws (17).

5. Install special shims 15501490 & 15501491 and measuring shaft 15269934 into the bearing bores. Determine the dimension between the measuring shaft and the collar of the bearing retaining bush (27). Note - Diameter of measuring shaft is 30mm. Refer to Fig. 12.

   E.g. 204.60 mm  - 15.00 mm  (1/2 the Dia. of the shaft)  
   189.60 mm

   This value 189.60 is Dimension ‘A’.

6. Thickness of roller bearing (32) should be measured now. Refer to Fig. 13.

7. Dimension of roller bearing (32) plus the dimension etched on the pinion gear (33), refer to Fig. 13, is dimension ‘B’

   E.g. 32.10 mm  +151.70 mm  
   188.80 mm

   Therefore the thickness of shim (31) is dimension ‘A’ minus dimension ‘B’

   E.g. 189.60 mm  -188.80 mm  
   0.80 mm

8. Press roller bearing (7) and shaft seal (6) into the bore of bearing retaining bush (9), shaft seal (6) should be flush mounted to retaining bush (9). This should be done by use of tooling driver 15501499. Sealing lip should be towards the bearing (7).

9. Cover outer diameter with a sealing compound. Slide pre-assembled bearing retaining bush (9) over input shaft (4) by heating inner race of bearing (7) and placing it up against the shoulder.
10. Place spacer (24) collar towards spur gear (11), now place spacer and spur gear into countershaft case (20). Refer to Fig. 14

11. Slide pre-assembled input shaft (4) through splines of spur gear (11) until contact is obtained.

12. Install outer race of bearing (26) into countershaft case (20) until contact with shoulder of case. Heat the inner race of roller bearing (26) and place over spacer (24).

13. Fit bearing retaining bush (28) flush against bearing (26) inner race, then install retaining ring (29) into the mating groove on the end of input shaft (4).

14. Fit drive flange over splines on the end of input shaft (4) and seat fully home.

15. Taking clamping yoke 15270120, lock off drive flange (1) and fit slotted nut (3) over threads on input shaft (4), tighten for the following measurement, using socket 15501489.

16. Determine actual endplay of installed input shaft (4) by means of a dial indicator, refer to Fig. 15.

17. Endplay must be zero, adjustment of spacer (24) will be required to obtain this value. Alternatively selection of a new spacer (24) of the desired width can be used.

18. Once correct spacer width (24) has been determined, bearing flange (9) will have to be removed. Before fastening in place, contact area of bearing flange (9) should be covered with a sealing compound.

19. Taking clamping yoke 15270120 to lock drive flange (1) and input shaft (4) assembly in place. Torque nut (3) to a value of 700 Nm (516 lbf ft) using slotted nut wrench 15501489.

20. Measure the rolling resistance of installed input shaft (4) and record the value for reference when installation of the pinion gear (33) becomes necessary.

21. Heat inner race of roller bearing (32) using special tool 15269899 (220V Hot Air Blower) or 15269900 (110V Hot Air Blower) and place it over the end of pinion gear (33).

22. Install determined shim (31) and outer race of roller bearing (32) into bearing retaining bush (27) until contact is obtained.

23. Place spur gear (25) into countershaft case (20).
chamfered side of splines facing upwards. Refer to Fig. 16.

24. Heat countershaft case (20) bore and spur gear (25) bore and install the pre-assembled bearing retaining bush (27).

25. It is necessary to determine the thickness of spacer (23) at this stage. Taking a ring gauge and pin set, refer to Fig. 17. Install gauge on the opposite end of pinion gear (33).

26. Heat inner race of roller bearing (15) and install over end of pinion gear (33).

27. Heat inner race of roller bearing (15) and install this over the end of pinion gear (33) as well.

28. Install nut (14) screwing up until the rollers of bearing (15) make full contact with the end of the nut i.e. no endplay present.

29. Remove nut (14), bearing (15) inner race and ring gauge. Now measure the thickness of the ring gauge; dimension 'X' refer to Fig. 17. This will be the required thickness of spacing ring (23) that will be fitted.

30. Install spacing ring (23) of the correct thickness, paying attention to the orientation of the chamfer, refer to Fig. 18.

31. Install bearing (15) outer race and nut (14). Torque nut (14) to a value of 750 Nm (553 lbf ft).

32. It is now necessary to determine the rolling resistance of the pinion gear (33) bearing. Refer to Fig. 19.

<table>
<thead>
<tr>
<th>Total rolling resistance of</th>
<th>= 5.0 Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>input shaft (4) and pinion gear (33)</td>
<td>2.5 Nm</td>
</tr>
<tr>
<td>Rolling resistance of input shaft (4)</td>
<td>2.5 Nm</td>
</tr>
</tbody>
</table>

The correct rolling resistance of pinion gear (33) should be 2-3 Nm. If the measured rolling resistance is out with the designated range, the thickness of the spacer must be adjusted. Once the spacer equates to the resistance being within the correct range, nut (14) should now be secured in place, tighten nut (14) to a torque of 750 Nm (553 lbf ft).

33. Take cover (13) and secure in place to countershaft case (20) using screws (12). Note: Cover threads of screws (12) with sealing compound.

34. Reassemble differential assembly, refer to Fig. 2. is the reverse of disassembly.

35. Place ring gear (39) against collar of the differential assembly (40) and fasten by means of lockbolts (41), refer to Fig. 7.

35. Heat inner race of bearings (38 & 45) and place them upon the ends of the differential assembly until full contact is obtained.

36. Install the outer races of bearings (38 & 45) into differential housing (35).

37. Install both adjusting nuts (37 & 46) into bearing caps. Place bearing cap (44) upon bearing (45) and secure with washers (43) and bolts (42) Tighten bolts (42) to a torque of 245 Nm (180 lbf ft). Displace the differential to obtain a backlash of 0.25 - 0.35 mm (0.0010 - 0.0014 in). Refer to Fig. 20.

38. Bearing adjusting nuts (37 & 46) have two basic functions: Pre-loading the bearings and positioning ring gear (39) to obtain the correct backlash between the ring and pinion gear.

39. To check the backlash between ring gear (39) and pinion gear (33), mount a dial indicator gauge at a right angle on the ring gear outer diameter as shown in Fig. 21. Rock the ring gear back and forth being careful not to move the pinion.

40. Note: Backlash can be adjusted without changing the bearing pre-load by loosening one bearing adjusting nut a certain number of notches and tightening the opposite nut the same number of notches.

41. Tighten adjusting nut (37) opposite ring gear (39) two notches in order to obtain the bearing pre-load of 3-4 Nm (115 - 155 lbf ft), then re-check backlash.

42. Ring gear run out is measured by mounting a dial indicator gauge on the backside of ring gear. Carefully rotate the ring gear and read the dial indicator gauge. Maximum allowable run out is 0.08 mm (0.003 in).

43. To check the ring gear (39) tooth pattern, coat about twelve gear teeth with Prussian blue, oiled red lead or equivalent easily removed paint or dye. When the pinion is rotated, the paint is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts.

Gear tooth patterns are covered under 'Gleason Gear tooth system'
44. After adjustments are made and the gear tooth pattern is correct, lock adjusting nuts (37 & 46) with cotter pins (36 & 47). Lock bearing cap bolts (42) in place with lockwire (57).

GLEASON GEAR TOOTH SYSTEM
Ideal tooth-contact patterns are shown in Figs. 22 & 23 indicating the pinion distance is correct.

If the patterns obtained are the same as that shown in Figs. 24 & 25 then decrease the pinion distance. Refer to Fig. 26.

If the patterns obtained are the same as that shown in Figs. 27 & 28 then increase the pinion distance. Refer to Fig. 29

MAINTENANCE
Proper lubrication of the differential assembly is essential if the differentials are to deliver the service intended. Section 300-0020, LUBRICATION SYSTEM gives full information on the proper lubrication intervals and the lubricant which should be used.

SPECIAL TOOLS
The special tools referenced in this section are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and sealants required.
Fig. 24 - Coast Side (Concave)

Fig. 25 - Drive Side (Convex)

Fig. 26 - Pinion Distance Must Be Decreased

Fig. 27 - Coast Side (Concave)

Fig. 28 - Drive Side (Convex)

Fig. 29 - Pinion Distance Must Be Increased
Differential Diagnosis

Noises and vibrations originating in the tyres, transmission, planetaries and drivelines are easily transmitted and may be erroneously attributed to the differential. Therefore, all possible sources of noise should be investigated before the differential is taken apart.

Whenever noises such as a grating or rattle are heard coming from the differential, stop the unit immediately. One tooth from a gear can cause damage to all gears and bearings. When the differential is definitely at fault, remove the axle shafts and disconnect the driveline before moving the vehicle.

**DIAGNOSIS CHART**

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>REASON</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>Broken gear teeth, worn bearings</td>
<td>Replace gear or bearings</td>
</tr>
<tr>
<td>Continual noise</td>
<td>Worn gear or bearings</td>
<td>Replace gear or bearings</td>
</tr>
<tr>
<td>Noise on drive</td>
<td>Ring or pinion gear adjustment tight</td>
<td>Adjust</td>
</tr>
<tr>
<td>Noise on coast</td>
<td>Bearings damaged</td>
<td>Replace bearings</td>
</tr>
<tr>
<td></td>
<td>Ring and pinion gear adjustment loose</td>
<td>Adjust</td>
</tr>
<tr>
<td></td>
<td>Excessive pinion gear end play</td>
<td>Adjust</td>
</tr>
</tbody>
</table>

**DIAGNOSIS CHART (CONTINUED)**

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>REASON</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise on turns</td>
<td>Normal limited slip differential operation</td>
<td>Use an EP oil with limited slip additives. Refer to Section 300-0020, LUBRICATION SYSTEM</td>
</tr>
<tr>
<td></td>
<td>Worn pinion gears or side gears</td>
<td>Replace gears</td>
</tr>
<tr>
<td></td>
<td>Worn or damaged axles (spiders)</td>
<td>Replace axles (spiders)</td>
</tr>
<tr>
<td>Loss of lubricant</td>
<td>Oil seals worn</td>
<td>Replace seals</td>
</tr>
<tr>
<td></td>
<td>Loose nuts or bolts</td>
<td>Tighten nuts or bolts to correct torque</td>
</tr>
<tr>
<td></td>
<td>Cracked housing/case</td>
<td>Repair or replace housing/case</td>
</tr>
</tbody>
</table>

**WARNING**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

**WARNING**

Removing the axle shafts or drivelines will make the parking brake ineffective.
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DESCRIPTION

Numbers and letters in parentheses refer to Fig. 1.

Fig. 1 illustrates both a standard pinion gear and spider differential (A) and a limited slip type (B). Basically the differential consists of pinion gear (3) and ring gear (5). The differential is a spiral bevel ring gear type with an automatically operating limited slip element (B).

The differential is mounted to the axle housing. The driveline yoke attaches directly to differential flange (4) which is splined to the shaft of pinion gear (3).

**Limited Slip Assembly**

Numbers in parentheses refer to Fig. 2.

The limited slip assembly consists of housing (1), thrust washers (2), externally splined discs (3), internally splined discs (4), thrust ring (5), side gears (6), pinion gears (7), differential axle (8) and cover (9).
OPERATION

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Pinion gear (3, Fig. 1) is mated with ring gear (5, Fig. 1) which is bolted to differential case assembly (8, Fig. 1).

When both drive wheels are free to turn under equal resistance loads, ring gear (5, Fig. 1) and four small pinion (spider) gears (7, Fig. 1) act as one rigid unit, transmitting torque to both splined side gears (6). Side gears (6), being splined to the axle shafts, then drive each rear wheel with the same amount of torque at identical rates of speed. In this instance, pinion gears (7) do not rotate on their axis, therefore, side gears (6) rotate at the same rev/min as ring gear (5 Fig. 1).

When resistance on one drive wheel exceeds the resistance on the other, or when the vehicle makes a turn creating the same effect, one gear continues to revolve but pinion gears (7) cease to act rigidly with it. Pinion gears (7) now rotate on their own axis, permitting one drive wheel to rotate at a different speed from the other. Since the ratio of the pinion and side gear assembly is approximately 2 to 1, the result is that as one drive wheel slows down, the speed of the other proportionately increases. This prohibits the application of a torsional load to either axle, which is greater than that existing during normal operation.

Thus pinion gears (7) serve a dual purpose:

1. They allow a differential in speed between the two drive wheels, permitting maximum manoeuvrability.

2. They prohibit the application of all torque to one axle shaft.
REMOVAL
Numbers in parentheses refer to Fig. 3.

**WARNING**
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Before attempting to remove the road wheels, drive the vehicle onto a level, solid concrete floor, preferably after a short run to warm the oil.

**Note:** If the rear differential is being removed, raise the body and prop it up with the body prop.

2. Apply the parking brake and switch off the engine.

3. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

4. Drain the gear oil out of the axle housing and both planetaries into a suitable container.

5. Remove the planetary assemblies and axle shafts from the axle housing. If necessary, note from which side the long and short axle shafts are removed. Refer to Section 160-0030, AXLE GROUP (HUB).

6. Identify the relationship of the driveline flange and differential pinion flange with punch marks.

7. Disconnect the driveline from the differential drive flange. The driveline can be removed if it is convenient to do so.

8. Index mark differential housing (14) and the axle housing to ensure that differential housing (14) is installed in the same position.

9. Loosen and remove bolts (13) from the differential and axle housings. Thread in three puller bolts to break the seal between the differential and axle housings and to partially pull the differential assembly out of the axle housing.

10. Using suitable lifting equipment, support the weight of the differential assembly.

**Note:** When removing the rear differential, weld a loop to the bottom side of the body above the differential and attach the lifting device.

11. Pull out the differential assembly until it clears the axle housing, then carefully lower it to the floor. Slide the differential assembly out from beneath the vehicle.

INSTALLATION
Installation is the reversal of the 'Removal' procedure.

**Note:** Use sealing compound between the axle housing and differential housing mounting faces.

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, AXLE BOLT AND NUT TORQUE SPECIFICATIONS.

Add gear oil of the type specified in Section 300-0020, LUBRICATION SYSTEM, through the differential filler/level hole until the oil is level with the bottom of the filler/level hole. Fill the planetary assemblies up to the 'Oil Level Check Line'.
Fig. 3 - Exploded View of Front and Rear Differential
DISASSEMBLY

Numbers in parentheses refer to Fig. 3.

**Note:** The following removal procedure assumes the complete axle assembly was removed from the vehicle.

1. Punch mark the mounting position of differential housing (14) to the axle housing as shown by arrows in Fig. 4. Remove mounting bolts (13).

2. Remove both planetary assemblies and axle shafts by following the procedure in Section 160-0030, AXLE GROUP (HUB). Use three puller bolts to pull the differential assembly away from the axle housing and then lift it out of the axle housing as shown in Fig. 5.

3. Remove lockwire (21) from bolts (20 & 23) as shown by the arrows in Fig. 6.

4. Remove bolts (23) and lock plate (24) from bearing caps (22) as shown in Fig. 7.
5. Punch mark bearing caps (22) and differential housing (14) as shown in Fig. 8. Loosen adjusting nuts (10). Remove bolts (20), washers (19) and bearing caps (22).

6. Remove both adjusting nuts (10) as shown in Fig. 9.

7. Lift the differential assembly out of differential housing (14) with the special tool as shown in Fig. 10.

8. Remove outer races of tapered roller bearings (11 & 12). Pull the inner race of the bearings with a puller from cover (26) and housing (33) with the puller shown in Fig. 11.
9. Remove bolts (25) from cover (26) as shown in Fig. 12.

10. Punch mark cover (26) and housing (33) as shown by the arrows in Fig. 13, then lift off the cover.

11. Remove thrust washer (27), two externally splined plates (28), two internally splined plates (29), thrust ring (35) and side gear (30).

12. Remove four pinion gears (31) and axle (32) out of housing (33).

13. Remove other side gear (30), thrust ring (35), two internally splined plates (29), two externally splined plates (28) and thrust washer (27) from housing (33).

14. If necessary, pull the inner race of tapered roller bearing (11) off housing (33). If ring gear (18) is being removed from housing (33), punch mark them so they can be assembled in the same position. Remove bolts (34) as shown in Fig. 14 and press ring gear (18) off housing (33).

15. Remove cotter pin (1), slotted nut (2), washer (3) and drive flange (4) from pinion gear (17).

16. Remove and discard pinion shaft seal (7) from differential housing (14) as shown in Fig. 15.
17. Press pinion gear (17) out of differential housing (14) as shown in Fig. 16. Remove spacing washer (15).

18. With the special tool shown in Fig. 17 pull the inner race of the bearing off the pinion drive end.

**INSPECTION**

1. Clean all parts with a suitable solvent. Dry all parts, except bearings, with compressed air or with soft, clean lint free cloths. DO NOT spin bearings with compressed air. Place bearings on a clean surface, cover with lint free cloths and allow to dry.

2. Coat cleaned, dried parts immediately with light oil to prevent corrosion. If parts are not to be assembled immediately, treat them with a good quality rust preventive and wrap them with treated paper or suitable material designed to prevent corrosion.

3. Before installing the differential assembly into the axle housing, clean the inside and outside of the axle housing to remove any debris or dirt.

4. Inspect all gears, pinions and splines for cracked or broken teeth, excessive wear, and pitted or scored surfaces. Repair or replace as necessary.

**Note:** If either ring gear or pinion gear is defective, both gears must be replaced, because they are serviced only as a matched set. Make sure the ring gear and pinion gear have the same mating numbers.

5. Check for pitted, scored or worn thrust surfaces of differential case halves.

6. During assembly and installation, make sure that mated, punch marked or otherwise identified parts are returned to their original positions, if still serviceable.

**ASSEMBLY**

Numbers in parentheses refer to Fig. 3.

**Note:** Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, AXLE BOLT AND NUT TORQUE SPECIFICATIONS.

The first step in the assembly procedure is to determine the thickness of the spacing washer or shim (15). Fig. 18 illustrates the special tools needed to determine the shim size. Dimensions A + B + C = X which is the shim size.
1. Using a feeler gauge, determine the gap between the measuring piston and measuring shaft as shown in Fig. 19. For example:

Dimension 'A' + 'B' = 191.8 mm (7.551 in)
+ Dimension 'C' = 15.0 mm (0.591 in)
(half the diameter of the measuring shaft).

Dimension 'X' = 206.8 mm (8.142 in)

2. Next, determine the thickness of tapered roller bearing (16) as shown in Fig. 20. For example:

(Straight edge + gauge blocks) = 90.0 mm (3.543 in)
- Measured Value = 43.9 mm (1.728 in)

Bearing Thickness = 46.1 mm (1.815 in)
Rear Axle Group - Differential Drive Head

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3. The arrow in Fig. 21 is pointing to a dimension etched on the face of pinion gear (17). For example 159.90 mm (6.295 in).

\[
\text{Dimension 'X' } = 46.10 \text{ mm (1.815 in)} \\
\text{+ } 159.90 \text{ mm (6.295 in)} \\
\text{= 206.00 mm (8.110 in)}
\]

Example:

- Dimension 'X'
- Dimension 'XI'

Shim Thickness = 0.80 mm (0.032 in)

4. Place shim (15), of the correct thickness as determined in Steps 1, 2 and 3 into differential housing (14) as shown in Fig. 22.

5. Using a special driving tool, drive the outer race of tapered roller bearing (16) into differential housing (14) as shown in Fig. 23.

6. Turn differential housing (14) over and install outer race of tapered bearing (8) into its bore as shown in Fig. 24.
7. Heat the inner race of tapered roller bearing (16) to approximately 90° C (190° F) and install it on the shaft of pinion gear (17). Be sure it is seated against the shaft shoulder as shown in Fig. 25.

8. The following steps are required to determine the thickness of spacing washer (9). Place the special measuring ring on the shoulder of pinion gear (17) as shown by the arrows in Fig. 26.

9. Place the pre-assembled pinion gear (17) on a suitable spacing tube. Lift up differential housing (14) and carefully place it over the pinion. Heat the inner race of bearing (8) to approximately 90° C (190° F) and install it on the shaft of pinion gear (17). Drive the inner bearing race until it is seated against the outer race as shown in Fig. 27.

10. If dust shield (6) was removed from drive flange (4), press it back on the drive flange. Spline drive flange (4) to pinion (17). Install slotted nut (2) and tighten to a torque of 600 Nm (443 lbf ft). Check the rolling resistance as shown in Fig. 28. Rolling resistance should be 1.1 - 2.3 Nm (0.81 - 1.70 lbf ft).

**Note:** Correct rolling resistance is obtained by loosening or tightening the slotted nut. Record the torque figure because it will be required later.
11. Remove slotted nut (2), pull off drive flange (4) and remove pinion gear (17) from differential housing (14). Remove and measure the measuring ring with a micrometer. The thickness of the compressed measuring ring will be the thickness of spacing washer (9).

Place spacing washer (9) on the shoulder of the pinion shaft. Then install the assembled pinion gear into differential housing (14).

12. Coat the outer diameter of pinion shaft seal (7) with sealing compound. With the seal lip facing inward and using the seal driver shown in Fig. 29, drive seal (7) into differential housing (14).

13. Slide drive flange (4) on the shaft of pinion gear (17). Place washer (3) on the pinion shaft and thread on slotted nut (2). Torque slotted nut (2) to the setting determined in Step 10. Lock slotted nut (2) in place with cotter pin (1).

14. If ring gear (18) was removed from housing (33), make sure the ring gear and housing surfaces are clean and free from grease. Install two line-up studs, line up index marks and press the ring gear back on. Install bolts (34) and, with a dial indicator gauge, check ring gear run-out. Maximum allowable run-out is 0.08 mm (0.003 in).

15. Heat inner roller bearing (12) race to 90° C (190° F) and press it on to the hub of housing (33) until it is firmly seated.

16. Place one thrust washer (27) with the lubrication slot facing up.

17. Alternately, install an externally splined plate (28) and then an internally splined plate (29) until all plates have been installed.

18. Install thrust ring (35) on top of the internally splined plate (29). Install thrust ring (35) with open face up.

19. Install one side gear (30) into thrust ring (35). Make sure the side gear splines into the two internally splined plates (29).

20. Assemble axles (32) and pinion gears (31) together and install on the installed side gear (30), as shown in Fig. 30.

21. Install the other side gear (30) and the other thrust ring (35), flat side up, as shown in Figs. 31 and 32.
22. Alternately install an internally splined plate (29) and externally splined plate (28) until all plates are installed.

23. Determine the end play between the plates and the housing as shown in Figs. 33 and 34.

Step 1 - Determine the dimension between the housing face and the internally splined plate (29). For example - the measurement is 6.00 mm (0.236 in).

Step 2 - Determine the dimension between housing (33) and cover face (26). For example - the measurement is 5.80 mm (0.228 in).

Step 1 Dimension ........... 6.00 mm (0.236 in)
Step 2 Dimension ........... 5.80 mm (0.228 in)
Difference ....................... 0.20 mm (0.008 in)

The correct end play between the housing cover and both plate packs should be between 0.20 - 0.80 mm (0.008 - 0.031 in). The end play should be as close to 0.20 mm (0.008 in) as possible. The end play is controlled by installing different thicknesses of internally splined plates. Refer to the parts book for different thicknesses of plates available.

24. Place thrust washer (27) on side gear (30), as shown in Fig. 35.

25. Heat inner race of roller bearing (11) to approximately 90° C (190° F) and press it on to the hub of cover (26) until it is firmly seated against the cover.

26. Place cover (26) on housing (33), cover threads of necked-down bolts (25) with Loctite 270 and fasten cover and housing together as shown in Fig. 36. Use only new necked-down bolts. Tighten bolts (25) to a torque of 110 Nm (82 lbf ft).
27. Place outer races of roller bearings (11 & 12) on both differential ends. Using the special lifting tool install ring gear (18) assembly into differential housing (14), as shown in Fig. 37.

28. Coat the threads of adjusting nuts (10) with Molykote and loosely thread into lower bearing cups, as shown in Fig. 38.

29. Align the index marks and install bearing caps (22) with washer (19) and bolts (20), as shown in Fig. 39. Tighten bolts (20) to a torque of 295 Nm (218 lbf ft).

30. Thread both adjusting nuts (10) into bearing caps (22) as shown, until the yoke width is between 340 - 340.30 mm (13.386 - 13.400 in) diagonally across the bearing cap lock pads, as shown in Fig. 40.

Note: Bearing adjusting nuts (10) have two basic functions: preloading the bearings and positioning ring gear (18) to obtain the correct backlash between it and pinion gear (17).
31. To check the backlash between ring gear (18) and pinion gear (17), mount a dial indicator gauge at right angles to the outer diameter of the ring gear tooth flank as shown in Fig. 41. Rock the ring gear back and forth being careful not to move the pinion gear. Backlash should be 0.30 mm (0.012 in).

**Note:** Backlash can be adjusted without changing the bearing preload by loosening one bearing adjuster nut a certain number of notches and tightening the opposite adjuster nut the same number of notches.

32. The ring gear run-out is measured by mounting a dial indicator gauge on the backside of ring gear (18) as shown in Fig. 42. Carefully rotate ring gear (18) and read the dial indicator. Maximum allowable run-out is 0.08 mm (0.003 in).

33. To check the tooth pattern of ring gear (18), coat about twelve ring gear teeth with prussian blue, oiled red lead or some other easily removed print or dye. When the pinion is rotated, the paint is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts as shown in Fig. 43.

Gear tooth patterns for the Gleason Gear Tooth system are on the following pages.

34. After all adjustments and gear patterns are correct, secure adjusting nut lock plates (24) in place with bolts (23) and lockwire (21), as shown in Fig. 44.
Rear Axle Group - Differential Drive Head

Section 160-0020

GLEASON GEAR TOOTH SYSTEM

Ideal tooth-contact pattern shown in Figs. 45 and 46 indicating the pinion distance is correct.

If the patterns obtained are the same as that shown in Figs. 47 and 48 then decrease the pinion distance (Fig. 49).

If the patterns obtained are the same as that shown in Figs. 50 and 51 then increase the pinion distance (Fig. 52).
Rear Axle Group - Differential Drive Head

Fig. 50 - Coast Side (Concave)

Fig. 51 - Drive Side (Convex)

Fig. 52 - Pinion Distance must be Increased
Rear Axle Group - Differential Drive Head
Section 160-0020

MAINTENANCE
Proper lubrication of the differential assembly is essential if the differentials are to deliver the service intended. Section 300-0020, LUBRICATION SYSTEM gives full information on the proper lubrication intervals and the lubricant which should be used.

SPECIAL TOOLS
The special tools referenced in this section are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and sealants required.

DIFFERENTIAL DIAGNOSIS
Noises and vibrations originating in the tyres, transmission, planetaries and drivelines are easily transmitted and may be erroneously attributed to the differential. Therefore, all possible sources of noise should be investigated before the differential is taken apart.

Whenever noises such as a grating or rattle are heard coming from the differential, stop the unit immediately. One tooth from a gear can cause damage to all gears and bearings. When the differential is definitely at fault, remove the axle shafts and disconnect the driveline before moving the vehicle.

WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Removing the axle shafts or drivelines will make the parking brake ineffective.

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>REASON</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>Broken gear teeth</td>
<td>Replace damaged gear</td>
</tr>
<tr>
<td></td>
<td>Excessive run-out of pinion or flanged case</td>
<td>Disassemble, correct or replace faulty part</td>
</tr>
<tr>
<td>Continual noise</td>
<td>Bearing worn</td>
<td>Replace worn parts</td>
</tr>
<tr>
<td></td>
<td>Gears damaged or worn</td>
<td>Replace gears</td>
</tr>
<tr>
<td>Noise on drive</td>
<td>Ring or pinion gear adjustment tight</td>
<td>Adjust</td>
</tr>
<tr>
<td>Noise on coast</td>
<td>Bearings damaged</td>
<td>Replace bearings</td>
</tr>
<tr>
<td></td>
<td>Loose pinion gear adjustment tight</td>
<td>Adjust</td>
</tr>
<tr>
<td></td>
<td>Excessive pinion gear end play</td>
<td>Adjust</td>
</tr>
<tr>
<td>Noise on turns</td>
<td>Normal limited slip differential operation</td>
<td>Use an EP oil with limited slip additives. Refer to Section 300-0020, LUBRICATION SYSTEM</td>
</tr>
<tr>
<td></td>
<td>Worn pinion gears or side gears</td>
<td>Replace gears</td>
</tr>
<tr>
<td></td>
<td>Worn or damaged axles (spiders)</td>
<td>Replace axles (spiders)</td>
</tr>
<tr>
<td>Loss of lubricant</td>
<td>Oil seals worn</td>
<td>Replace seals</td>
</tr>
<tr>
<td></td>
<td>Loose nuts or bolts</td>
<td>Tighten nuts or bolts to correct torque</td>
</tr>
<tr>
<td></td>
<td>Cracked housing/case</td>
<td>Repair or replace housing/case</td>
</tr>
</tbody>
</table>

SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>PART NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>Slotted Nut</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>Bolt</td>
<td>295</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>Bolt</td>
<td>110</td>
</tr>
</tbody>
</table>

* * * *
OPERATION

Numbers and letters in parentheses refer to Fig. 1.

Power from the differential is transmitted through a fully floating axle shaft connected to sun gear shaft (17) by driver (25). As sun gear shaft (17) rotates in a clockwise direction, the four planet gears (19) meshed with sun gear shaft (17) rotate anticlockwise. Ring gear (16) is splined to hub carrier (1) and does not rotate but causes planet gears (19), which are meshed with ring gear (16), to move around it in a clockwise direction. As planet carrier (18) is bolted to wheel hub (10) the wheel then rotates in a clockwise direction.
REMOVAL AND DISASSEMBLY
Numbers in parentheses refer to Fig. 1.

Note: On dismantling, clean all parts in paraffin or other suitable cleaning agent and place on a clean work surface.

![Fig. 2 - Jacking Planet Carrier Out Of Hub](Image)

![Fig. 3 - Removing Planet Carrier Assembly](Image)

1. Before attempting to remove the road wheels, drive the vehicle onto a level, solid concrete floor, preferably after a short run to warm the oil.

2. Apply the parking brake and switch off the engine.

3. Block the appropriate road wheels, place the steering lock bar in the ‘Locked’ position and the battery master switch in the ‘Off’ position.

4. Whilst road wheels are still on the ground, loosen wheel nuts (12).

5. Jack up the axle and support with suitably placed stands or timbers.

6. Support tyre and rim assembly with a suitable sling and lifting device. Remove wheel nuts (12) and remove tyre and rim assembly from the machine. Remove opposite road wheel in the same way.

7. Place suitable containers under the differential and both hubs (10). Remove differential drain plug and drain oil from the differential.

8. Rotate hubs (10) until plug screws (24) are at their lowest points. Remove plug screws (24) and 'O' rings (23) and drain oil from hubs.

9. Index mark planet carrier (18) and hub (10) to aid in installation.

10. Remove bolts (22) then prise planet carrier (18) from hub (10) and place on the floor with planet gears (19) facing upwards. If necessary, use jacking bolts in tapped holes provided, as shown in Fig. 2.

11. Remove bearing inner race (7) from hub carrier (1).

12. Lift out sun gear shaft (17) from planet carrier (18) assembly. Remove retainer rings (20) and pull planet gears (19) from planet carrier (18). Remove thrust washer (21).

13. Remove driver (25) from axle shaft (28). Remove thrust washer (26) from grooved pins (27) on hub carrier (1). Pull axle shaft (28) from axle housing (30).

14. Remove the brake calliper. Refer to Section 165-0010, BRAKE PARTS - REAR.
18. Remove shaft seal (9), roller bearing (6) and bearing outer race (8) from hub (10) as shown in Fig. 5.

19. If it is necessary to remove hub carrier (1) from axle housing (30), index mark hub carrier and axle housing to aid in installation. Support hub carrier (1) with suitable lifting equipment and remove capscrews (2 & 3), washers (4), nuts (5) and slot pins (34 & 35). If necessary, tap hub carrier (1) loose from axle housing (30).

20. If necessary, drive or press wheel bolts (11) from hub (10).

**INSPECTION**

Numbers in parentheses refer to Fig. 1.

Thoroughly clean all parts with a suitable solvent and dry with compressed air. Inspect all parts for damage or excessive wear and replace where necessary. Inspect thrust washers (21 & 26) to make sure they are free of burrs and are absolutely flat. Replace all ‘O’ rings.

**ASSEMBLY AND INSTALLATION**

Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, AXLE BOLT AND NUT TORQUE SPECIFICATIONS.

**WARNING**

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Cover the mounting flange of axle housing (30) with Loctite 574 sealing compound and line up the index mark on hub carrier (1) with the mark on axle housing (30). Secure hub carrier (1) to axle housing (30) with capscrews (2 & 3), washers (4), nuts (5) and slot pins (34 & 35). Tighten capscrews (2 & 3) to a torque of 460 Nm (340 lbf ft).

2. If removed, install new wheel bolts (11) on hub (10) using the special tool shown in Fig. 6.

3. Place brake disc (31) on hub (10) and secure with capscrews (32) and washers (33). Tighten capscrews (32) to a torque of 295 Nm (220 lbf ft).
4. Install roller bearing (6) in inner bore of hub (10) using special tool (15275085, driver). Coat outer diameter of shaft seal (9) with Loctite 574 sealing compound and, with the seal lip facing down, press shaft seal (9) into the bore of hub (10) with the special tool (15275086, driver) as shown in Fig. 7. Turn the hub over and press bearing outer race (8) into the hub bore using special tool (15269896, driver). **Note:** Driver handle (15269898) also required.

5. With a suitable lifting device, pick up hub (10) assembly, then, being careful to prevent damaging the lip of shaft seal (9), slide hub (10) assembly onto hub carrier (1). Be sure hub (10) assembly is firmly seated against the shoulder of hub carrier (1).

6. Install bearing inner race (7) on the splined end of hub carrier (1) as shown in Fig. 8. Be sure the inner race is firmly seated.

7. Slide ring gear (16) over the splines of hub carrier (1). Be sure it is pushed all the way in.

8. Select shim (36) and install over the splines of hub carrier (1) so that front edge of ring gear (16) is protruding by 0.03 - 0.30 mm (0.001 - 0.012 in).

9. Install slotted nut (29) on hub carrier (1) threads and, using special tool (15269893, socket) shown in Fig. 9, tighten slotted nut (29) to a torque of 1 000 Nm (738 lbf ft).

**Note:** During tightening the wheel hub must be spinning.

10. Check the rolling resistance of hub (10) by wrapping a length of string around hub (10) and pulling with a suitable scale as shown in Fig. 10. The rolling resistance (T) should be 12 - 18 Nm (9 - 13 lbf ft) for new bearings, or 6 - 9 Nm (4.5 - 6.5 lbf ft) for run-in bearings.

Formula to calculate F.

\[ F = \frac{T}{R} \]

Where:

- F = Pull in N (lbf)
- T = Rolling resistance Nm (lbf ft)
- R = Radius of hub m (ft)

Adjust shim (36) thickness to achieve the correct rolling resistance. If rolling torque not reached, select a thinner shim (36). If rolling torque is exceeded, select a thicker shim (36).

11. When rolling resistance is correct, remove slotted nut (29).
15. Carefully slide axle shaft (28) through the bore of hub carrier (1) until the axle shaft splines into the differential side gears. Place thrust washer (26) onto grooved pins (27) on hub carrier (1). Slide driver (25) onto axle shaft (28).

16. Press planet gear assemblies (19) onto the pins of planet carrier (18) as shown in Fig. 11. Secure planet gears by installing retainer rings (20).

17. Position thrust washer (21) into the recess in planet carrier (18). Before positioning sun gear shaft (17) it is necessary at this stage to determine the end play of sun gear shaft (17) before installing the planetary assembly into the hub. The required end play should be 0.3 - 0.5 mm (0.012 - 0.020 in) and can be achieved by installing different thicknesses of thrust washer (21).

**Note:** Thrust washers are available in thicknesses of 6.5 mm (0.256 in), 6.3 mm (0.248 in), 6.0 mm (0.236 in), 5.0 mm (0.197 in), 3.5 mm (0.138 in), 3.3 mm (0.130 in), 3.1 mm (0.122 in), 2.9 mm (0.114 in) and 2.7 mm (0.106 in).

Determine end play of sun gear shaft (17) as follows:

a. Position the assembled planet carrier (18) as shown in Fig. 12. Place a straight edge along top of planetary gears and measure the dimensions to carrier mounting face (dimension 'X') and thrust washer (21) (dimension 'Y'). Note the difference and record this as dimension 'A'.

**Example:**

Dimension 'X' = 100.00 mm (3.937 in)
Dimension 'Y' = 85.40 mm (3.362 in)
Dimension 'A' = 14.60 mm (0.575 in)

b. Slide sun gear shaft (17) fully into driver (25). Place a straight edge across the mounting surface of hub (10) and measure the distance from the mounting surface of hub (10) to the end of sun gear shaft (17) as shown in Fig. 13. Record this as dimension 'B'.

**Example:**

Dimension 'B' = 14.90 mm (0.587 in)

12. Using Loctite 243, coat the threads of hub carrier (1) and slotted nut (29). Thread slotted nut (29) on hub carrier (1) threads and, using the special tool shown in Fig. 9, tighten slotted nut (29) to a torque of 1 000 Nm (738 lbf ft).

13. Install locking plate (14) and secure with lock screws (15). Tighten lock screws (15) to a torque of 79 Nm (58 lbf ft).

14. Re-check the rolling resistance of hub (10). The rolling resistance (T) should be 12 - 18 Nm (9 - 13 lbf ft) for new bearings, or 6 - 9 Nm (4.5 - 6.5 lbf ft) for run-in bearings.
Rear Axle Group - Axle Group (Hub)

Section 160-0030

18. Remove sun gear shaft (17) from driver (25) and position in planet carrier (18) in mesh with planet gears (19).

19. Coat the face of planet carrier (18) with Loctite 574 sealing compound. Install planet carrier (18) assembly into hub (10) and secure with bolts (22). Tighten bolts (22) to a torque of 190 Nm (140 lbf ft).

20. Place a new 'O' ring (23) on plug screw (24) and thread assembled plug screw into the outer face of planetary carrier (18). Tighten plug screw (24) to a torque of 80 Nm (60 lbf ft).

21. Install brake calliper. Refer to Section 165-0010, BRAKE PARTS - REAR.

22. Install differential drain plug. Add gear oil of the type specified in Section 300-0020, LUBRICATION SYSTEM, through the differential filler/level hole until the oil is level with the bottom of the filler/level hole.

23. Fill the planetary assemblies up to the 'Oil Level Check Line' with gear oil of the type specified in Section 300-0020, LUBRICATION SYSTEM.

24. Refit road wheels, securing with wheel nuts (12). Remove stands or timber supports and lower the machine to the ground. Fully tighten wheel nuts to a torque of 590 Nm (435 lbf ft). Remove blocks from the wheels.

Note: Wheel nuts should be checked and tightened if necessary, after the first 10 hours of operation. Check torque every 50 hours (weekly) thereafter.

MAINTENANCE

Proper lubrication of the axle group is essential if axles are to deliver the service intended. Section 300-0020, LUBRICATION SYSTEM gives full information on the proper lubrication intervals and the lubricant which should be used.

SPECIAL TOOLS

The special tools referenced throughout this section are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and sealants required.

AXLE DIAGNOSIS

Noises originating in the tyres, transmission, brakes or drivelines might be attributed by mistake to the axle components, therefore, all possible sources of noise should be investigated before deciding the axle is at fault.

WARNING

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

True axle noises may be located by lifting or jacking the machine up until all tyres are clear of the floor or ground. Securely block the machine in this position. Run power train at moderate speed. Be certain all tyres are off the ground to prevent damage to the differential and make sure that there is no brake drag.

<table>
<thead>
<tr>
<th>AXLE DIAGNOSIS CHART</th>
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<tbody>
<tr>
<td>CONDITION</td>
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<tr>
<td>Noises</td>
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</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Loss of lubricant</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Gain of lubricant</td>
</tr>
<tr>
<td>Planetaries running hot</td>
</tr>
</tbody>
</table>
### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
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<tr>
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<td>Capscrew</td>
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<td>3</td>
<td>Capscrew</td>
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<tr>
<td>1</td>
<td>12</td>
<td>Wheel Nut</td>
<td>590</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td>Lock Screw</td>
<td>79</td>
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<tr>
<td>1</td>
<td>22</td>
<td>Bolt</td>
<td>190</td>
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<tr>
<td>1</td>
<td>24</td>
<td>Plug Screw</td>
<td>80</td>
</tr>
<tr>
<td>1</td>
<td>32</td>
<td>Capscrew</td>
<td>295</td>
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</tbody>
</table>

* * * * *
DESCRIPTION AND OPERATION

The rim and wheel assembly are designed to allow the tyre and rim assembly to be replaced with a pre-assembled tyre and rim. The tyre and rim may be removed from the machine as an assembly and transported to a more suitable location for removing the tyre from the rim.

Procedures for removing tyre and rim assembly from machine, and dismounting tyre from rim, the use of hand, hydraulic, and special tools, are described in this section.

The rim assembly consists of the following components which are illustrated in Fig. 1: rim, inner and outer flange, ‘O’ ring, bead seat band, driver, and lock ring.

When dismounting a tyre and rim assembly from the machine, special equipment and careful handling are required because of the size and weight of the tyres.

One of the following pieces of hoisting equipment should be used to lift the tyre and rim: chain block and tackle, overhead crane, fork lift truck, boom truck, or tripod tyre changing tool.

PREPARATION FOR SERVICING

**WARNING**

Before performing any service on the tyres or rim components, to prevent personal injury and property damage, completely deflate the tyre by removing the valve cap and core. Insert a thin wire through valve to be sure valve is not plugged. Even a flat tyre, in some cases, will retain sufficient air pressure to blow off a rim component with enough force to cause bodily injury or death.
REMOVING TYRE AND RIM ASSEMBLY FROM MACHINE

Numbers in parentheses refer to Fig. 1.

**Note:** If tyre and rim assembly is to be replaced pre-assembled, it is not necessary to remove the tyre from the rim. It may be removed as an assembly.

**WARNING**
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and shutdown the engine.

2. Block all road wheels, except the one to be raised, and place the battery master switch in the 'Off' position.

3. Break wheel nuts (10) loose with tyre still on the ground, but do not remove from wheel studs.

4. Jack up the axle to the height required to allow removal of the tyre and rim assembly.

5. Place safety blocks under the axle.

6. Support tyre and rim assembly with a suitable sling and attach a suitable lifting device.

7. Remove wheel nuts (10) and lock washers (9) securing wheel rim (5) to the wheel.

8. With lifting device, remove tyre and rim assembly from the wheel and lift clear of the vehicle.

DISMOUNTING TYRE FROM RIM

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

**Note:** The following instructions apply to use of hand tools. For procedures and tooling required to dismount the tyre from the rim using hydraulic tools, contact the relevant tyre manufacturer.
**WARNING**

When lifting tyre from the rim, be sure the equipment is of sufficient capacity and properly secured to do the job safely.

1. Remove valve cap (7, Fig. 1) and valve core and leave valve open to prevent trapping of air in tyre. Tape valve threads for protection.

2. If used, remove driver (2) from bead seat band (3) and wheel rim (5).

3. Break outer tyre bead loose with pry bar shown in Fig. 3.

4. Insert flat hooked end of pry bar into breaking slots between bead seat band (3) and outer flange (1). See Fig. 4. A pipe over the straight end of the pry bar will increase leverage.

5. Twist pry bar toward tyre to break bead.

6. A second pry bar may be inserted in the space between bead seat band (3) and outer flange (1). Twist the second pry bar to maintain the space gained by the first pry bar.

7. Move the first pry bar around wheel rim (5), twisting and following with the second pry bar, until the outer tyre bead is loose.

8. Pry bead seat band (3) away from lock ring (4) by placing hooked end of pry bar in the groove of wheel rim (5), between ends of lock ring (4), and prying up with the pry bar. Using two pry bars, as in Step 7, work completely around wheel rim (5).

9. Pry lock ring (4) out in the same manner by starting at prying notch in wheel rim (5) assembly, and work all the way around wheel rim (5) with two pry bars.

10. Remove and discard ‘O’ ring (2, Fig. 1).

11. Remove lock ring (4) then pry out and remove bead seat band (3).

12. Breaking slots are provided inside the rims. The inner bead may be broken as described in Steps 4 through 8. If the tyre and rim assembly is on the vehicle, the following procedure may be used for breaking the inner bead.

13. Place jack between inner flange (6) and vehicle frame. Extend jack until tyre bead is broken. Continue around the rim until tyre bead is broken at all points.

14. Using suitable lifting equipment, remove tyre from rim. This completes the removal of the tubeless tyre.

15. If necessary, remove inner flange (6).

**Note:** If tyre rim is on the vehicle, and no tyre lifting equipment is available, ‘walk’ the tyre off the rim as follows:

- Force bottom of tyre outward as far as possible; lower jack enough to allow weight of tyre to rest on ground; force top of tyre out as far as possible; raise jack to original height and repeat the above until the tyre is off the rim.

**INSPECTION**

**Tyre**

Check the interior surface of the tyre to determine its condition. Inspect for cuts or fabric breaks that have penetrated the tyre body. The casing should be inspected closely for any sharp, pointed object that may have penetrated the tyre body but is invisible from the outside. All dust, dirt, water or other foreign matter should be cleaned from the inside of tyre.

**Rim Assembly**

Overloading, improper tyre inflation, rough terrain, high speed, accidents, dirt accumulation, and corrosion all tend to reduce the service life of rims and rim components. It is recommended that rims be inspected, as below, not less often than at every tyre change and that, as the warranty limit approaches, consideration be given to periodic replacement.

The rim and its components are designed with built-in safety factors, to prevent the components from flying off with killing force during inflation. Check components for cracks, bends, distortion, or other damage. If damage is found, the component must be replaced.

**WARNING**

Never mix components of one manufacturer’s rims with those of another. Using the rim base of one manufacturer with the lock ring of another or vice versa is dangerous. The lock ring of one may not fully engage with the lock ring groove of the other. Always consult the rim manufacturer for proper matching and assembly instructions.
Clean all rust and dirt from the rim parts and wheel and apply a coat of good grade primer paint. Allow the paint to dry thoroughly before remounting tyre.

The rim parts used with tubeless tyres form an important part of the air chamber. Therefore, they should be carefully checked for distortion or mutilation that would prevent an effective air seal when the tyre and rim are reassembled.

Rubber 'O' rings are air seals for tubeless tyre and rim assemblies and therefore should be carefully handled to provide an airtight seal when the tyre is remounted on the rim. Always use new 'O' rings when mounting a tubeless tyre.

Note: Handle 'O' rings carefully, as damage will prevent an airtight seal for tyre inflation.

MOUNTING TYRE ON RIM

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

For mounting a tyre with rim on or off machine, the procedure is basically the same.

1. For off-machine installation, lay wheel rim (5) on blocks or mounting stand with 'O' ring groove up. Wheel rim (5) should be off the floor enough to allow tyre to rest on rim and not the floor. Blocks are not to extend more than 13 mm (0.50 in) beyond rim base.

2. If removed, install inner flange (6) over wheel rim (5).

3. Lubricate tyre beads and 'O' ring, with a thin solution of vegetable base soap and water.

4. Using suitable lifting equipment, lower tyre onto wheel rim (5). Seat tyre firmly against inner flange (6).

5. Install outer flange (1) on wheel rim (5).

6. Align lock ring driver notch in bead seat band (3) with notch in wheel rim (5), and install bead seat band on rim.

7. On vehicles which use a driver (2), align driver slot of bead seat band (3) with driver pocket of wheel rim (5) and install bead seat band (3) on wheel rim (5).

8. Install lock ring (4) in groove of wheel rim (5) so that lock ring lug engages both notches. Notches and lock ring lug must line up correctly. If necessary, use only a soft hammer to rotate the lug. Use pry bar for installing lock ring (4), as shown in Fig. 5.

9. Force bead seat band (3) past 'O' ring groove in wheel rim (5) by prying, or with lift truck forks. Use blocking between the forks and tyre to prevent damage. Insert a new 'O' ring (2, Fig. 1) in groove of the rim behind lock ring (4). Lubricate area of front taper of bead seat band (3) adjacent to 'O' ring (2, Fig. 1), with a thin solution of soap and water or another approved lubricant which is not harmful to rubber. Avoid using an excessive amount of lubricant.

10. If used, install driver (2). Make sure all rim components are correctly assembled.

11. Lift the tyre upwards to effect a seal between bead seat band (3) and 'O' ring (2, Fig. 1). In some cases the tyre will automatically spring out, making this step unnecessary.

12. Refer to heading, 'Tyre Inflation' in this section for the proper procedure for inflating the tyre.
MOUNTING TYRE AND RIM ASSEMBLY ON MACHINE
Numbers in parentheses refer to Fig. 1.

⚠️ WARNING
To prevent personal injury and property damage, be sure blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Support tyre and rim assembly with a suitable chain, or rope sling. Attach sling to overhead lifting device. Slide assembly onto wheel of the vehicle, with lock ring (4) and bead seat band (3) facing outward.

2. Install lock washers (9) and wheel nuts (10) on wheel studs. Gradually tighten wheel nuts opposite each other until all wheel nuts are snug. Tighten wheel nuts (10) to a torque of 590 Nm (435 lbf ft). Tighten wheel nuts (10) again, after 10 hours of operation.

TYRE INFLATION

⚠️ WARNING
To prevent personal injury and property damage, the tyre and rim assembly should be placed in a safety cage before inflating. If no safety cage is available or tyre is on the machine, the tyre and rim assembly should be wrapped with safety chains or with lash cables before inflating.

Even with these precautions remember that air-blast is a potential hazard. Tyre inflation should be carried out away from busy working areas.

⚠️ WARNING
To avoid personal injury and property damage, never stand or sit in front of a mounted tyre during tyre inflation. Use a clip-on air chuck with a long hose and stand to one side while the tyre is being inflated.

⚠️ WARNING
To prevent personal injury and property damage, always prevent flammable vapours that could produce tyre explosions, from being pumped into tyres during inflation, by observing the following precautions:

A. Use an air compressor and reservoir located inside a heated building, when available, so that alcohol, methanol, or other flammable antifreeze liquids are not needed in the air tanks to prevent moisture freezing in the tank and lines in subfreezing outside temperatures.

B. Make sure that paints, lacquers, paint thinners, or similar materials that produce volatile, flammable vapours are not used or stored near the air intake of the compressor that supplies the air for inflating tyres. The compressor should be isolated from all such sources of flammable vapours.

C. Be sure to thoroughly flush and blow off all flammable solvents used for cleaning the air compressor inlet screen before using the compressor for tyre inflation, or any other purpose.

D. Do not charge batteries, either in or out of a machine, near the air inlet of a compressor used for inflating tyres. Charging batteries produces highly explosive hydrogen gas which can be readily drawn into a nearby compressor inlet and pumped into the tyre.

E. Never exceed the specified concentration of alcohol when adjusting the alcohol vaporizer, or adding alcohol to the auxiliary air tank, used on machine air systems to prevent freezing or moisture condensate in below-freezing temperatures. Excessive alcohol, added to the machines air tanks in this manner can produce flammable vapours that will be pumped into a tyre when this air supply is used for tyre inflation. If the tyre inflation kit is not equipped with a moisture filter. Alcohol added to machine air systems in recommended concentration to prevent condensate freezing are below hazardous levels for tyre inflation.

F. Another source of hazardous flammable vapours in tyres is the tyre bead lubricant. Always use bead lubricants that do not introduce flammable vapours into the tyre.
Inflation

Note: Always use tyre inflation equipment with an air filter that removes moisture from the air supply, when available, to prevent moisture corrosion of internal rim parts.

1. Inflate tyre to 1 bar (15 lbf/in²) initially to seat components and tap lock ring lightly to ensure correct seating. Visually check that all components are in place, then continue inflation observing all safety precautions. (See Step 2).

2. If the tyre is off the machine, place it in a safety cage after initially inflating to 1 bar (15 lbf/in²) to seat components. See Fig. 6.

3. Inflate tyres to 5.2 bar (75 lbf/in²) to seat beads and seal the ‘O’ ring, then adjust to the recommended inflation pressure.

4. For recommended operating air pressure, refer to the 'Tyre Inflation Pressures' table.

NITROGEN TYRE INFLATION

Note: All Warnings and procedures under ‘Tyre Inflation’ will apply, except for differences covered by this passage.

In certain environments it is recommended that tyres be inflated with dry nitrogen gas, and that the resulting oxygen content of the inflation does not exceed 5%.

All machines whose tyres are factory inflated with dry nitrogen gas will be identified by a decal on the body or frame.

Nitrogen gas improves tyre pressure retention, increases tyre life by reducing carcass oxidation from within, minimizes rim rust and has no detrimental effects on the tyre. It also reduces the potential of a tyre explosion because it is an inert gas and will not support combustion inside the tyre.

The same tyre inflation pressure used for air inflation should be used for nitrogen inflation. Tyre valves formerly used with air inflation are entirely satisfactory for use with nitrogen gas.

Nitrogen Tyre Inflation Kit

WARNINGs

DO NOT USE charging assembly, Part No. 9359489, for tyre inflation because this assembly does not include a pressure regulator, safety relief valve, and adequate pressure gauging which is mandatory for tyre inflation purposes. Tyre volume is as much as 90 times greater than the average accumulator volume and hence it takes very much longer to inflate a tyre - up to 40 minutes or more for very large tyres.

Nitrogen gas cylinders used to inflate tyres are generally charged to approximately 152 bar (2 200 lbf/in²). A tyre blowout and/or rim failure could occur if inflation equipment is not properly used. Proper nitrogen charging equipment and personnel training for its use is a must to avoid over inflation.

1. A nitrogen tyre inflation kit is available from your dealer and consists of the following. Refer to Fig. 7.

   a. Pressure regulator, 0 - 13 bar (0 - 200 lbf/in²), with two dual pressure gauges.

   b. Safety relief valve, 8.6 bar (125 lbf/in²), that will assure an upper limit to the pressure available for tyre inflation.

   c. A 15.2 m (50 ft) length of flexible hose with interconnecting fittings. On the tyre end of the hose is a large bore quick connect/disconnect clip-on chuck.

2. The pressure regulator is connected to a nitrogen compressed gas cylinder available from local suppliers.
To re-inflate a tyre with dry nitrogen gas which is now inflated with air, proceed as follows:

1. Exhaust the tyre until only air at atmospheric pressure remains in the tyre.

2. Re-inflate the tyre using only dry nitrogen gas to 4.15 bar (60 lbf/in²) gauge as a minimum, or to bead-seating pressure as a maximum.

3. Adjust to the service inflation pressure required:
   a. If the required service inflation pressure is LESS than 4.1 bar (60 lbf/in²), remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.
   b. If the required service inflation pressure is greater than 4.1 bar (60 lbf/in²), further inflate, with dry nitrogen gas only, to the pressure level required. Then remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

To newly mount or remount a tyre to its rim, use only dry nitrogen gas; this includes the pressure required to seat the beads. After seating the tyre beads, remove the clip-on chuck and adjust the pressure with the tyre gauge in the usual manner.

Note: Although a little more nitrogen gas is used to seat beads than that used for re-inflation of a mounted tyre, refer to ‘Re-inflation of a Mounted Tyre’, its cost is generally negligible in comparison to the time and labour saving and, longer tyre life achievable with the reduced oxygen content which results.

**TYRE EXPLOSION HAZARD**

⚠️ **WARNING**
Whenever a machines tyre(s) is (are) exposed to excessive heat such as a machine fire or extremely hot brakes the hazard of a subsequent violent tyre explosion must be recognized. All persons must avoid approaching the machine so as not to be physically endangered in the event of an explosion of the tyre and rim parts.
**WARNING (cont.)**

The machine should be moved to a remote area, but only when this can be done with complete safety to the operator operating or towing the machine. All other persons should stay clear of the machine. The fire or overheated brakes, wheel, etc. should be extinguished or cooled from a safe distance. Do not attempt to extinguish the fire or cool the machine by use of hand-held fire extinguishers.

If it is absolutely necessary to approach a machine with a suspect tyre, approach only from the front or the back. Stay at least 15 m (50 ft) from the tread area. Keep observers out of the area and at least 460 m (1500 ft) from the tyre sidewall. Refer to Fig. 8. The tyre(s) should be allowed at least eight (8) hours cooling time after the machine is shut down or the fire extinguished before approaching closer.

There is always a possibility of a tyre explosion whenever the smell of burning rubber or excessively hot brakes is detected. The danger is also present when a fire on the machine reaches the tyre and wheel area. Under such conditions, all personnel must avoid approaching the machine in a manner that could result in injury should an explosion actually occur. Move the machine to a remote area only if it can be done without endangering the operator or other personnel in the area.

**WARNING**

**DO NOT WELD ON OR HEAT RIM COMPONENTS.** For several years the company and tyre and rim manufacturers have warned users never to weld rim components with the tyre mounted on the rim. The gases that build up inside the tyre during arc welding or heating on rim components can ignite, resulting in one of these explosive-like failures of the tyre and rim. This warning also applies to nitrogen inflated tyres. Ignition will not occur in the nitrogen atmosphere, but the pressure buildup from the heat of welding may be sufficient to cause a blowout severe enough to injure or kill. It is recommended to scrap the part if heat is necessary to repair any rim component.

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**TYRE AND WHEEL RIM MAINTENANCE**

**Tyre Repairs**

Prompt repair of tyre injuries will prevent small injuries from enlarging and causing tyre failure. Use the best tyre facilities available. If good repair facilities are not available, have the nearest dealer make the necessary repairs.

Minor cuts, snags, or punctures should be repaired upon discovery. Skive with a sharp pointed knife around any cut in the tyre tread area that is of sufficient depth or shape to hold pebbles or dirt. The angle of the skive should be no more than sufficient to expel all foreign material and should extend no deeper than the breaker. The skive should go to the bottom of the hole. Tyres with shallow cuts, if treated promptly, may be allowed to continue in service. If the cut extends deeper into the tyre carcass, the tyre should be removed for repair.

The tyre must be removed from the rim to repair larger punctures or cuts. Irregular shaped punctures or cuts less than 13 mm (0.50 in) in size can be repaired with a plug and hot patch. Insert a repair plug into the hole to keep out moisture and to back up the hot patch. Trim the plug off flush with the inside of the casing, buff, and apply the hot patch according to the instructions supplied with the hot patch equipment.
Punctures 13 mm (0.50 in) or larger, large cuts, or bruise breaks require sectional or reinforced vulcanized repair. Cover the repair patch with a layer of cushion gum after application to the tubeless tyre to ensure an airtight repair. Any cords of the inside ply that are exposed in buffing and are not covered with repair patch must be coated with cushion gum to prevent air leakage into the carcass plies on tubeless tyres.

Recapping and Retreading
There are two general methods employed in restoring the tread surface of off-the-highway tyres: recapping and retreading.

A recapped tyre has a new tread cured right over the old tread surface.

A retreaded tyre has the old tread removed entirely and a new tread cured directly onto the body of the tyre. A tyre can be recapped or retreaded if the cord body is free of cuts, bruises and separation, and is thoroughly sound, including previous repairs.

TYRE CARE
To obtain maximum service from off-highway tyres, the following common-sense precautions should be followed.

Maintain Correct Inflation
The most common cause of tyre damage is improper inflation. Both over-inflation and under-inflation are detrimental to tyre life. Tyre pressure should be checked daily, preferably before the machine is placed in operation. Refer to 'Tyre Inflation Pressures' table.

The valve cores should be checked for leaks. Keep in mind that valve cores are delicate mechanisms that wear out in service; therefore, they should be replaced with new ones when they become worn. Each tyre should be equipped with a valve cap to prevent dirt from damaging the valve core and causing air leakage.

Maintain Good Haul Roads
Because haul roads are considered temporary roads they are frequently neglected. The better the haul road, the longer the tyre and machine life of off-highway machines.

Although it takes time and effort to maintain good haul roads, the delay and cost of tyres and machine breakdowns caused by poor haul roads is many times greater.

Inspect Tyres Regularly
A systematic plan for tyre inspection will more than pay for itself in lowered tyre costs per hour of operation. All tyres should be checked regularly for cuts, bruises, ply material breaks, excessive or uneven wear, embedded foreign matter, and any other damage which can be repaired. A considerable increase in tyre service can be realized if tyre injuries are repaired before they have progressed to the irreparable stage.

The rim mounting nuts should also be checked periodically and tightened to the torque specified.

Prevent Overloading
Off-highway machines are designed to carry a maximum allowable payload. Excessive loading will overstress both the machine and tyres and shorten the life of both.

Prevent Contact with Oil
Prevent tyre contact with petroleum products. Rubber that is exposed to oil, gasoline, or grease becomes soft and spongy and deteriorates rapidly. Always avoid driving machine through a puddle of gasoline, fuel oil, lubricating oil, or grease. Never let a tyre stand in an oil or grease spot overnight.

Store Tyres Properly
The best of care given to tyres in service by operators and maintenance personnel can be completely nullified by careless storage. Time is not the only contributing factor to the deterioration of rubber products. Therefore, tyres that are to be stored must be protected from light, heat, oils, dirt, moisture, and ozone. Stored tyres should be carefully covered with a tarpaulin or some other suitable material, such as opaque plastic sheeting, to prevent contact with the contaminants listed above.

Proper Handling of Tyres and Wheel Rim Parts
Tyres should be stored vertically. Horizontal stacking may compress the tyre walls, making inflation difficult. If tyres are stored in racks, the lower supporting members should provide as broad a surface as possible to the tyre tread to avoid a concentration of load.

The beads of tubeless tyres must be protected from damage or a faulty air seal will result. Do not use hooks, cables, or chains in contact with the tyre beads.
when lifting these tyres. If forklift trucks are used for handling, they should be equipped with broad, well-rounded arms to distribute the load and prevent damage to the tyre bead. When handling tyres with the fork truck do not scrape the fork across the bead.

Tubeless tyre rims perform an important function as part of the assembly air seal. Proper care, therefore, must be taken not to distort or mutilate the rim parts because they must mate properly to form part of the basic air chamber. Since the rim base and bead seat band are mating surfaces, distortion may prevent easy assembly as well as possibly resulting in no seal.

Never drop, tumble, or roll rim parts.

If rim parts are stored outdoors, they should be given a protective coat of a good commercial primer.

Similar parts should be stacked neatly to prevent distortion.

Babbit or lead hammers, not sledge hammers, should be used in assembling rim parts.

'O' rings are seals and should be carefully stored in a cool, dry place where they will not be injured or damaged.

Valve cores should also be stored in a cool, dry and clean place.

**MAINTENANCE**

Check tyre pressures daily, preferably before the machine is placed in operation. Refer to 'Tyre Inflation Pressures' table.

Every 50 hours of operation (weekly), torque tighten wheel rim nuts to 590 Nm (435 lbf ft).

Check tyres regularly and replace or repair if required.

**SERVICE TOOLS**

The nitrogen tyre inflation kit shown in Fig. 7 is available from your dealer. Refer to Section 300-0070, SERVICE TOOLS for part numbers of general service tools required.

**TYRE INFLATION PRESSURES (BRIDGESTONE)**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TYRE SIZE</th>
<th>FRONT</th>
<th>CENTRE AND REAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>bar</td>
<td>lbf/in²</td>
</tr>
<tr>
<td>TA27</td>
<td>23.5 R 25**</td>
<td>4.35</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>750/65 R 25**</td>
<td>3.0</td>
<td>44</td>
</tr>
</tbody>
</table>

**TYRE INFLATION PRESSURES (MICHELIN)**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TYRE SIZE</th>
<th>FRONT</th>
<th>CENTRE AND REAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>bar</td>
<td>lbf/in²</td>
</tr>
<tr>
<td>TA27</td>
<td>23.5 R 25**</td>
<td>3.5</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>750/65 R 25**</td>
<td>2.75</td>
<td>40</td>
</tr>
</tbody>
</table>

**TYRE INFLATION PRESSURES (PIRELLI)**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TYRE SIZE</th>
<th>FRONT</th>
<th>CENTRE AND REAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>bar</td>
<td>lbf/in²</td>
</tr>
<tr>
<td>TA27</td>
<td>23.5 R 25**</td>
<td>4.3</td>
<td>62</td>
</tr>
</tbody>
</table>

**TYRE INFLATION PRESSURES (CONTINENTAL)**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TYRE SIZE</th>
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<th>CENTRE AND REAR</th>
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<td></td>
<td></td>
<td>bar</td>
<td>lbf/in²</td>
</tr>
<tr>
<td>TA27</td>
<td>23.5 R 25**</td>
<td>4.3</td>
<td>62</td>
</tr>
</tbody>
</table>
TUBELESS TYRE LEAK DIAGNOSIS

Occasionally a tubeless off highway tyre/rim assembly may leak in field service. To determine cause of leakage, the entire assembly including valve hardware, multi-piece rim assembly, ‘O’ ring and tyre should be checked using a soap solution.

This table lists various causes of air loss and possible remedy.

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defective valve</td>
<td>Tighten parts. Replace defective parts. Use valve caps.</td>
</tr>
<tr>
<td>Cracked rim or weld</td>
<td>Replace defective part</td>
</tr>
<tr>
<td>Twisted or damaged ‘O’ ring</td>
<td>Replace ‘O’ ring (lubricate)</td>
</tr>
<tr>
<td>Tyre cuts and snags</td>
<td>Repair tyre damage</td>
</tr>
<tr>
<td>Bead area awl holes</td>
<td>Repair inner liner (preferred)</td>
</tr>
<tr>
<td>Leakage between tyre bead trim</td>
<td>With tyre removed from rim:</td>
</tr>
<tr>
<td></td>
<td>Clean tyre beads in rim contact area</td>
</tr>
<tr>
<td></td>
<td>Clean rim with wire brush</td>
</tr>
<tr>
<td></td>
<td>Inspect 5 degree tapered bead seat band and the rim base in the bead seating area to determine if the transverse weld trims are flat or concave.</td>
</tr>
<tr>
<td></td>
<td>Replace defective part(s)</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong>: Weld trim should follow rim contour.</td>
</tr>
<tr>
<td></td>
<td>Mount tyre using a lubricant such as Murphy’s Tyre and tube Mounting Compound, or equivalent, on tyre beads and rim bead seat area.</td>
</tr>
</tbody>
</table>

SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>Wheel Nut</td>
<td>590</td>
</tr>
</tbody>
</table>
WARNINGS

Use only hydraulic oils meeting specifications outlined in Section 300-0020, LUBRICATION SYSTEM. Do Not use Brake Fluid (J1703). Use of improper fluids is destructive to rubber components of brakes resulting in loss of braking and possible catastrophic failure.

Exercise extreme caution while working on the braking system.

DESCRIPTION AND OPERATION

The service brakes are of the calliper disc-type. The calliper brake head is designed for use with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. Do Not use Brake Fluid (J1703).

The head is bolted to a mounting plate on the axle housing. The disc is bolted to the wheel. There are two brake heads and one brake disc at each wheel.

Each calliper brake head assembly consists of a torque plate, two brake pads (one on each side of the brake disc) and four brake pistons, two on each side of the brake disc. The piston bores on each side of the torque plate are interconnected by internal passages.

When the brake is actuated, hydraulic oil enters brake head and forces pistons against brake pads which are, in turn, forced against each side of the brake disc, slowing or stopping the disc and wheel rotation.

GENERAL INSPECTION

1. Inspect brake pads for wear. If the brake pad friction material is worn down to 3 mm (0.12 in) thickness, the pads must be replaced.
WARNING
Failure to replace pads when worn to limits will result in loss of braking and possible catastrophic failure.

2. Inspect brake disc as follows:

a. Measure original thickness of disc at outside diameter (this area is not contacted by brake pad friction material).

b. Measure thickness of disc at three points on the brake pad friction material contact circumference and determine the average disc thickness.

c. Subtract 'b' from 'a'. If difference is 3 mm (0.12 in) or greater, the disc must be replaced.

Note: Refer to Section 160-0030, AXLE GROUP (HUB), for brake disc replacement instructions.

3. Inspect brake piston and torque plate for wear.

BRAKE PAD REMOVAL AND INSTALLATION
Numbers in parentheses refer to Fig. 2.
1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Operate steering right and left several times to relieve any pressure in the steering system.

**WARNINGS**

Hydraulic fluid pressure will remain within the braking system after engine shutdown. Operate the brake pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

To prevent possible personal injury, keep hands and fingers etc. clear of the area between the disc and the brake head pistons.

2. Block all road wheels, except the wheel to be removed, and place the battery master switch in the ‘Off’ position.

3. Remove wheel from the machine following instructions in Section 160-0050, WHEEL RIM AND TYRE.

4. Loosen bolts (2) securing large torque pins (3) at the end of torque plate (16). It is not necessary to loosen or remove the two smaller torque pins (5) at opposite end.

5. Move the two unlocked torque pins (3) away from brake disc (2, Fig. 1).

6. Remove dust cap (15) from bleeder valve (1) and attach a bleeder hose to bleeder valve. Open bleeder valve (1). Use a screwdriver or pry bar inserted between brake disc (2, Fig. 1) and brake pads (4) to press pistons (11) back as far as possible, into the piston bores of torque plate (16). Close bleeder valve.

7. Rotate brake pads (4) out of the opened end of torque plate (16). Inspect boots (12) for deterioration.

8. Install new brake pads (4) by placing friction material next to the disc and rotating into position in torque plate (16).

9. Push the two unlocked pins (3) towards the disc.

10. Coat threads with locking compound and install two loosened bolts (2) until bolts seat in grooves of torque pins (3). This can be checked by limited axial movement of pins as the bolts are being seated. Tighten bolts (2) to a torque of 43 - 51 Nm (32 - 38 lbf ft).

**Note:** Make sure torque pins (3 & 5) do not touch brake disc (2, Fig. 1). If they do, loosen bolts (2) and adjust torque pins to clear disc by 1.5 - 3.2 mm (0.06 - 0.125 in). Check to make sure that bolts (2) fully engage in torque pin grooves and retighten bolts.

11. Pump brake pedal until brake pads (4) contact brake disc (2, Fig. 1).

12. When new brake pads are installed on a machine, the brake pad friction material should be burnished in accordance with the following procedure to achieve maximum braking performance:

a. Drive vehicle at 8 - 30 km/h (5 - 20 mile/h) with brakes applied at just enough pressure to produce a noticeable drag. Heavy smoke and foul odour from the brake pad friction material is normal during this procedure.

**Note:** An infrared thermometer pointed at the disc after stopping, can safely and easily determine brake disc temperature. Refer to ‘Special Tools’.

b. Continue cycle until the brake disc achieves a temperature of 315° - 370° C (600° - 700° F).

c. Permit disc to cool to less than 95° C (200° F).

d. Repeat Steps a and b.

e. Allow brake to cool to within 10° C (50° F) of ambient temperature, while driving the vehicle with the brakes released.

f. Repeat Steps a and b until full braking performance (per applicable government regulations) is achieved.

**BRAKE REMOVAL AND DISASSEMBLY**

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

To prevent personal injury and property damage, the procedure for removing tyre and rim assembly described in Section 160-0050, WHEEL RIM AND TYRE, must be strictly followed.
Brake Parts - Brake Parts - Rear

Section 165-0010

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Operate steering right and left several times to relieve any pressure in the steering system.

**WARNINGS**

Hydraulic fluid pressure will remain within the braking system after engine shutdown. Operate the brake pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

To prevent possible personal injury, keep hands and fingers etc. clear of the area between the disc and the brake head pistons.

2. Block all road wheels, except the wheel to be removed, and place the battery master switch in the ‘Off’ position.

3. Remove wheel from the machine following instructions in Section 160-0050, WHEEL RIM AND TYRE.

4. Remove fasteners securing wheel guards to axle housing, and remove guards.

5. Remove hydraulic fluid inlet line at brake head assembly. Plug line and brake head to prevent ingress of dirt.

6. Remove bolts (4, Fig. 1) and washers (5, Fig. 1) from mounting at axle housing and remove brake head assembly to a clean working area.

**WARNING**

Hydraulic fluid may cause irritation. Avoid skin and eye contact with fluid.

7. Disassemble brake head assembly in sequence of index numbers in Fig. 2. Items (1, 2 & 3) may be left in torque plate (16) when servicing packings (13), seals (10), backup rings (14), and boots (12) if desired.

**Note:** Repair kits are available which include new boots (12), backup rings (14), packings (13) and seals (10), in quantities sufficient to rebuild a brake head assembly. Refer to vehicle parts book for repair kit part number. All parts included in a repair kit should be replaced each time a brake head is rebuilt.

8. Inspect brake pads (4) per Step 1 in ‘General Inspection’ procedure.

9. Clean torque plate (16) making sure no solvent remains in fluid passages or grooves. Inspect boot (12) and seal (10) grooves, and land areas between grooves for damage or cracks. Minor nicks and scratches may be blended with crocus cloth. Replace torque plate (16) if corrosion is excessive or boot (12) and seal (10) grooves are damaged, prohibiting proper rebuild of the brake head.

10. Inspect pistons (11) for minor scratches and nicks and blend with crocus cloth. If piston (11) is badly nicked or scratched, or if the chrome plate is worn off, replace piston (11). Inspect pistons (11) and torque plate (16) as per ‘Piston and Caliper Wear Limits’, refer to Fig. 3.

11. Torque pins (3 & 5) that are deeply grooved should be replaced.

**ASSEMBLY**

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

1. Lubricate seals (10), packings (13) and pistons (11) with petroleum base oil or vaseline.

**WARNING**

Do not use brake fluid (SAE J1703).

2. Install backup rings (14), packings (13) and boots (12) in torque plate (16) piston bores. Lubricate per Step 1.

3. Install pistons (11) in torque plate (16) as follows:
Position lubricated piston (11) into boot (12) and piston bore, holding piston at a slight angle. Insert forefinger between piston (11) and boot (12) and rotate forefinger around outside diameter of piston (11), lifting inside diameter of boot (12) over outside diameter of piston (11). Make sure outside diameter lip of boot (12) remains in the groove in piston (11) bore.

4. After piston (11) is through boot (12), centre piston by feel over packing (13). Apply by hand, a turning thrusting pressure, working piston (11) into and through packing (13).

5. When assured pistons (11) are through packings (13), pressure other than hand pressure may be used to press pistons the remainder of the way into the piston bores. Snap open end of boot (12) into groove of piston (11).

6. Lubricate seals (10) and install seals and piston plugs (9) in open end of piston bores of torque plate (16).

7. Attach cover plate (8) to torque plate (16) and secure with bolts (6) and washers (7). Tighten bolts (6) to a torque of 505 - 515 Nm (370 - 380 lbf ft).

8. When installing torque pins (3 & 5) and bolts (2) make sure the groove in the pin is directly under the bolt so the bolt can perform its locking and retaining function.

**Note:** Lubricate torque pins (3 & 5) with a corrosion resistant lubricant prior to installation to facilitate next pin removal.

9. Inspect brake disc (2, Fig. 1), if worn, per instructions under ‘General Inspection’ in this section. Refer to Section 160-0030, AXLE GROUP (HUB) for brake disc replacement instructions.

### INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

**Warnings**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

---

**To prevent personal injury and property damage, the procedure for installing tyre and rim assembly described in Section 160-0050, WHEEL RIM AND TYRE, must be strictly followed.**

1. Install washers (5) on bolts (4). Use Loctite 262 on bolts (4).

2. Position brake head (3) over brake disc (2) on brake mounting plate, aligning bolt holes. Install assembled bolts (4) and washers (5) through mounting plate and into torque plate, and tighten bolts (4) to a torque of 515 Nm (380 lbf ft).

**Note:** Make sure torque pins (3 & 5, Fig. 2) do not touch brake disc (2). If they do, loosen bolts (2, Fig. 2) and adjust pins to clear disc by 1.5 - 3.2 mm (0.06 - 0.125 in). Check to make sure that bolt (2, Fig. 2) fully engages in pin groove and tighten bolt (2, Fig. 2) to a torque of 43 - 51 Nm (32 - 38 lbf ft).

3. Attach hydraulic fluid inlet line at brake head assembly.

4. Install fasteners and secure wheel guards to axle housing.

5. Install wheel on the vehicle following instructions in Section 160-0050, WHEEL RIM AND TYRE.

### BLEEDING THE BRAKING SYSTEM

Numbers in parentheses refer to Fig. 2.

In order to obtain satisfactory braking, the system should be bled as follows to eliminate any air in the hydraulic brake lines.

1. Fill the hydraulic tank with oil specified in Section 300-0020, LUBRICATION SYSTEM. Start the engine and allow systems to reach normal operating conditions.

2. Check oil level and add oil if low. Oil should be halfway up the sight gauge on the hydraulic tank.

**Warning**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.
Brake Parts - Brake Parts - Rear

Section 165-0010

3. Ensure gear shift selector is in neutral, block all road wheels, place the steering lock bar in the "Locked" position and release the parking brake.

4. Remove dust cap (15) and install a clear length of tubing over bleeder valve (1) on one of the brake heads. Submerge the opposite end of the tubing in a suitable container filled with hydraulic oil, specified in Section 300-0020, LUBRICATION SYSTEM.

5. Crack open the bleeder valve (1) and gently operate treadle valve several times to bleed air in the brake lines.

6. When the oil from the brake head is clear (not cloudy or creamy) close bleeder valve (1) and remove tubing.

**WARNING**

Do not operate the vehicle until all air is bled from the braking system.

7. Perform steps 4 through 6 for the remaining 11 brake head assemblies.

**MAINTENANCE**

Numbers in parentheses refer to Fig. 2.

**Every 10 Hours (Daily)**

Inspect brake assemblies to ensure that all bolts are tight and there are no leaks. Inspect boots for deterioration.

Check oil level and add oil if low. Fill hydraulic tank with oil specified in Section 300-0020, LUBRICATION SYSTEM. Oil should be halfway up the sight gauge on the hydraulic tank.

**Every 250 Hours (Monthly)**

Check brake pads and discs for wear and adjust or replace where necessary. Test for proper function.

**Note:** This service interval applies to normal driving. Check the pads more frequently under more severe conditions. Thickness of pad friction material should never be allowed to wear below 3 mm (0.12 in).

**Note:** Repair kits are available which include new boots (12), backup rings (14), packings (13) and seals (10), in quantities sufficient to rebuild a brake head assembly. Refer to vehicle parts book for repair kit part number. All parts included in a repair kit should be replaced each time a brake head is rebuilt.

**SERVICE TOOLS**

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the non-contact infrared thermometer and general service tools and adhesives required. These tools are available from your dealer.

**SPECIAL TORQUE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>Bolt</td>
<td>515</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Bolt</td>
<td>43 - 51</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>Bolt</td>
<td>505 - 515</td>
</tr>
</tbody>
</table>

* * * *
WARNINGS
Use only hydraulic oils meeting specifications outlined in Section 300-0020, LUBRICATION SYSTEM. Do Not use Brake Fluid (J1703). Use of improper fluids is destructive to rubber components of brakes resulting in loss of braking and possible catastrophic failure.

Exercise extreme caution while working on the braking system.

DESCRIPTION AND OPERATION
Numbers in parentheses refer to Fig. 1, unless otherwise specified.

The parking brake consists of a sliding calliper acting on a brake disc on a rear drive line. The parking brake is of 'Inverted Design' i.e. requiring pressure to hold the parking brake off.

Operation is by a spring applied/hydraulically released actuator (9). Actuator (9) is connected through slack adjuster (3) to the power screw shaft (19, Fig. 2) that is screwed into piston (6, Fig. 2) in calliper head assembly (2). Calliper head assembly (2) slides on mounting plates (1) bolted to the frame. Slack adjuster (3) automatically maintains brake clearance after each application through the control strap (12). Control strap (12) connects the slack adjuster (3) to the cap assembly (13).

A push control on the dash panel activates the park brake solenoid in the main hydraulic valve, controlling oil pressure from the accumulators to actuator (9). Application of the push control releases oil from actuator (9) allowing internal springs in the actuator to apply the parking brake. Pulling out the push control directs oil pressure from the accumulators to actuator (9), compressing internal springs, to release the parking brake.

Note: The parking brake is automatically applied when the ignition is switched off.
Parking Brake - Parking Brake and Mounting

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REMOVAL

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Hydraulic fluid pressure will remain within the braking system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

1. Position the vehicle on a level surface, apply the parking brake, block all road wheels and place the steering lock bar in the 'Locked' position.

2. Raise the body and install body safety prop to secure in partially raised position.

3. Pull out push control to release the parking brake.

4. Release spring tension on slack adjuster clevis pin (7) by unscrewing tensioning bolt on slack adjuster (3) until clevis pin (7) feels loose. Remove cotter pin (8) and clevis pin (7) from actuator (9).

Note: On engine shutdown the parking brake will automatically apply. Ensure there is sufficient clearance for actuator rod travel.

5. Switch off the engine and place the battery master switch in the 'Off' position.

6. Disconnect and plug hydraulic line from actuator (9). Cap actuator (9) to prevent ingress of dirt.

7. Remove nuts (10) and washers (11) securing actuator (9) to cap assembly (13). Remove actuator (9) from cap assembly (13).

8. Support caliper head assembly (2) and remove bolts (4 & 16), washers (5) and nuts (6) securing mounting plates (1) to mounting bracket on the frame.

9. Remove mounting plates (1) and caliper head assembly (2) from the vehicle.

DISASSEMBLY

Numbers in parentheses refer to Fig. 2.

1. Remove caliper head assembly as described under removal.

2. Remove snap ring (13) from power screw shaft (18), and remove fasteners securing control strap (27) to slack adjuster (14).

3. Slide slack adjuster (14) from power screw shaft (18).

4. Remove and discard washer (16), wave spring washer (15) and packing (17) from power screw shaft (18).

5. Remove bolts (2) and washers (3) securing cap assembly (21) to calliper (6).

6. Remove as a unit, power screw shaft (18), piston (5) and cap assembly (19 through 22) from calliper (6).

7. Slide power screw shaft (18) and piston (5) from cap assembly (21).

8. Unscrew piston (5) from power screw shaft (18).

9. Remove and discard thrust bearing (19) from power screw shaft (18) and gasket (20) from cap assembly (21).

10. Remove and discard piston seal (4) from calliper (6).

INSPECTION

Numbers in parentheses refer to Fig. 2.

1. Thoroughly clean all parts. Inspect journal bearing (22) in cap assembly (21) for wear. Journal bearing (22) ID should not exceed 38.35 mm (1.51 in). Replace if necessary.

2. Replace cap assembly (21) if excessively worn.

3. Inspect all brake parts for cracks, excessive wear or scoring. Replace brake parts as required.

ASSEMBLY

Numbers in parentheses refer to Fig. 2.

1. Install new piston seal (4) into seal groove in calliper (6).

2. Apply grease (Lubriplate Aero or equivalent) to flat
face of new thrust bearing (19).

3. Install and seat new thrust bearing (19) over splined end of power screw shaft (18) with greased side of thrust bearing (19) against thrust collar of power screw shaft (18).

**Note:** Ensure correct installation of thrust bearing (19) by verifying that installation was made over the larger diameter end of power screw shaft (18), and, that thrust bearing (19) ID lip is towards splined end of power screw shaft (18).

4. Lubricate threads of power screw shaft (18) with grease (Lubriplate Aero or equivalent) and screw power screw shaft (18) into piston (5).

5. Coat outside of piston (5) with grease (Lubriplate Aero or equivalent) then slide assembled power screw shaft (18) and piston (5) into cap assembly (21), shaft end first.

6. Line up gasket (20) and bolt cap assembly (21), with assembled power screw shaft (18) and piston (5), to calliper (6) using bolts (2) and washers (3). Tighten bolts (2).

**Note:** Care should be taken not to push piston seal (4) out of seal groove in calliper (6) when assembling cap assembly (21), with piston (5) and power screw shaft (18), to calliper (6).

7. Install new packing (17), wave spring washer (15) and washer (16) over power screw shaft (18), in the order shown in Fig. 2.

8. Mount actuator (12) on cap assembly (21) with nuts (10), lockwashers (25) and washers (11). Tighten nuts (10) finger tight only at this stage.

9. Apply coat of grease (Lubriplate Aero or equivalent) to mounting spline of slack adjuster (14).
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10. With adjusting screw facing towards actuator (12) slide slack adjuster (14) on power screw shaft (18) aligning slack adjuster (14) arm with clevis (7).

11. Install snap ring (13) on power screw shaft (18).

12. Remove nuts (10), lockwashers (25) and washers (11) securing actuator (12) to cap assembly (21). Remove actuator (12) from cap assembly (21) to aid in installation.

INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

<table>
<thead>
<tr>
<th>WARNING</th>
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<tbody>
<tr>
<td>To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.</td>
</tr>
</tbody>
</table>

1. Attach suitable lifting device and position mounting plates (1) in mounting bracket and calliper head assembly (2) over brake disc. Secure mounting plates (1) to mounting bracket on the frame with bolts (4 & 16), washers (5) and nuts (6). Tighten nuts (6) to a torque of 75 Nm (55 lb ft).

2. Remount actuator (9) on cap assembly (21, Fig. 2) and install washers (11), lockwashers (25, Fig. 2) and nuts (10). Tighten nuts (10) finger tight only at this stage.

<table>
<thead>
<tr>
<th>WARNING</th>
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<tbody>
<tr>
<td>Do not pressurize actuator until the following instruction has been carried out. Pressurizing the actuator beforehand can result in serious brake damage.</td>
</tr>
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</table>

3. Turn adjustment screw (14) on the slack adjuster (3) in a clockwise direction until the brake pads in calliper head assembly (2) are tight against the brake disc.

4. Connect hydraulic line to actuator (9). Place the battery master switch in the ‘On’ position, start the engine and pull out parking brake control knob to extend the actuator.

5. Connect slack adjuster (3) to actuator (9) by inserting clevis pin (7) through clevis (7, Fig. 2) on actuator (9). Secure clevis pin (7) with cotter pin (8).

6. Align actuator (9) to slack adjuster (3) and tighten nuts (10).

7. Loosen bolt (15) at the control arm of slack adjuster (3) and control strap (12).

8. Position control arm of slack adjuster (3) in fully released position (forcing it in a direction away from actuator (9)) by turning adjustment screw (14) on the slack adjuster (3), until it comes to a positive stop inside the control strap (12).

9. Tighten bolt (15) at the control arm of slack adjuster (3) and control strap (12).

**Note:** Failure to position the slack adjuster against the internal stop may result in brake drag.

10. Use feeler gauges between brake pads in calliper head assembly (2) and brake disc. Turn the adjustment screw (14) on the slack adjuster (3) until the total pad-to-disc clearance is between 0.04 - 0.06" (1.0 - 1.5 mm), which is 0.02 - 0.03" (0.5 - 0.75 mm) per side.

11. Remove feeler gauge and apply brake several times. The automatic slack adjuster will adjust the brake pad clearance with each application, which can be seen by the rotation of the adjustment screw (14).

12. When the adjustment screw (14) stops rotating, the specified clearance has been obtained and the brake is ready for normal operation.

13. Remove wheel blocks and place the steering lock bar in the ‘Stowed’ position.

MAINTENANCE

Every 250 hours

Test park brake for proper operation. Check brake pads and disc for wear. Replace brake pads when lining thickness is 3.0 mm (0.125 in) or less. Replace disc when worn by 3.0 mm (0.125 in) or more.

Brake Pad Replacement

1. Remove calliper head assembly as described under ‘Removal’.

2. Replace worn brake pad and carrier assemblies.

3. Install calliper head assembly and adjust slack adjuster as described in 'Installation'.
SPECIAL TOOLS
There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
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<tr>
<td>1</td>
<td>6</td>
<td>Nut</td>
<td>75 Nm</td>
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<tr>
<td></td>
<td></td>
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<td>55 lbf ft</td>
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</table>
**WARNINGS**

Use only hydraulic oils meeting specifications outlined in Section 300-0020, LUBRICATION SYSTEM. Do Not use Brake Fluid (J1703). Use of improper fluids is destructive to rubber components of brakes resulting in loss of braking and possible catastrophic failure.

**Exercise extreme caution while working on the braking system.**

**DESCRIPTION AND OPERATION**

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

The parking brake consists of a sliding calliper (2) acting on a brake disc (6) on a rear drive line. The parking brake is of 'Inverted Design' i.e. requiring pressure to hold the parking brake off.

Operation is by a spring applied/hydraulically released actuator (1). Actuator (1) is connected to lever & slack adjuster (7) via clevis rod and pin (3 & 4 Fig. 2). Lever (10, Fig. 2), is mated to slack adjuster (12, Fig. 2) rotor end. This in turn mates to the piston (14, Fig. 2). Slack adjuster and lever automatically maintain brake clearance after each application.

A push control on the dash panel activates the park brake solenoid in the main hydraulic valve, controlling oil pressure from the accumulators to actuator (1). Application of the push control releases oil from actuator (1) allowing internal springs in the actuator to apply the parking brake. Pulling out the push control directs oil pressure from the accumulators to actuator (1), compressing internal springs, to release the parking brake.

**Note:** The parking brake is automatically applied when the ignition is switched off.
REMOVAL
Numbers in parentheses refer to Fig. 2, unless otherwise specified.

1. Position the vehicle on a level surface, apply the parking brake, block all road wheels and place the steering lock bar in the ‘Locked’ position.
2. Raise the body and install body safety prop to secure in partially raised position.
3. Pull out push control to release the parking brake.
4. Remove 4-off cotter pins (18) from mounting pins (19).
5. Calliper (17) and constituent parts should be held in place by bracket (8, Fig. 1) which mounting pins (19) are located through.
7. Disconnect the clevis rod (3) end from the lever (10) by removing cotter pin (5) and clevis pin (4).
8. Push park brake button in, releasing hydraulic pressure. This should cause the clevis rod (3) and clevis pin (4) end to retract away from the lever (10).

Note: On engine shutdown the parking brake will automatically apply. Ensure there is sufficient clearance for actuator rod travel.

9. Disconnect and plug hydraulic line from actuator (1). Cap actuator (1) to prevent ingress of dirt.
10. Remove nuts (7) and washers (6) securing actuator (1) to arm (20).
11. Actuator (1) can be removed from the arm (20).

HYDRAULIC FLUID PRESSURE WILL REMAIN WITHIN THE BRAKING SYSTEM AFTER ENGINE SHUTDOWN. OPERATE THE TREADLE PEDAL CONTINUOUSLY UNTIL THE PRESSURE HAS DISSIPATED BEFORE CARRYING OUT ANY WORK ON THE BRAKING SYSTEM OR SERIOUS INJURY COULD RESULT.

DISASSEMBLY
Numbers in parentheses refer to Fig. 2.

1. Remove cap plug (8), and insert a 3/8” hex socket onto the shaft and rotate in the opposite direction of actuation until you feel a positive stop. Do not over torque.
2. Remove retaining ring (9) and lever (10) from slack adjuster (12) rotor end.
3. Remove 4-off bolts (11) and arm (20).
4. Slack adjuster (12) can now be removed from the calliper (17) mounting face.
5. ‘O’-ring (13), piston (14) and seal (15) should be removed when removing calliper (17).

Note: Ensure piston (14) and seal (15) are pushed through the calliper at removal, i.e. away from slack adjuster end.

4. Remove seal (15), piston (14) and ‘O’-ring (13) from the slack adjuster (12) and calliper (17) bore.
5. Ensure calliper housing (17) is held in place. Remove mounting pins (19), this should enable the calliper (17) to be removed from the chassis frame.

6. Should it be necessary to aid in the removal of the calliper (17), remove bolts (9, Fig. 1), washers (10, Fig. 1) and nuts (11, Fig. 1) securing bracket (8, Fig. 1) to the frame rail. Remove bracket (8, Fig. 1) and calliper (17).

INSPECTION
Numbers in parentheses refer to Fig. 2.

Note: Polish any discoloured or stained areas with crocus cloth only. Use finger pressure and rotate the crocus cloth in the bore. Do not use any other kind of abrasive cloth.

1. Examine all parts carefully. Parts showing signs of excessive wear, damage or corrosion should be replaced.
2. Clean all parts with denatured alcohol and either wipe dry with a clean lint free cloth or blow dry with an air hose.
3. Inspect Calliper housing (17) bore for scoring, pitting or corrosion. According to severity of wear / damage, light scores and stains may be removed. For more severe damage replace as necessary.

4. Similarly inspect items whose surfaces may be considered 'critical' i.e. piston (14) outer diameter and mating elements. Any such components whose damage will affect operational performance or integrity of the system should be replaced where applicable.

5. Check to see that the brake disc (9, Fig. 1) is not bent or misshapen.

6. Inspect lever (10) for wear and replace if necessary.

7. Check to make sure that mounting pins (19) slide freely through the mating holes of the calliper (17).

8. Check to make sure that the slack adjuster (12) is still functioning properly. To do this, rotate the lever (10) while it is mated to the rotor end of slack adjuster (12), in the direction of actuation. The coloured shaft that is extending through the spring cup should rotate and extend whilst the rotor is turning.

9. If the coloured shaft rotated and extended out while the rotor was rotated, it should not rotate but only retract inwards when the rotor is rotated back to its home position.

Repeat this procedure several times will show the coloured shaft properly adjusting outwards simulating adjustment due to pad wear.

10. To return the sub-assembly back to its original starting position, remove the plastic cap plug (8) from the rotor end of the slack adjuster (12), and insert a 3/8" socket into the rotor until it seats on the shaft. Turn the socket the opposite direction of the brake unit (Counter clockwise for a CW unit, or clockwise for a CCW unit), until you feel a positive stop. Do not over torque.
Parking Brake - Parking Brake and Mounting

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11. Inspect the actuator (1) and bracket (20) for damage or cracks. Replace the entire actuator (1), if the outer housing, pull rod or hydraulic fitting is damaged or if there is any leaking from the unit.

ASSEMBLY

Numbers in parentheses refer to Fig. 2.

1. Taking actuator (1) assembly, which includes clevis rod (3) and pin end. Secure in place to mating surface of arm (20), using 4-off washers (6) and nuts (7).

**Note:** Ensure all parts are clean and are suitable for use prior to assembly. When reinstalling the piston (14), ensure it is fitted from the slack adjuster (12) mounting face end of the calliper (17).

2. Coat bore of calliper (17) with silicon grease.

3. Insert new seal (15) into calliper (17) bore. Make sure seal is not damaged or torn during this process.

**Note:** Care should be exercised when inserting piston (14), so as not to damage piston or other components during this assembly stage.

4. Install piston (14) into the bore from the same end as the seal. Push the piston (14) through the seal (15) until the seal (15) is seated fully into the piston (14) groove.

5. Lubricate and install 'O'-ring (13) into the groove end cover.

6. Install slack adjuster (12) sub assembly into the calliper (17) and place the arm (20), with actuator (1) attached into the rotor end of the slack adjuster (12).

7. Secure in place using 4-off bolts (11). Torque bolts (11) to a value of 40 - 60 lbf ft (54 - 81 Nm).

8. Place lever (10) on spline of rotor end of slack adjuster (12) in the correct orientation and install retaining ring (9) into groove.

9. Insert a new cap plug (8) into end of slack adjuster (12) rotor.

INSTALLATION

Numbers in parentheses refer to Fig. 2, unless otherwise specified.

⚠️ **WARNING**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠️ **WARNING**

Do not pressurize actuator until the following instruction has been carried out. Pressurizing the actuator beforehand can result in serious brake damage.

1. Examine brake pads (16) for wear or damage. If pad thickness is less than 1/32" (0.79mm), new pads should be fitted. If the pads are within limit, they can be reused.

2. Ensure pads are installed in their original position.

**Note:** The thinner pad should be orientated nearest the actuator side of the calliper. This maintains the thicker pad on the carrier side of the calliper which is necessary for wear reasons, in operation.

3. Ensure any new pads have the same friction material type as the old ones as determined by the code stamped on the pads.

4. Should the bracket assembly (8, Fig. 1) have been removed. Reinstall to frame rail, securing in place using bolts, washers and nuts (9, 10 & 11 Fig. 1).

5. Remount the calliper (17) and brake pads (16) in place, by locating mounting pin (19) through the bracket (8, Fig. 1) and the calliper (17).

6. Secure calliper (17) in place between bracket (8, Fig. 1) support arms by inserting 4-off cotter pins (18) into the mounting pins (19).

7. Remove cap fitted to actuator (1) to prevent dirt ingress at removal.

8. Connect hydraulic line to actuator (1). Start the vehicle and pull the park brake button out, thus applying oil pressure into the actuator (1).
9. Install clevis pin (4) through clevis (rod (3) and lever (10). If pin does not assemble freely, push the park brake button in, thus releasing oil pressure from the actuator. At this stage, readjust the clevis rod (3) using the jam nut.

10. Reapply oil pressure to the actuator (1), by pulling the park brake button out.

11. Repeat steps 8 to 10 until the pin (4) can be freely assembled. Install cotter pin (5) and torque clevis jam nut (2) hand tighten plus 1/4 turn without causing clevis to turn and bind clevis pin (4) in lever (10).

12. Actuate brake several times to allow slack adjuster (12) to fully adjust the brake to proper pad gap 0.025”-0.030” (0.635 - 0.762mm)

13. Remove wheel blocks and place the steering lock bar in the 'Stowed' position.

MAINTENANCE

Every 250 hours
Test park brake for proper operation. Check brake pads and disc for wear.

⚠️ WARNING
This time interval should only be used as a guide to maintenance, assuming 'normal' operating conditions, under hard use, checks should be carried out more frequently, at the discretion of the operator / serviceman.

1. Check floating parts move freely and that there is adequate freedom of movement for positive brake operation.

2. Check actuator (1) linkage and see that there is adequate freedom of movement for positive brake operation.

3. Check brake disc (9, Fig. 1) surface condition. Replace if it is badly warped, pitted or below minimum recommended thickness. Check for loose mounting bolts (11) or cracks.

4. Check to see if brake pads are worn to less than 1/32” (0.79mm) thick. Replace if they are. In normal service, pads will need replacing only after prolonged use.

Brake Pad Replacement

⚠️ WARNING
To replace brake pads it is necessary to release the park brake by applying hydraulic pressure to the actuator chamber and rotating the actuator shaft in the opposite direction that the lever is actuated. Replace brake pads in pairs only!

⚠️ WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle on a level surface, apply the parking brake, block all road wheels and place the steering lock bar in the 'Locked' position.

2. Raise the body and install body safety prop to secure in partially raised position.

3. Pull out park brake button to release the parking brake.

4. Remove cap plug (8) from end of slack adjuster (12) end.

5. Insert a 3/8" socket into the rotor until it seats on the shaft. Turn the socket the opposite direction of the brake unit (Counter clockwise for a CW unit, or clockwise for a CCW unit), until you feel a positive stop. Do not over torque.

6. Using a hard wood dowel or flat edge of a large screwdriver, work the piston (14) back into the bore of calliper (17), by carefully prying against old pads and the brake disc.

7. Remove a cotter pin (18) from one end of each pin (19) and remove the pad pins and worn brake pads (16).

Note: To replace the pads it may be necessary to slide the calliper in its floating mount and not to remove or disassemble it.

⚠️ Note: Stamped on the front of each pad is a code. The first character is a number(s) that specify the friction material type. Ensure new pads are the same as the worn pads that were removed.
8. Install new brake pads (16) and secure in place by reinstalling the pins.

9. After assembly, insert 3/8" hex socket onto the shaft and rotate the shaft in the same direction as the actuation, until a clearance of 0.030" (0.762mm) is obtained between pad and disc.

10. Reinstall cap plug (8). With the unit assembled and clearances correctly set, apply and release the park brake 10 times to allow the slack adjuster to find its position.

11. Apply the brakes lightly several times, allowing cooling time in between to burnish the new pads. Always burnish new pads since preburnished pads will have reduced braking power.

**SPECIAL TOOLS**
There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
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<th>FIG. NO.</th>
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</tr>
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<td>2</td>
<td>11</td>
<td>Bolt</td>
<td>Nm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54 - 81</td>
</tr>
<tr>
<td></td>
<td></td>
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</table>
DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The front axle assembly is mounted on the leading arms of suspension frame (1) which pivots on the front frame.

Suspension is provided by two heavy duty rubber suspension mounts (18) mounted between axle plates (4 & 5) and front frame. In addition, there are four heavy duty double acting shock absorbers (27) (two off each side) to smooth out the ride. Two chain and shackle assemblies (23) provide extra retention on rebound.

REMOVAL

Numbers in parentheses refer to Fig. 1.
Suspension System - Front Suspension

Section 180-0020

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering system.

2. Block rear road wheels, place the steering lock bar in the 'Locked' position and place the battery master switch in the 'Off' position.

3. Whilst the front road wheels are still on the ground, loosen the wheel nuts.

4. Using suitable lifting equipment, raise the machine until both front tyres are off the ground. Support the vehicle with suitable stands and blocking at the front frame and articulation pivot area.

5. Support one tyre and rim assembly with suitable lifting equipment and remove wheel nuts securing the rim to the axle. Remove tyre and rim assembly.

6. Repeat step 5 for the opposite tyre and rim assembly.

7. Disconnect hydraulic brake line at tee on front axle assembly. Disconnect differential breather line. Cap lines and fittings to prevent ingress of dirt.

8. Jack up suspension frame (1) and remove nuts (26), lockwashers (25) and bolts (24) securing chain and shackle assemblies (23) to suspension frame (1) and link assembly (21).

9. Support driveline and remove bolts securing driveline to front axle. Refer to Section 130-0010, FRONT AND REAR DRIVELINES.

10. Remove thread caps and mounting hardware securing shock absorbers (27) to suspension frame (1).

11. Using jack, lower suspension frame (1) onto a suitable trolley until rubber suspension mounts (18) are free of compression.

12. Remove thread caps and mounting hardware securing shock absorbers (27) to front frame. Remove shock absorbers (27), and remove rubber suspension mounts (18).

13. Support the rear end of suspension frame (1) using suitable equipment. Loosen and remove locknuts (20) securing stop screw (19) in front frame. Remove stop screw (19) from front frame.

14. Using torque multiplier (see Special Tools), loosen nuts (6) securing suspension frame (1) to front frame.

15. Remove nuts (6), hardened washers (16) and bolts (31) securing suspension frame (1) to front frame.

16. Remove bolts (12 - 14) and washers (15) securing outer bushes (8) to front frame. Remove inner bushes (7), outer bushes (8) and shims (9 - 11).

17. Carefully lower suspension frame (1) assembly onto the trolley and remove from under the vehicle.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Remove nuts (30), hardened washers (29) and bolts (28) securing front axe assembly and axle plates (4 & 5) to suspension frame (1). Using suitable lifting equipment, remove front axe assembly from suspension frame (1).

2. If required, press spherilastic bushes (2) from suspension frame (1) using press tool and power press (See Special Tools).

3. If required, remove bolts (17), spacer (22), washers and nuts (3) securing link assembly (21) to front frame.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.
Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**WARNING**
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. If spherilastic bushes (2) were removed during disassembly, install new spherilastic bushes as follows:
   a. Coat bores in suspension frame (1) with a water based lubricant.
   b. Using press tool and power press (See Special Tools), install spherilastic bushes (2) in suspension frame (1).

2. Using suitable lifting equipment, position front axle assembly on suspension frame (1). Position axle plates (4 & 5) and secure with bolts (28), hardened washers (29) and locknuts (30). Tighten locknuts (30) to a torque of 680 Nm (501 lbf ft).

3. If removed, install link assembly (21) to front frame using bolts (17), spacer (22), washers and nuts (3).

**INSTALLATION**
Numbers in parentheses refer to Figs. 1 & 2.

**WARNING**
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Position suspension frame (1) assembly and trolley under the front frame with spherilastic bushes (2) to the rear.

2. Using suitable lifting equipment, lift suspension frame (1) assembly and locate inner bushes (7) and outer bushes (8) in front frame.

3. Install bolts (31), hardened washers (16) and nuts (6) through spherilastic bearings (2). Hand tighten nuts (6) at this stage.

4. Position suspension frame (1) completely to one side and take a measurement of the gap between boss on front frame and inside face of outer bush (8). Half this size to obtain the thickness of shim (9 - 11) pack required for Gap 'A' (Fig. 2) at both sides.

**Note:** Do not overshim, it is important to leave some clearance.

5. Remove outer bushes (8) and shim Gap 'A' at both sides with shims (9 - 11) calculated at Step 4.

6. Reinstall outer bushes (8), bolts (12 - 14) and washers (15). Hand tighten bolts at this stage.

7. Install rubber suspension mounts (18) between axle plates (4 & 5) and front frame.

8. Mount two hydraulic jacks (see Special Tools) below suspension frame. Using hydraulic pump to operate hydraulic jacks, compress rubber suspension mounts (18) to 300mm (11.8”).

9. Using torque multiplier (see Special Tools), tighten nuts (6) to a torque of 1 835 Nm (1 325 lbf ft).

10. Remove bolts (12 - 14) and washers (15). Apply
Loctite Primer T (33) and Loctite 648 (34) to threads of bolts and reinstall bolts (12 - 14) and washers (15). Tighten bolts (12 - 14) to a torque of 170 Nm (125 lbf ft).

11. Connect chain and shackle assemblies (23) between link assembly (21) and suspension frame (1) and secure with bolts (24), lockwashers (25) and nuts (26).

12. Install shock absorbers (27) to the front frame and secure with locknuts. Tighten upper locknuts to a torque of 103 Nm (74 lbf ft). Refit thread caps.

13. Align bottom of shock absorbers (27) with mounting holes on suspension frame (1) and secure with locknuts. Tighten lower locknuts to a torque of 103 Nm (74 lbf ft). Refit thread caps.

14. Install and adjust stop screw (19) to achieve 0.75 - 1.25 mm clearance (Fig. 2) between suspension frame (1) and stop screw (19).

15. Once clearance is obtained, install and tighten locknut (20).

16. Remove trolley from underneath tractor frame.

17. Install driveline between axle and transmission and secure with bolts removed previously. Refer to Section 130-0010, FRONT AND REAR DRIVELINES.


19. Using suitable lifting equipment, position one tyre and rim assembly on a front wheel and secure with wheel nuts. Tighten locknuts to a torque of 590 Nm (435 lbf ft).

20. Using suitable lifting equipment, position opposite tyre and rim assembly on the opposite front wheel and secure with wheel nuts.

21. Using suitable lifting equipment, raise front frame sufficiently to remove stands and blocking from the front frame and articulation pivot. Lower vehicle to the ground and remove lifting equipment. Tighten all wheel nuts to a torque of 590 Nm (435 lbf ft).

22. Remove wheel blocks from rear road wheels and place the steering lock bar in the 'Stowed' position.

23. Bleed all air from hydraulic brake lines. Refer to Section 165-0010, BRAKE PARTS - REAR.

SPECIAL TOOLS
Refer to Section 300-0070, SERVICE TOOLS, for part numbers of torque multiplier, hydraulic jack, power press, press tool and general service tools and sealants required. These tools and sealants are available from your dealer.

<table>
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<th>FIG. NO.</th>
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<td>680</td>
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<td>27</td>
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<td>103</td>
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<tr>
<td></td>
<td>27</td>
<td>Shock Absorber Nut (Lower)</td>
<td>103</td>
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<tr>
<td></td>
<td></td>
<td>Wheel Nut</td>
<td>590</td>
</tr>
</tbody>
</table>

* * * *
DESCRIPTION

Numbers in parentheses refer to Fig. 1.

Each axle is coupled to the chassis by three rubber bushed control links (3) which provide longitudinal location and control torque reactions. Lateral location is by means of two Panhard rod links (16). The centre and rear axles are linked by longitudinal equaliser beams (6) which pivot on either side of the chassis.

Loads which act on the axles are balanced by equaliser beams (6), with bonded rubber/metal laminated interleaf mounts (30) located between the axles and beam ends providing the cushioning medium.

The rear suspension system requires minimal maintenance due to the use of rubber bushings (4) being used in control links (3). Lubrication of Spherical bearings (17) in Panhard rods (16) is through lube fittings (41), similarly lubrication of bushings (7) in equaliser beams (6) is through lube fittings (13).
Suspension System - Rear Suspension
Section 180-0040

REMOVAL
Numbers in parentheses refer to Fig. 1.

**WARNING**
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

**WARNING**
Hydraulic fluid pressure will remain within the braking system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

1. Position the vehicle in a level work area, raise the body and install the body safety prop to secure the body in the partially raised position.

2. Apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering system.

3. Block the front road wheels, place the steering lock bar and oscillation lock pin in the 'Locked' position and the battery master switch in the 'Off' position.

4. Using suitable blocking equipment, block equaliser beams (6) to prevent movement when raising the trailer frame.

5. Whilst the rear road wheels are still on the ground, loosen the wheel nuts.

6. Using suitable lifting equipment, raise the trailer frame until the rear wheels are off the ground. Support the vehicle with suitable stands and blocking equipment at the trailer frame, articulation pivot area and centre and rear axles.

7. Support one tyre and rim assembly with suitable lifting equipment and remove wheel nuts and lockwashers securing the rim to the axle. Remove tyre and rim assembly.

8. Repeat step 7 for the remaining rear tyre and rim assemblies.

9. With a suitable container in position, disconnect hydraulic brake lines from the tee pieces at the centre and rear axle assemblies. Cap lines and fittings to prevent entry of dirt.

10. Remove mounting hardware connecting brake line guards (33 & 34) to axles and remove brake line guards.

11. Remove blocking materials from equaliser beams (6). Remove locknuts (29), washers (25) and bolts (21) securing interleaf mounts (30) to equaliser beams (6).

12. Remove bolts (24) and lockwashers (25) securing interleaf mounts (30) to suspension link brackets (1 & 2) mounted on the centre and rear axles. Remove interleaf mounts (30).

13. Remove bolts (14) and lockwashers (15) securing end cap (11) to equaliser beam (6). Remove end cap (11).

14. Remove bolts (12) and lockwashers (10) securing retainer (9) to spindle on the frame. Remove retainer (9).

15. Using suitable lifting equipment, support equaliser beam (6) and withdraw from spindle on the frame.

16. Remove and discard 'V' seal (8) from bushing (7). If required, remove bushing (7) from spindle on the frame.

17. Repeat steps 13 through 16 to remove the opposite equaliser beam (6).

18. Remove locknuts (19), hardened washers (23) and bolts (18) securing centre control links (3) to cross shaft mounting brackets.

19. Remove locknuts (29), hardened washers (23) and bolts (20) securing centre control links (3) to suspension link brackets (5). Remove centre control links (3).

20. Remove locknuts (29), hardened washers (23) and bolts (20) securing control link (3) to bracket assembly (2) on the rear axle and the LH frame mounting bracket. Remove control link (3).

21. Remove locknuts (29), hardened washers (23) and bolts (20) securing control link (3) to bracket assembly (1) on the centre axle and the LH frame mounting bracket. Remove control link (3).

22. Remove locknuts (29), hardened washers (23) and bolts (20) securing control link (3) to bracket assembly (1) on the rear axle and the RH frame mounting bracket. Remove control link (3).
23. Remove locknuts (29), hardened washers (23) and bolts (20) securing control link (3) to bracket assembly (2) on the centre axle and the RH frame mounting bracket. Remove control link (3).

24. Refer to detail D: Remove hose assemblies (36) and elbows (35) from panhard rods (16).

25. Remove hose assemblies and elbows (35 & 36) from manifold bracket (41). Remove remote lube fittings (41) if necessary.

26. Remove bolts (39) securing p-clips (37), washers (50) and hoses (36) in place. Carefully remove hose assemblies and elbow (35 & 36) from panhard rods (16).

27. If necessary remove manifold bracket (41) from frame, by removing bolts (42) and washers (49).

28. Refer to details B & C: Remove bolts (48), washers (44) and Lockwashers (38) from suspension link brackets (2) and frame assembly. Remove pins (43).

29. Remove V-ring seals (46 & 47), Spacers (45) and Panhard rods (16) from suspension link brackets (2) and frame assembly.

30. Remove locknuts (28), hardened washers (27) and bolts (26 & 31) securing suspension link bracket (2) on the rear axle. Remove suspension link bracket (2).

31. Remove locknuts (28), hardened washers (27) and bolts (26) securing suspension link bracket (1) on the rear axle. Remove suspension link bracket (1).

32. Remove bolts (22) and hardened washers (23) securing suspension link bracket (5) on the rear axle. Remove suspension link bracket (5).

33. Remove locknuts (28), hardened washers (27) and bolts (26) securing suspension link bracket (1) on the centre axle. Remove suspension link bracket (1).

34. Remove locknuts (28), hardened washers (27) and bolts (26 & 31) securing suspension link bracket (2) on the centre axle. Remove suspension link bracket (2).

35. Remove bolts (22) and hardened washers (23) securing suspension link bracket (5) on the centre axle. Remove suspension link bracket (5).

36. If either axle assembly requires to be removed from under the vehicle; raise axle assembly with suitable lifting equipment, remove blocking from under the axle assembly and lower axle assembly onto a trolley. Slide the axle assembly from under the vehicle to a suitable work area.

**INSTALLATION**

Numbers in parentheses refer to Figs. 1, 2 & 3.

---

**WARNING**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Ensure centre and rear axle assemblies are correctly positioned and securely blocked below the frame.

2. Install suspension link bracket (5) on centre axle. Apply Loctite 270 to bolts (22) and secure suspension link bracket (5) to centre axle with bolts (22) and washers (23). Tighten bolts (22) to a torque of 324 Nm (239 lbf ft).

3. Install suspension link bracket (2) on RH side of the centre axle. Apply Loctite 243 to bolts (26 & 31) and secure suspension link bracket (2) to centre axle with bolts (26 & 31), hardened washers (27) and locknuts (28). Tighten bolts (26 & 31) to a torque of 671 Nm (495 lbf ft).

4. Install suspension link bracket (1) on LH side of the centre axle. Apply Loctite 243 to bolts (26) and secure suspension link bracket (1) to centre axle with bolts (26 & 31).
(26), hardened washers (27) and locknuts (28). Tighten bolts (26) to a torque of 671 Nm (495 lbf ft).
5. Apply Loctite 243 to bolts (24) and secure interleaf mounts (30) to centre axle with bolts (24) and lockwashers (25). Tighten bolts (24) to a torque of 165 Nm (122 lbf ft).

6. Install suspension link bracket (5) on rear axle. Apply Loctite 270 to bolts (22) and secure suspension link bracket (5) to rear axle with bolts (22) and washers (23). Tighten bolts (22) to a torque of 324 Nm (239 lbf ft).

7. Install suspension link bracket (2) on LH side of the rear axle. Apply Loctite 243 to bolts (26 & 31) and secure suspension link bracket (2) to rear axle with bolts (26 & 31), hardened washers (27) and locknuts (28). Tighten bolts (26 & 31) to a torque of 671 Nm (495 lbf ft).

8. Install suspension link bracket (1) on RH side of the rear axle. Apply Loctite 243 to bolts (26) and secure suspension link bracket (1) to rear axle with bolts (26), hardened washers (27) and locknuts (28). Tighten bolts (26) to a torque of 671 Nm (495 lbf ft).
9. Apply Loctite 243 to bolts (24) and secure interleaf mounts (30) to rear axle with bolts (24) and lockwashers (25). Tighten bolts (24) to a torque of 165 Nm (122 lbf ft).

10. If bushings (7) were removed from spindle on the frame, thoroughly clean spindles with Loctite activator 'N' and allow to dry. Apply Loctite 648 retaining compound all over bushing (7) contact area of the spindles and install bushings (7) on the spindles. Ensure paint dot on bushing (7) is at TDC, and that one of the grease channels lines up with channel on spindle end face (both grease channels should be at bottom). Once installed, end face of spindle should protrude by 3mm.

Note: A curing time of fifteen minutes is required for acceptable handling strength.

11. Install new 'V' seals (8) over bushings (7) with the lip to the outside, as shown in Fig. 2.
12. Clean bores on equalising beams (6) and, using suitable lifting equipment, install beams onto bushings (7). Apply Loctite 243 to bolts (12) and secure retainers (9) to spindles with bolts (12) and lockwashers (10). Tighten bolts (12) to a torque of 150 Nm (110 lbf ft).

13. Apply Loctite 243 to bolts (14) and Loctite 574 gasket eliminator to mounting face of end caps (11). Secure end caps (11) to equalising beams (6) with bolts (14) and lockwashers (15). Tighten bolts (14) to a torque of 75 Nm (55 lbf ft).

14. If removed, install lube fittings (13) in end caps (11). Lubricate with grease specified in Section 300-0020, LUBRICATION SYSTEM, until excess lube is seen.

15. Apply Loctite 243 to bolts (21) and secure interleaf mounts (30) to equaliser beams (6) with bolts (21), lockwashers (25) and locknuts (29). Tighten bolts (21) to a torque of 165 Nm (122 lbf ft).

16. Install centre control links (3) between suspension link brackets (5) and cross shaft mounting brackets. Secure at cross shaft mounting brackets with bolts (18), hardened washers (23) and locknuts (19). Tighten bolts (18) to a torque of 556 Nm (410 lbf ft).

17. Secure centre control links (3) at suspension link brackets (5) with bolts (20), hardened washers (23) and locknuts (29). Tighten bolts (20) to a torque of 556 Nm (410 lbf ft).

18. Install control links (3) between rear and centre axle suspension link brackets (1 & 2) and frame mounting brackets and secure with bolts (20), hardened washers (23) and locknuts (29). Tighten bolts (20) to a torque of 556 Nm (410 lbf ft).

19. Pre-assemble Panhard rods (16), spherical bearings (17) and retainers (32).

20. Refer to Details B: Install both LH and RH Panhard rod assemblies (16) between suspension link brackets
31. Using suitable lifting equipment, raise the trailer frame sufficiently to remove stands and blocking equipment from the centre and rear axles, articulation pivot area and trailer frame. Lower vehicle to the ground and remove the lifting equipment.

32. With the vehicle lowered to the ground, tighten all wheel nuts to a torque of 590 Nm (435 lbf ft).

33. Place the battery master switch in the 'On' position, start the engine and check hydraulic brake lines for leaks. Bleed all air from the hydraulic brake lines as described in Section 165-0020, HYDRAULIC BRAKING SYSTEM SCHEMATIC.

34. Remove wheel blocks from the front road wheels and place the steering lock bar and oscillation lock pin in the 'Stowed' position.

### MAINTENANCE

Numbers in parentheses refer to Fig. 1.

**Pre-Starting Inspection:** Visually check condition and mounting of equaliser beams (6), interleaf mounts (30) and control links (3 & 16).

**Every 50 Hours:** Lubricate spherical bearings (17) in panhard rods (16) through remote lube fittings (41), with grease specified in Section 300-0020, LUBRICATION SYSTEM, until excess lube is seen.

**Every 250 Hours:** Lubricate bushings (7) in equaliser beams (6) through lube fittings (13), with grease specified in Section 300-0020, LUBRICATION SYSTEM, until excess lube is seen.

### SERVICE TOOLS

There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required during the removal and installation of the rear suspension. These tools and adhesives are available from your dealer.
### SPECIAL TORQUE SPECIFICATIONS

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<th>FIG. NO.</th>
<th>ITEM NO.</th>
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<td></td>
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<td></td>
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<td>Wheel Nut</td>
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* * * *
COMPONENT DESIGNATIONS

A4 - 12V Radio/Cassette
A5 - Radio/Cassette Speaker
B2 - Coolant Temp Sender
B7 - Coolant Level Sensor
B8 - Fuel Level Sender
B13 - Rotational Speed Sensor
B19 - Throttle Position Sensor
B21 - Trans Oil Temp Sender
B32 - Trans Oil Temp Sender
B35 - Trans Oil Cooler Fan Temp Sender
B36 - Brake Pedal Potentiometer
E3 - Interior Light
E5 - Reverse Light
E6 - Flashing Amber Reverse Light
E7 - Instrument Panel Lights
E11 - Side Marker Light, L
E12 - Taillight, L
E13 - Side Marker Light, R
E14 - Taillight, R
E15 - High/Low Beam H'lamp, L
E16 - High/Low Beam H'lamp, R
E19 - Rear Fog Lamp
E21 - Rotating Beacon
E23 - Work Light
E26 - High Beam H'lamp, L
E27 - High Beam H'lamp, R
E35 - Heated Mirror
G1 - Generator/Alternator
G2 - Battery
H6 - Direction Indicator; F, L
H7 - Direction Indicator; B, L
H8 - Direction Indicator; F, R
H9 - Direction Indicator; B, R
H10 - Brake Light, L
H11 - Brake Light, R
H29 - Cigar Lighter Illumination
K1 - Starter Relay
K4 - Dir Ind Flasher Unit
K5 - A/C Comp Clutch/Relay
K14 - Start Interlock Relay
K15 - Headlamp Relay
K17 - Reverse Relay
K21 - Trans Shift Clutch
K22 - Lockup Clutch
K23 - Ignition Sensed Relay
K27 - Difflock Relay
K33 - Radiator Fan Relay
K34 - Horn Relay
K40 - Radiator Fan Clutch
K47 - Intermittent Wipe Relay
K50 - Brake Lights Control Relay
K51 - Brake Pedal Ret Control Relay
K52 - Body Proximity Switch Relay
K57 - Sound Power Relay No. 1
K58 - Sound Power Relay No. 2
L3 - Reverse Alarm
L5 - Electric Horn
L6 - Reverse Camera
L7 - Reverse Camera Monitor
M1 - Starter Motor
M4 - Washer Motor, F
M5 - Wiper Motor, F
M6 - Wiper Motor, B
M7 - Washer Motor, B
M13 - Air Seat Compressor
N3 - Voltage Convertor 24V/12V
N4 - Speedo Frequency Divider Module
N5 - Brake Pedal Interface
P1 - Speedometer/Odometer
P2 - Tachometer
P3 - Coolant Temp Gauge
P4 - Fuel Gauge
P12 - Hourmeter
P15 - Trans Temp Gauge
R7 - Cigar Lighter
R10 - Rkr Switch ‘Locating’ LED
R11 - Rkr Switch ‘Function’ LED
S1 - Battery Master Switch
S2 - Starter Keyswitch
S7 - Emerg/Park Brake Switch
S9 - Washer Switch, F
S10 - Wiper Switch, F
S11 - Rear Wash/Wipe Switch
S13 - Horn Button
S14 - Hazard w/l Switch
S15 - Direction Ind Switch
S18 - Lights Switch
S19 - Dipswitch
S20 - Headlamp Flash Switch
S22 - Body Proximity Switch
S31 - Park Brake w/l Switch
S37 - Axle Difflock Swt (Unused)
S41 - Auxiliary Lights Switch
S48 - Acc Press Switch (Tractor)
S49 - Acc Press Switch (Trailer)
S57 - Steering Press Switch
S60 - Difflock Request Switch
S68 - Eng Diag/Request Switch
S69 - Accel Idle Validation Switch
S74 - Kickdown Switch
S78 - Body Lower Emergency Switch
S79 - Heated Mirror Switch
S81 - Ret/Engine Brake 1st Stage Retardation Request.
S82 - Engine Brake 2nd Stage Retardation Request.
S90 - Trans Filter Restriction Swt
X1 - Handlamp Socket
Y3 - Retarder Valve
Y4 - Emerg/Park Brake Solenoid
Y7 - Difflock Solenoid (Trans/ mid-axle)
Y24 - Exh Brake Actuation Sol
Y26 - Body Raise Solenoid
Y27 - Body Lower Solenoid
Y32 - Trans oil cooler fan solenoid
Y33 - System Hyd Unloader Valve
Y34 - System Hyd Float Valve
Y36 - Trans oil cooler fan isolation solenoid

Wire Colours

- B - Black
- N - Brown
- U - Blue
- R - Red
- G - Green
- L - Light Green
- O - Orange
- Y - Yellow
- P - Purple
- W - White
- S - Slate
- K - Pink

TERMINAL DESIGNATIONS IN ACCORDANCE WITH DIN 72 552

L - LEFT, R - RIGHT, F - FRONT, B - BACK

DIODE RESISTOR FUSE PLUG

TRAILER CONNECTION

---
<table>
<thead>
<tr>
<th>Location</th>
<th>Fuse No.</th>
<th>Circuit</th>
<th>Current Rating</th>
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</thead>
<tbody>
<tr>
<td>Main Fuse Box -</td>
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<td></td>
</tr>
<tr>
<td>Column A</td>
<td>1</td>
<td>Ignition Sensed Relay Contacts (Heater)</td>
<td>30A</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Keyswitch</td>
<td>15A</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Rear Wash/Wipe</td>
<td>10A</td>
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<tr>
<td></td>
<td>5</td>
<td>Horn Relay Coil, Front Wash/Wipe</td>
<td>10A</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Air Seat Compressor</td>
<td>10A</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Lights Supply</td>
<td>10A</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Main Beam/Flash</td>
<td>10A</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Wiper Park Front and Rear</td>
<td>7.5A</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Hazards</td>
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</tr>
<tr>
<td></td>
<td>11</td>
<td>Transmission System Ignition Supply</td>
<td>7.5A</td>
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<td></td>
<td>12</td>
<td>Reverse System</td>
<td>7.5A</td>
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<tr>
<td>Main Fuse Box -</td>
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<tr>
<td>Column B</td>
<td>13</td>
<td>Brake Lights</td>
<td>5A</td>
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<tr>
<td></td>
<td>14</td>
<td>Interior Light, Handlamp</td>
<td>5A</td>
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<td>15</td>
<td>Direction Indicators/Rocker Switch LEDs</td>
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<td>16</td>
<td>Emergency/Park Brake</td>
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<td>17</td>
<td>Warning Light Module</td>
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<td>18</td>
<td>Heated Mirrors</td>
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<td>19</td>
<td>Gauges/Ignition Sensed Relay Coils</td>
<td>3A</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Neutral Start</td>
<td>3A</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Washers, Front</td>
<td>3A</td>
</tr>
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<td></td>
<td>23</td>
<td>Washers, Rear</td>
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<td></td>
<td>24</td>
<td>Horn</td>
<td>10A</td>
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<td>Main Fuse Box -</td>
<td></td>
<td></td>
<td></td>
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<td>Column C</td>
<td>25</td>
<td>Ignition Sensed Relay Contacts (Air Conditioning)</td>
<td>30A</td>
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<tr>
<td></td>
<td>26</td>
<td>Air Cond/Heater/Ventilation System</td>
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<td>28</td>
<td>Front Working Lights</td>
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<tr>
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<td>29</td>
<td>Rear Working Lights</td>
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<td>30</td>
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<td>Auxiliary Fused Supply (Cab Manufacturers Harness)</td>
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<td></td>
<td>35</td>
<td>Brake Pedal Interface Module</td>
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<td></td>
<td>36</td>
<td>Cigar Lighter</td>
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<td>Main Fuse Box -</td>
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<tr>
<td>Column D</td>
<td>38</td>
<td>Reverse Camera Monitor Supply</td>
<td>10A</td>
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<tr>
<td></td>
<td>39</td>
<td>Reverse Camera Supply</td>
<td>10A</td>
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<tr>
<td></td>
<td>40</td>
<td>Body Proximity Switch</td>
<td>10A</td>
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<tr>
<td></td>
<td>47</td>
<td>Sound Power Legislation Relay No. 1 Supply</td>
<td>3A</td>
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<td></td>
<td>48</td>
<td>TOC8 Hydraulics Electronic Control Module Supply</td>
<td>30A</td>
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<tr>
<td>Battery Box</td>
<td>49</td>
<td>QSL ECM Battery Supply</td>
<td>7.5A</td>
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<td>50</td>
<td>QSL ECM Battery Supply</td>
<td>7.5A</td>
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<td></td>
<td>51</td>
<td>QSL ECM Ignition Sensed Supply</td>
<td>5A</td>
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<td></td>
<td>55</td>
<td>Radio/Cassette Voltage Converter Supply</td>
<td>10A</td>
</tr>
<tr>
<td>Fuse Box</td>
<td>56</td>
<td>Body Hydraulics Auxiliary/Emergency Dump Switch</td>
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<td>58</td>
<td>Spare Battery Supply</td>
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<td>59</td>
<td>Transmission Battery System Supply</td>
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<td>61</td>
<td>Alternator Charge Cable (Power Fuse - Battery Box)</td>
<td>100A</td>
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<td></td>
<td>62</td>
<td>Cab Busbar Supply Cable (Power Fuse - Battery Box)</td>
<td>100A</td>
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## RELAYS

<table>
<thead>
<tr>
<th>Location</th>
<th>Relay</th>
<th>Circuit</th>
</tr>
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<tbody>
<tr>
<td>Main Fuse Box - Column E</td>
<td>K23</td>
<td>Ignition Sensed Relay - Air Con</td>
</tr>
<tr>
<td></td>
<td>K23</td>
<td>Ignition Sensed Relay - Wipers</td>
</tr>
<tr>
<td></td>
<td>K34</td>
<td>Horn</td>
</tr>
<tr>
<td></td>
<td>K15</td>
<td>Headlamps</td>
</tr>
<tr>
<td>Main Fuse Box - Column F</td>
<td>K17</td>
<td>Reverse Alarm/Lights</td>
</tr>
<tr>
<td></td>
<td>K14</td>
<td>Neutral Start</td>
</tr>
<tr>
<td></td>
<td>K5</td>
<td>Air Conditioner Compressor</td>
</tr>
<tr>
<td></td>
<td>K51</td>
<td>Brake Pedal Retarder Control</td>
</tr>
<tr>
<td>Main Fuse Box - Column G</td>
<td>K50</td>
<td>Brake Lights Control</td>
</tr>
<tr>
<td></td>
<td>K23</td>
<td>Ignition Sensed Relay - Engine Ignition</td>
</tr>
<tr>
<td></td>
<td>K33</td>
<td>Radiator Fan</td>
</tr>
<tr>
<td></td>
<td>K4</td>
<td>Indicator Flasher Unit</td>
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<td>Main Fuse Box - Column H</td>
<td>K52</td>
<td>Body Proximity Switch</td>
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<td>K27</td>
<td>Diff-lock</td>
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<td>K23</td>
<td>Ignition Sensed Relay - Engine Ignition</td>
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<td>Below Right Hand Console</td>
<td>K47</td>
<td>Intermittent Wipe</td>
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<td>K56</td>
<td>Air Compressor Run Relay</td>
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<td>K57</td>
<td>Sound Power Legislation Relay No. 1</td>
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<td>K58</td>
<td>Sound Power Legislation Relay No. 2</td>
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</tbody>
</table>

![Fig. 1 - Main Fuse Box - Fuse/Relay Location](image1)

![Fig. 2 - Battery Box Fuse Box - Fuse Location](image2)

![Fig. 3 - Relays Below Right Hand Console](image3)
DESCRIPTION

The hydraulic electronic control unit (ECU) (Fig. 1) is a stand alone control which controls the machines hydraulic systems, including body hoist and transmission oil cooler fan drive. The IQAN-TOC8 ECU communicates with a variety of input and output devices. It utilises analog/digital inputs, proportional current outputs and digital outputs.

The ECU continuously monitors the system and warns the operator when a fault develops, and also helps diagnose the nature of the fault. ECU is located inside the cab, on the support below the right hand console (see Fig. 2).

WARNING

Before any welding is done on a machine equipped with an IQAN-TOC8 hydraulic system, disconnect the following in this order: Battery earth cable, battery supply cable, alternator earth cables, alternator supply cables and electrical connections at the engine ECM, transmission ECU, body control lever, hydraulics ECU and cab bulkhead to avoid damage to electrical components. Turn off battery master switch to isolate the batteries before disconnecting any components.

After welding connect all of the above in the reverse order.

ECU Inputs

Refer to Figs. 3 & 4 and Section 190-0000, CIRCUIT DIAGRAMS.

Ignition Switch - connected to the starter keyswitch, rendering the circuit energised or de-energised.

Starter Motor Relay - when starter motor relay is activated, a digital signal is fed to the ECU.

Body Control Lever - three position lever sends analog signals to ECU.

Transmission Cooler Fan Drive Temperature Sensor - sensor at transmission sends analog signal to ECU.
**Body Up Proximity Switch** - sends a digital signal to ECU depending on position of body.

**Body Lower Emergency Switch** - located in the cab, the switch sends a digital signal to ECU when pressed. This is used to lower the body in the event of system failure.

**ECU Outputs**

**Cold Start Solenoid** - when ECU receives input from starter motor relay, the ECU sends an output signal to activate cold start solenoid. This prevents the engine starting under hydraulic load.

**Body Raise/Lower** - when ECU receives signals from body control lever, ECU sends output signals to the raise and lower proportional control valves to shift the main control valve spool accordingly. Typical output from ECU is 250 - 800 mA, providing a delivery pressure between 4 - 25 bar (58 - 363 lbf/in²) at main control valve spool. For raise proportional control valve, measure current output across pins 17 and 18 on ECU. For lower proportional control valve, measure across pins 31 and 32.

**Transmission Oil Cooler Fan Drive Proportional Solenoid** - the transmission cooler fan drive temperature sensor feeds back to the ECU, which outputs a signal to the fan drive proportional solenoid (typically 150 - 210 mA measured across pins 19 and 20, resulting in a delivery between 38 - 83 bar (551 - 1204 lbf/in²)). This causes the fan speed to increase proportionally. Refer to Section 215-0050, MAIN HYDRAULIC VALVE ASSEMBLY.

**Transmission Oil Cooler Fan Drive Isolation Solenoid** - the transmission cooler fan drive temperature sensor feeds back to the ECU, which outputs a signal to the fan drive isolation solenoid. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

**Body-Up Warning Light** - the body-up proximity switch sends a signal to the ECU, and depending on the body position, the ECU sends a signal to illuminate the warning light in the cab.

**Body Float Solenoid** - the body lower emergency switch sends a signal to the ECU, which outputs a signal to energise body float solenoid. This ensures...
that the hoist side of the body cylinders are vented to tank, allowing body to lower onto chassis under its own weight.

The body float solenoid is always energised when the body-up proximity switch is made. This prevents the body being powered down onto the chassis. Also prevents pressure being trapped in the hoist side of cylinders when travelling, ensuring body is resting on the chassis. If body is not resting on the chassis when travelling, hinge points and cylinders may be damaged, especially when body is laden.

Check the body float solenoid across pin 23 on ECU and vehicle ground. Solenoid is rated at 15 W, 0.6 A, 42 ohms.

**Body Control Lever Detent** - when the body control lever is pushed fully forward to power down the body, the ECU energises a detent solenoid within the lever to hold the lever fully forward. This continues until the body-up proximity switch is made, when the ECU de-
energises the detent solenoid so that the lever returns to the neutral position, and the body float solenoid is energised (see Body Float Solenoid).

2nd Gear Restriction - when the body-up proximity switch is broken, the ECU sends a signal to the transmission ECU to restrict the transmission to second forward gear. When the body-up proximity switch is made i.e. body is lowered, full gear range is available.

System Safety

Input/Output Protection - all inputs to the ECU are designed to withstand the maximum specified supply voltage. The outputs are protected against short circuit. Additionally, an error on one input/output will not influence other inputs/outputs. External fuse (10A), located in the battery box, will blow if supply exceeds 35 V.

Current Check - for the current outputs, a current check is performed. The ECU compares the return current with the output’s set-value. If current deviation occurs, the user will be notified through an appropriate error code on the unit's LED.

If the ECU detects a short circuit to battery supply, the unit will shut off the outputs in order to increase safety.

Memory Test - the ECU will perform a self test during operation to verify the software. The test includes a processor and memory verification, and an internal signal verification. If any software error is detected, appropriate precautions will be taken.

System Diagnosis

Refer to Figs. 2 & 5.

The two LEDs on the ECU are used to diagnose basic system errors. The ECU indicates error status through the red blinking LED as shown in Fig. 5, giving an immediate diagnosis as to the nature of the error that has occurred.

If there are no errors, the bottom LED flashes yellow to indicate normal status. Some errors will cause the ECU to stop operating or at least shut down the outputs to increase safety. The green LED indicates power on.

⚠️ WARNING

Do not use the machine if an error code is present. Shutdown the machine until the problem is resolved.

Refer to table of error codes for corrective action. The ECU has a RS232 interface below the right hand console which plugs directly into a laptop. This allows communication with the ECU using IQANdevelop software, and gain more information about the ECU’s status.
## Error Codes, Messages and Actions

<table>
<thead>
<tr>
<th>Situation</th>
<th>Error Code</th>
<th>Action ECU</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ERROR: OUTPUT HIGH</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COUT: Current return low or high</td>
<td>Error 1</td>
<td>Active output shuts off</td>
<td>Check wiring and loads</td>
</tr>
<tr>
<td>COUT: Both directions commanded</td>
<td>Error 1</td>
<td>Active output shuts off</td>
<td>Check application</td>
</tr>
<tr>
<td>DOUT: Overload</td>
<td>Error 1</td>
<td>Active output shuts off</td>
<td>Check load</td>
</tr>
<tr>
<td>PWMOUT: Both directions commanded</td>
<td>Error 1</td>
<td>Active output shuts off</td>
<td>Check application</td>
</tr>
<tr>
<td>COUT/DOUT: Internal driver failure</td>
<td>Error 6</td>
<td>Active output shuts off</td>
<td>Replace ECU</td>
</tr>
<tr>
<td><strong>ERROR: INPUT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIN: &gt; specified max or &lt; specified min</td>
<td>Error 2</td>
<td>Active input goes to error value</td>
<td>Check wiring and sensors</td>
</tr>
<tr>
<td><strong>ERROR: VREF</strong></td>
<td>Error 3</td>
<td>-</td>
<td>Check voltage, replace ECU</td>
</tr>
<tr>
<td>VREF_ &lt; 4.9 V</td>
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<td></td>
</tr>
<tr>
<td>VREF_ &gt; 5.1 V</td>
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</tr>
<tr>
<td><strong>LOW/HIGH SUPPLY VOLTAGE</strong></td>
<td>Error 4</td>
<td>-</td>
<td>Check voltage supply</td>
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<tr>
<td>+BAT &lt; 8.5 V</td>
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<td>+BAT &gt; 34 V</td>
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<td>Check voltage supply</td>
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<tr>
<td><strong>HIGH TEMPERATURE</strong></td>
<td>Error 5</td>
<td>-</td>
<td>Check ambient temperature, allow ECU to cool</td>
</tr>
<tr>
<td>Internal temperature &gt; max temp</td>
<td>Error 5</td>
<td>-</td>
<td>Replace ECU</td>
</tr>
<tr>
<td>Internal temperature sensor error</td>
<td>Error 6</td>
<td>-</td>
<td>Replace ECU</td>
</tr>
<tr>
<td><strong>ERROR: PARAMETER</strong></td>
<td>Error 5</td>
<td>No calibration of signals</td>
<td>Replace ECU</td>
</tr>
<tr>
<td><strong>ERROR: SOFTWARE</strong></td>
<td>Error 6</td>
<td>Unit stops operating</td>
<td>Replace ECU</td>
</tr>
</tbody>
</table>
Electrical System - Hydraulic System ECU

Section 190-0085

REMOVAL

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

High electrical current can cause sparks and personal injury from burns. Turn battery master switch to the ‘Off’ position before removing any components. Remove battery ground cable first, and reconnect last, to avoid damaging electrical components.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering circuit.

2. Operate the treadle valve continuously to discharge the accumulators, block all road wheels, place the steering lock bar in the ‘Locked’ position and the battery master switch in the ‘Off’ position.

3. Disconnect the battery ground cable first, then the battery supply cable, before disconnecting harness from IQAN-TOC8 ECU inside cab.

4. Remove bolts securing ECU to support below the right hand console, and remove ECU.

INSTALLATION

1. Secure ECU to support below the right hand console using bolts removed previously.

2. Firstly connect harness to ECU, then connect battery supply cable and battery ground cable in that order.

3. Turn master switch on, start engine and ensure that the top LED is green which indicates voltage is being supplied, and that the bottom LED flashes yellow, indicating normal status.

4. Remove wheel blocks from all road wheels.

SPECIAL TOOLS

There are no special tools required for procedures outlined in this section. To obtain IQANdevelop diagnostic software, contact your dealer.

* * * *
DESCRIPTION
Numbers in parentheses refer to Fig. 1, unless otherwise specified.

This section describes the location and function of various switches and sensors fitted to the vehicle to monitor all major components and systems. Gauges and warning lights located in the dash panel, relay this information to the operator.

Note: Always make sure all gauges, warning lights and controls are working properly before operating the vehicle.

Engine
The Quantum engine management system monitors the engine at all times and sends a signal to the engine check light (16, Fig. 2) and engine stop light (17, Fig. 2) on the dash panel to alert the operator of a fault in the engine circuit. Refer to Section 110-0030, ENGINE AND MOUNTING.

Engine Coolant Temperature Sender (1) - Located in the right hand side of the engine. Sends a signal indicating engine coolant temperature to engine coolant temperature gauge (3, Fig. 2).

Engine Coolant Level Sensor (2) - Located in the radiator header tank, the sensor sends a signal to engine coolant level warning light (26, Fig. 2) indicating that engine coolant level is low.

Engine Coolant Temperature Gauge (3, Fig. 2) - Indicates the engine coolant temperature. The gauge should read between 70° C and 100° C after the engine has warmed. If the gauge reads above this, stop engine and investigate the cause.
**Tachometer (6, Fig. 2)** - Driven from the engine ECU, the tachometer indicates the number of engine crankshaft revolutions per minute. The needle shows the variations in engine operating speed. Never accelerate the engine to speeds indicated by the red zone on the dial face.

**Tachometer Calibration**
1. Ensure all three encoding switches at the back of the tachometer are OFF.

2. To verify calibration, a stroboscope can be used to compare engine speed with tachometer reading. If necessary, the tachometer can be fine-tuned using adjustment screw (see Fig. 3).

**Hourmeter (2, Fig. 2)** - Driven from the engine alternator, the hourmeter records the total number of engine hours.

**Starter Relay (4)** - Mounted on the tractor frame rail, the starter relay powers up the starter motor when the keyswitch is turned.
Transmission
Refer to Section 120-0010, TRANSMISSION AND MOUNTING, for further information on switches and sensors fitted to the transmission.

Speedometer/Hourmeter (1, Fig. 2) - Driven by a signal from the transmission ECU, the speedometer indicates travel speed in kilometres per hour and miles per hour. A digital hourmeter is incorporated in the speedometer to record total hours of engine operation.

Speedometer Calibration
1. Determine the impulse setting required. Reference speedometer calibration table.
2. Depress and hold calibration button at the back of the speedometer (see Fig. 4) with a suitable screwdriver and turn the ignition keyswitch to position '1'. Release button when PULSE is displayed.
3. After a few seconds, the digits will flash in sequence. Depress the button until the desired number is displayed then release the button for a few seconds until the next digit flashes.
4. Repeat step 3 to obtain the desired impulses/revolution. The speedometer is now calibrated.

Transmission Oil Temperature Sender (6) - The sender, located on the elbow at the retarder housing, sends a signal to indicate transmission oil temperature on the transmission oil gauge in the cab (4, Fig. 2).

Transmission Oil Cooler Fan Temperature Sensor (7) - Located in the retarder housing, the sensor sends a signal to the hydraulics ECU to operate the transmission oil cooler fan drive at a speed proportional to transmission oil temperature.

Retarder Oil Temperature Sensor (8) - The temperature sensor is located at the retarder housing and records both the retarder and converter oil temperature, which is supplied to the transmission ECU.

Transmission Oil Filter Restriction Switch (15) - Located on the filter head, this sends a signal to the transmission ECU when the filter becomes restricted. This in turn sends a signal, triggering a fault code 'BA' on the cab mounted display.

Braking System
Rear Brake Pressure Switch (9) - The normally closed (NC) pressure switch, located in port ACC2S of the main hydraulic valve, senses the pressure in the rear brake circuit. The pressure switch sends a signal to illuminate 'Red' rear brake accumulator pressure warning light (20, Fig. 2) when pressure drops to 122 bar (1769 lbf/in²). An audible buzzer also sounds.

Front Brake Pressure Switch (10) - The normally closed (NC) pressure switch, located in port ACC1S of the main hydraulic valve, senses the pressure in the front brake circuit. The pressure switch sends a signal to illuminate 'Red' front brake accumulator pressure warning light (19, Fig. 2) when pressure drops to 122 bar (1769 lbf/in²). An audible buzzer also sounds.

Parking Brake Pressure Switch (11) - The normally closed (NC) pressure switch, located in port PBS of the main hydraulic valve, senses pressure in the parking brake circuit. The pressure switch closes at a pressure of 5 bar (70 lbf/in²) and sends a signal to illuminate 'Green' parking brake indicator light (28, Fig. 2), indicating that the parking brake is applied.
Electrical System - Switches and Sensors

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Steering System

Steering System Pressure Switch (12) - The normally closed (NC) pressure switch is located in port P1S of the main hydraulic valve. The pressure switch closes and sends a signal to illuminate 'Red' emergency steering warning light (22, Fig. 2) when steering pressure drops to 5 bar (70 lbf/in²) or lower. An audible buzzer also sounds.

Hydraulic System

Hydraulic Filter Restriction Gauge (14) - The hydraulic filter restriction gauge is located on top of hydraulic tank. After 1 000 hours or when the needle moves into the red zone, whichever comes first, the hydraulic filter should be changed.

Air Cleaner

Air Cleaner Restriction Gauge (5) - Mounted on the air cleaner, the restriction gauge indicates the degree of air cleaner element restriction as the red panel rises in the gauge window. The filter element(s) should be replaced if the red band locks in place when the engine is shut down. Reset the gauge by pressing the button on the gauge with the engine running.

Fuel Tank

Fuel Level Sender (3) - Located at the rear of the fuel tank, the fuel level sender sends a signal to fuel level gauge (5, Fig. 2) to indicate the amount of fuel left in the tank.

Body

Body Up Proximity Switch (13) - Mounted off the inside of the trailer left hand frame rail. When the body is raised off the trailer frame, the switch sends a signal to illuminate body up warning light (9, Fig. 2).

Note: Never move the vehicle until body up warning light (9, Fig. 2) goes out, indicating that the body is fully lowered onto the trailer frame.

Note: The proximity switch prevents the body being fully powered down onto the frame. When the proximity switch makes contact, the body control lever detent is de-energised and float solenoid at main hydraulic valve is energised.

* * * *
FUEL SYSTEM - Fuel System

Section 200-0040

DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The fuel system consists of the Quantum Celect Plus electronic fuel system controls, fuel filter (12), fuel pump (19), ECM cooling plate (14), electronic unit injectors (15), fuel tank (1) and the necessary connecting fuel lines.

The fuel filter (12) is mounted inside the battery box, alongside the oil filter.

Fuel pump (19) is attached to a drive assembly mounted on the rear side of the gear case at the front LH side of the engine and transfers fuel from fuel tank (1), via fuel filter (12), to the electronic unit injectors (15).

The electronic unit injector (15) is a lightweight, compact unit that injects diesel fuel directly into the combustion chamber. The amount of fuel injected and the beginning of injection timing is determined by the electronic control module (ECM). The ECM sends a command pulse which activates the injector solenoid.

The EUI (15) performs four functions:

a - Creates the high fuel pressure required for efficient injection.
b - Meters and injects the exact amount of fuel required to handle the load.
c - Atomizes the fuel for mixing with the air in the combustion chamber.
d - Permits continuous fuel flow for component cooling.

Fig. 1 - Fuel Lines and Components
Electronic unit injectors are self compensating and virtually eliminate engine tune-ups.

Note: Never apply 12 V directly to terminals on the injector as it will burn out. Before removing injectors, the fuel passages must be blown out to prevent fuel flow from entering the cylinder head.

ECM cooling plate (14) is mounted behind the ECM on the LH side of the engine and absorbs heat generated by the ECM. Fuel from fuel pump (19) outlet line flows through ECM cooling plate (14) to absorb this heat.

Flexible fuel lines (10, 11 & 13) are used to facilitate connection of lines leading to and from fuel tank (1), and to minimize the effects of any vibration in the installation.

When installing fuel lines, it is recommended that connections be tightened only sufficiently to prevent leakage of fuel; thus flared ends of the fuel lines will not become twisted or fractured because of excessive tightening.

A fuel tank breather/filter assembly is incorporated into the fuel filler cap (17), allowing fuel tank (1) to vent to atmosphere, preventing pressure from building up within fuel tank (1) assembly.

OPERATION

Numbers in parentheses refer to Fig. 1.

Fuel is drawn from fuel tank (1) through fuel filter (12) and enters fuel pump (19). Leaving fuel pump (19) under pressure, the fuel flows through ECM cooling plate (14) to the engine cylinder head. The fuel flows to electronic unit injectors (15) in the cylinder head through passages integral with the cylinder head. Surplus fuel exits the cylinder head and back to fuel tank (1) through fuel line (10).
REMOVAL

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.
2. Block all road wheels and place the battery master switch in the 'Off' position.
3. Pull on handle to release hood catch mechanism and raise hood.
4. Remove transmission oil cooler from vehicle. Refer to Section 210-0060, TRANSMISSION OIL COOLER.
5. Remove padlock (13) and remove filler cap (2) from fuel tank (1).
6. Remove fuel strainer (4) from fuel tank (1) and clean with clean diesel fuel.
7. With a suitable container in position, remove drain plug from fuel tank (1) and drain fuel from fuel tank (1). Reinstall drain plug and tighten securely when fuel tank (1) is completely drained.
8. Identify and tag fuel lines (10, 11 & 13, Fig. 1) and, with a suitable container available to catch leakage, disconnect fuel lines (10, 11 & 13, Fig. 1). Cap open line ends and adaptors to prevent entry of dirt.
9. Remove hose clamp mounting plate from inside face of fuel tank (1) assembly.
10. Remove bolts (11) and washers (12) securing fuel sender guard (10) to fuel tank (1). Remove fuel sender guard (10). Disconnect electrical harness from fuel sender.
11. Using suitable lifting equipment, support fuel tank (1) assembly. Ensure fender is adequately supported. Remove fasteners securing fender to fuel tank (1) assembly.
12. Remove nuts (18), bolts (16), hardened washers (17) and shims (19 - 23) securing fuel tank (1) assembly to the front frame rail.
13. Remove nuts (18), bolts (15), hardened washers (17) and shims (19 - 23) securing fuel tank (1) assembly to the front frame bumper. Using a suitable lifting device, remove fuel tank (1) assembly from the vehicle.

DISASSEMBLY

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

1. Remove bolts (7) securing step plate (5) to fuel tank (1).
2. Remove bolts (8) and washers (9) securing step assembly (6) to fuel tank (1).
3. Remove grab handles from fuel tank (1).
3. Remove screws and washers securing fuel sender to fuel tank (1). Remove fuel sender.

ASSEMBLY

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

1. Install fuel sender to tank (1) using screws and washers.
2. Install grab handles to fuel tank (1).
3. Install step assembly (6) to fuel tank (1) and secure using bolts (8) and washers (9).
4. Install step plate (5) to fuel tank (1) and secure using bolts (7).

INSTALLATION

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

Note: Tighten all fasteners to standard torques specified in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Using suitable lifting equipment, position fuel tank...
Fuel System - Fuel System

Section 200-0040

1. Assembly to the front frame.

2. Secure the front of fuel tank (1) assembly to the front frame bumper with bolts (15), hardened washers (17), shims (19 - 23) and nuts (18). Use shims (19 - 23) as necessary to improve transverse alignment of fuel tank (1) assembly.

3. Secure the inside of fuel tank (1) assembly to the front frame rail with bolts (16), hardened washers (17), shims (19 - 23) and nuts (18). Use shims (19 - 23) as necessary to improve longitudinal alignment of fuel tank (1) assembly.

4. Secure fender to fuel tank (1) assembly using fasteners previously removed.

5. Reconnect electrical harness to fuel sender. Fit fuel sender guard (10) using bolts (11) and washers (12).

6. Refit hose clamp mounting plate to inside face of fuel tank (1) assembly.

7. Remove blanking caps and secure fuel lines (10, 11 & 13, Fig. 1) to adaptors, as identified at removal.

8. Install fuel strainer (4) in fuel tank (1).

9. Fill fuel tank (1) assembly with clean diesel fuel specified in Section 300-0020, LUBRICATION SYSTEM.

10. Install filler cap (2) assembly on fuel tank filler neck. Tighten filler cap (2) securely and secure in place with padlock (13).

11. Install transmission oil cooler to vehicle. Refer to Section 210-0060, TRANSMISSION OIL COOLER.

12. Place the battery master switch in the 'On' position, start the engine and run for a few minutes to ensure fuel is being supplied to the engine. Check for leaks at fuel lines (10, 11 & 13, Fig. 1) and tighten if required.

13. Remove wheel blocks from all road wheels.

MAINTENANCE

Numbers in parentheses refer to Fig. 1.

WARNINGs

To prevent personal injury and property damage, be sure wheel blocks and blocking materials are properly secured and of adequate capacity to do the job safely.

To prevent personal injury or even death, welding of the fuel tank is strictly prohibited at all times, due to the hazardous flammable liquids and vapours present inside the tank, even when empty.

General

Refill fuel tank (1) at the end of each day's operation to prevent condensation from contaminating the fuel. When filling fuel tank (1), check that there is no buildup of dirt and sludge at fuel strainer (4, Fig. 2) and filler cap (2, Fig. 2). Remove and clean fuel strainer and filler cap as required.

Every 10 Hours/Daily:

Make a visual check for fuel leaks at all engine mounted fuel lines, connections and at the fuel tank suction and return lines. Examine lines for leaks and check all fittings, clamps and ties carefully.

Make sure that fuel lines are not resting on or touching rotating components, heated surfaces including exhaust manifolds or sharp edges. If fittings have loosened or cracked, or if lines have ruptured or worn through, take corrective action immediately.

From time to time, remove fuel sender guard and check condition of electrical connections at fuel level sender.

Fuel Filter/Water Separator (12) - Drain the water and sediment from the separator daily.

Position the vehicle on a level work area, apply the parking brake, shut off the engine and, with a suitable container below the drain valve to catch spillage, open the drain valve by hand. Turn the valve anticlockwise approximately 1.5 to 2 turns until draining occurs. Drain the filter sump until clear fuel is visible. Turn the valve clockwise to close the drain valve.

Note: Do not overtighten the drain valve as overtightening can damage the threads.
Every 500 Hours:
Check condition of filler cap (2, Fig. 2) and clean fuel strainer (4, Fig. 2) and filler cap with clean fuel.

Every 1 000 Hours:
Fuel Filter/Water Separator (12) - Clean the area around the filter head and replace the fuel filter/water separator.

Position the vehicle on a level work area, apply the parking brake and switch off the engine. Using a strap type filter wrench, remove the fuel filter/water separator and discard the thread adaptor sealing ring. Clean the gasket surface of the filter head.

Install the new thread adaptor sealing ring (supplied with new filter) and apply a film of clean engine oil to lubricate the filter seal. Fill the new fuel filter/water separator with clean fuel specified in Section 300-0020, LUBRICATION SYSTEM.

Install new fuel filter/water separator on the filter head and tighten by hand until the gasket contacts the filter head surface. Tighten fuel filter/water separator per filter manufacturer's instructions.

Note: Mechanical tightening of the filter is not recommended and may result in seal and/or cartridge damage. Tighten filter by hand only.

Fuel Filler Cap
Remove filler cap (2, Fig. 2) from filler neck. With the handle in the up and rotated position, remove the two screws securing the filter assembly (3, Fig. 2) to the cap. Discard 'O' rings. Clean top of filler cap and valve cavity. Install new filter assembly to filler cap using new screws and 'O' rings (supplied with new filter). Tighten screws to 10 - 13 in lbs.

Diesel Fuel Oil
The sulphur content of diesel fuel oil should be as low as possible to avoid premature wear of piston rings and line, excessive deposit formation, and minimise sulphur dioxide exhausted into the atmosphere. Limited amounts can be tolerated, but the amount of sulphur in the fuel and engine operating conditions can influence corrosion and deposit formation tendencies. The use of diesel fuel oil with a MAXIMUM sulphur content of 0.5% is recommended for use. Refer to Section 300-0020, LUBRICATION SYSTEM.

TROUBLESHOOTING
Locating Air Leaks in Fuel Lines
Air drawn into the fuel system may result in uneven running of the engine, black or white smoking and stalling when idling, or a loss of power. Poor operation is particularly noticeable at lower engine speeds. If air is found in the fuel, the source will normally be between the fuel tank and the fuel pump.

Check for loose, faulty or improper fuel line connectors. Presence of an air leak may be detected by following the procedures under 'Checking Fuel Flow'.

Checking Fuel Flow
1. Disconnect the fuel return line from the fitting at the fuel tank and hold the open end in a suitable container.

2. Start and run the engine at maximum rev/min and immerse the end of the fuel return line in the fuel. Air bubbles rising to the surface of the fuel will indicate air being drawn into the fuel system on the suction side of the pump. If air is present, tighten all fuel lines connections between the fuel tank and fuel pump.

3. If the fuel flow is insufficient for satisfactory engine performance then proceed as follows:
   a. Replace the fuel filter/water separator, as described under 'Maintenance'. Start the engine and run it at maximum rev/min and recheck for the presence of air. If fuel flow is still unsatisfactory, perform step 'b'.
   b. Check the fuel lines for restrictions due to pinching, kinking or other damage. If no problem is found, substitute another fuel pump that is known to be operating correctly and recheck the fuel flow. When changing the fuel pump, inspect the fuel pump drive. Clean all fuel lines with compressed air and be sure all fuel connections are tight.
   c. Disconnect the fuel lines from the ECM cooling plate and, using a suitable connector, connect the two fuel lines, bypassing the cooling plate. Run the engine at maximum rev/min and recheck the fuel flow. If the fuel flow with the cooling plate bypassed is normal, the cooling plate should be replaced.
SPECIAL TOOLS
There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

The electronic foot pedal assembly provides an electrical signal to the engine's fuel control system in proportion to the degree of pedal actuation. Maximum and minimum stops are built into the pedal assembly during manufacture. The pedal assembly comes preset and therefore no adjustment is necessary.

The pedal incorporates an idle validation switch which informs the engine ECM that the pedal is in the idle position. Kickdown switch, which can be used when automatic range is selected, allows for the possibility of selecting a lower gear by pressing down fully on pedal (2) and holding (see Fig. 2). This can be used to provide a downshift on demand provided that the vehicle speed is within the range allowable. That is, the vehicle is not travelling at a speed that would result in the engine overspeeding in the lower gear. To disengage the transmission kickdown, release the pedal (2) and allow it to return to a light throttle position. Refer to Section 120-0010, TRANSMISSION AND MOUNTING.

REMOVAL
Numbers in parentheses refer to Fig. 1.

⚠️ WARNING
To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine.

2. Block all road wheels and place the battery master switch in the 'Off' position.

3. Disconnect electrical harness (1) from dash harness.

4. Remove bolts (5) and washers (6) securing pedal assembly to cab wall. Remove pedal assembly.
INSTALLATION
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Position pedal assembly on cab wall and secure with bolts (5) and washers (6). Ensure that pedal assembly (1) is free to operate.

2. Connect electrical harness (1) to dash harness. Pedal must be calibrated before the machine is operated. See 'Pedal Calibration'.

3. Place the battery master switch in the 'On' position, remove wheel blocks and start the engine. Ensure that pedal (2) assembly operates correctly.

Note: The engine should be started with the foot 'OFF' pedal (2) assembly.

PEDAL CALIBRATION
The pedal calibration must be checked if the harness is disconnected or the pedal replaced. Using Cummins INSITE diagnostic reader, the pedal can be checked as follows:

1. With engine off, turn keyswitch to position ‘1’, and connect diagnostic reader.

   Note: With the pedal at idle position, the diagnostic reader should show 0%.

   3. Press pedal fully to full throttle position (before kickdown, ref. Fig. 2) and release three times.

      Note: The diagnostic reader should show 100% at full throttle position.

   4. If these figures are achieved, the pedal is correctly calibrated. Turn keyswitch off and remove diagnostic reader.

   5. If figures are not realised, the pedal will have to be re-calibrated. This can only be done by authorised Cummins personnel. Please contact your local Cummins dealer.

TROUBLESHOOTING
The pedal can be checked by measuring the voltage signal across the pedal harness.

Voltage Ref: Measure voltage across red and black wires - reading should be 5V.

Pedal at Idle: Measure voltage across white and black wires - reading should be less than 0.8V.

Pedal at Full Throttle: Measure voltage across white and black wires - reading should be greater than 3.1V.

MAINTENANCE
Limited repair of the electronic foot pedal assembly is by replacement of parts only. Refer to vehicle Parts Book for part numbers.

SPECIAL TOOLS
Refer to Section 300-0070, SERVICE TOOLS, for part numbers of Cummins engine INSITE diagnostic tools which can be used to check pedal calibration. These tools are available from your dealer.

*     *     *     *
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

A radiator and fan cooling system is used on the Quantum engines installed in these vehicles. This system has a centrifugal type water pump (3) to circulate coolant throughout the system. A full blocking type thermostat located in thermostat housing (7), attached to the right hand side of the cylinder head, controls the flow of coolant.

The main components of the cooling system are: header tank (1), radiator assembly (2), engine water pump (3), DCA4 coolant filter (4), engine oil cooler (6) and thermostat housing (7).

OPERATION
Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Upon starting a cold engine or when the coolant is below operating temperature, the coolant is restricted at thermostat housing (7) and bypass line provides water circulation within the engine during the warm-up period.
Cooling System - Cooling System

Section 210-0000

**Note:** Engine coolant thermostats start to open at 82° C (180° F) and are fully open at 93° C (199° F).

Engine water pump (3) draws coolant from the radiator through radiator outlet pipe (9). Engine water pump (3) then pumps coolant through engine oil cooler (6) and engine block and passes up through the cylinder head to thermostat housing (7).

When the coolant reaches operating temperature, the thermostats open allowing coolant to flow into the radiator through radiator inlet pipe (10). The coolant passes through a series of tubes in radiator assembly (2) core, where the coolant temperature is lowered by the air stream created by the revolving fan, and into radiator outlet pipe (9) to be re-circulated back through the system.

Aerated coolant is drawn off to header tank (1) from the radiator and engine through deaeration lines (11, 12 & 13).

The use of antifreeze is mandatory with the cooling system. Refer to 'Recommended Coolants'. The lack of coolant flow through the radiator with the thermostats closed allows the coolant in radiator assembly (2) to freeze under low ambient temperature conditions.

**Coolant Filter**

The cooling system is protected by a replaceable spin-on type coolant filter (4) mounted on the left hand side of the engine. The filter provides mechanical filtration by means of a closely packed element through which the coolant passes. Any impurities such as sand and rust particles suspended in the cooling system will be removed by the straining action of the element. The removal of these impurities will contribute to longer engine water pump (3) life and proper operation of the thermostats.

Coolant flows from the engine block (3) through filter inlet line (15) and into coolant filter (4). Coolant flows through the filter element and exits through filter outlet line (14) and back into the engine block. Shut-off cocks on both filter lines allow coolant filter (4) to be replaced with the minimum loss of coolant.

**Air-To-Air Charge Cooling**

Numbers in parentheses refer to Fig. 2.

In the air system used on the Quantum engines, outside air is drawn into the engine through the air cleaner, passes through the air filter element and is pulled into the turbocharger where it is compressed. It then exits the turbocharger through inlet pipe (2) and enters air-to-air charge cooler (1). The hot air travels through a series of tubes in air-to-air charge cooler (1) core, where the air temperature is lowered. From here the air flows through outlet pipe (3) and into the engine intake manifold through inlet pipe (4). From the engine intake manifold the air travels into the cylinders where it mixes with atomized fuel from the injectors. This cooler air aids combustion, thereby increasing fuel economy.

**PREVENTIVE MAINTENANCE**

To ensure the continued efficient functioning of the cooling system, certain checks and operations should be performed at regular intervals.

**WARNING**

Do not remove the pressure control cap from the radiator header tank or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. Remove cap slowly as the sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.
Every 10 Hours (Daily)
Check coolant level and add recommended coolant if low. Fill the radiator header tank with coolant until coolant reaches the bottom of the filler neck and holds at that level.

**Note:** Any time a significant amount of coolant is added, the DCA4 coolant concentration MUST be checked. Failure to use recommended coolant and to maintain mixture at sufficient concentration levels can result in damage to the cooling system and its related components. Always maintain concentrations at recommended levels. Refer to 'Recommended Coolants'.

Check cooling fan for cracks and damage. Check fan mounting and tighten if required. Replace cooling fan if damaged.

Check coolant lines, pipes and components for leaks and wear. Check drive belts for damage.

**Every 250 Hours**
Inspect the radiator and air-to-air charge cooler fins and, if necessary, clean with a quality grease solvent such as mineral spirits and dry with compressed air.

**Note:** Fuel oil, kerosene or gasoline should not be used to clean fins.

**Note:** It may be necessary to clean radiator and air-to-air charge cooler fins more frequently if the vehicle is being operated in extremely dusty or dirty areas.

| **WARNING** |
| To prevent possible injury when using compressed air, wear adequate eye protection and do not exceed 2.75 bar (40 lbf/in²).

Every 500 Hours
Check and replenish the DCA4 concentrations as described under 'Coolant Recommendations' in this section.

The DCA4 coolant filter must be replaced. When testing the DCA4 concentration, the level of DCA4 determines which coolant should be installed. Refer to instructions under 'Coolant Recommendations' in this section.

**Note:** Under concentration of DCA4 coolant additive can result in liner pitting and system corrosion. Over concentration can result in water pump seal leakage. Always maintain DCA4 concentration at recommended levels.

**Note:** There is a shut off valve at the coolant inlet and outlet lines of coolant filter. Closing these valves will enable coolant filter to be replaced without an excessive loss of coolant.

**WARNING**
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50° C (120° F) before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

1. Remove the cooling system pressure cap from header tank.
2. Close shut off valves at coolant filter inlet and outlet lines and, using filter wrench, remove and discard coolant filter from engine.

3. Clean the filter adaptor with a clean, lint free cloth.

4. Lightly coat new coolant filter seal with clean engine oil as specified in Section 300-0020, LUBRICATION SYSTEM.

5. Start coolant filter on the filter adaptor and tighten it by hand until the seal touches the adaptor filter head. Tighten an additional 1/2 to 3/4 of a turn after contact, or as specified by the filter manufacturer.

**Note:** Mechanical tightening of coolant filter is not necessary and will distort or crack the adaptor. Tighten coolant filter by hand only.

6. Open shut off valves at coolant filter inlet and outlet lines, and install pressure cap on header tank.

7. Start the engine and check for leaks. If any leaks are noted, have them corrected. Add recommended coolant as required.

**Note:** Any time a significant amount of coolant is added, the coolant concentration MUST be checked.
Every 4,000 Hours (or two years)

Whichever interval arrives first: Drain and flush the cooling system as described under ‘Cleaning the Cooling System’ in this section. Fill the cooling system with the correct mixture of antifreeze, water and DCA4 liquid as described under ‘Coolant Recommendations’ in this section.

Cleaning The Cooling System

**WARNING**
Do not remove the pressure control cap from the radiator header tank or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. Remove cap slowly as the sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.

**Note:** It is recommended to use a cleaner such as Fleetguard RESTORE, or equivalent, when cleaning the cooling system.

1. Drain the cooling system. Do not allow the cooling system to dry out or remove the DCA4 coolant filter.

2. Add 3.8 litres (1 US gal) of cleaner for each 38 - 57 litres (10 - 15 US gal) of cooling system capacity, and fill the system with clean water.

**Note:** Fleetguard RESTORE contains no antifreeze and the cooling system should not be allowed to freeze during the cleaning operation.

3. Slide the heater temperature control to high to allow maximum coolant flow through the heater core. The blower switch does not have to be on.

4. Operate the engine at normal operating temperature, at least 85° C (185° F) for 1 - 1.5 hours.

**WARNING**
Do not remove the filler cap from the radiator header tank or attempt to drain the coolant until the engine has cooled to below 50° C (120° F).

5. Shut off the engine and drain the cooling system.

6. Fill the cooling system with clean water and operate the engine at high idle for 5 minutes with the coolant temperature above 85° C (185° F).

7. Shut off the engine and drain the cooling system.

**Note:** If the water being drained is still dirty, the system must be flushed again until the water is clean.

8. Refill the cooling system with the proper mix of coolant and water and install new DCA4 coolant filter. Refer to instructions under ‘Recommended Coolants’.

9. Install filler cap on the radiator header tank, operate the engine and check for coolant leaks.

**RECOMMENDED COOLANTS**

**WARNING**
Hazardous substance. To prevent personal injury, wear appropriate personal protective equipment when there is a risk of contact or inhalation of fumes. Always work in a well-ventilated area.

**WARNING**
If substance gets into your eyes, immediately flush eyes gently with water for at least 15 minutes. Seek immediate medical attention.

If substance contacts skin, immediately flush with water for at least 15 minutes. Remove contaminated clothing. Wash affected area with soap and water and seek immediate medical attention.

If substance is swallowed or inhaled, seek immediate medical attention.

Heavy duty diesel engines installed in these vehicles require a heavy duty coolant for optimum performance. Heavy duty coolant is defined as a correct mixture of good quality water, low silicate antifreeze and supplemental coolant additives (SCA’s).

Water quality is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

It is recommended to use a low silicate antifreeze concentrate that meets ASTM D4985 specifications (less than 0.1% silicate). Low silicate antifreeze must
be mixed with quality water at a 50/50 ratio (40 to 60% working range). A 50/50 mixture of antifreeze and water gives a -37° C (-34° F) freeze point and a boiling point of 109° C (228° F). The actual lowest freeze point of ethylene glycol antifreeze is at 68%. Using higher concentrations of antifreeze will raise the freeze point of the solution and increase the possibility of a silicate gel problem. A refractometer must be used to accurately measure the freeze point of the coolant. Refer to 'Special Tool and Test Kit'.

Supplemental coolant additives (DCA4), or equivalent, are used in conjunction with water and antifreeze to prevent liner pitting, corrosion and scale deposits in the cooling system. The cooling system must be precharged with the correct concentration of DCA4. Refer to the relevant 'Precharge Chart' in this section. When coolant is replaced in the field, it must be replaced with heavy duty coolant precharged with DCA4. In addition, a service coolant filter must be installed. Together, this will result in a total precharge of approximately 0.33 DCA4 units per litre of coolant.

Proper blending of heavy duty coolant is achieved as follows:

a. Pour water into a suitable clean container.

b. Add the same quantity of low silicate antifreeze to the water.

c. Add the correct quantity of DCA4 liquid for the cooling system capacity required. Refer to the relevant 'Precharge Chart' in this section for DCA4 quantities. Refer to Section 300-0020, LUBRICATION SYSTEM for cooling system capacity.

d. Thoroughly blend all components.

2. After every 250 hours of operation.

3. If the concentration is known to be above the high limit of 0.8 units per litre. Test at each subsequent oil change until the concentration decreases below the high limit.

Note: Do not use the test kit to omit or extend the service intervals unless the concentration is above 0.8 units per litre.

The test strip container is marked with an expiration date and the plastic container must be securely tightened to protect the moisture sensitive strips. Discard the strips if there is any doubt about the test strip quality.

Test Instructions

1. Collect coolant sample from the radiator or petcock. DO NOT collect from the coolant recovery or overflow system. Coolant must be between 10° C and 54° C when tested.

2. Remove one strip from the bottle and replace cap immediately. DO NOT touch the pads on the end of the strip.

Note: Discard kit if unused strips have turned light brown or pink.

3. Dip strip in coolant sample for one second, remove, and shake strip briskly to remove excess liquid.

4. 45 seconds after dipping strip compare and record results in the following order:

   a. Compare Freeze Point (end pad) to colour chart and record the result.

   b. Next, compare Sodium Molybdate (middle pad) to colour chart and record the result.

   c. Finally, compare Sodium Nitrate test to colour chart and record the result.

5. All three readings must be completed no later than 75 seconds after dipping the strip.

6. It is okay to estimate a value between colour blocks, but if uncertain about the colour match, pick the lower numbered block.

7. Determine where the Sodium Molybdate level intersects the Sodium Nitrite level on the chart. The amount of SCA units per litre in the cooling system is given where the Sodium Molybdate row intersects the Sodium Nitrite column.
**Cooling System - Cooling System**

Section 210-0000

**Note:** For best results follow test times carefully. Use a stopwatch or clock with a sweep second hand. Comparing the test strip to the colour chart too soon before, or too late after, the required test time will result in incorrect readings and improper treatment, and could result in liner pitting and engine damage.

8. All readings should be recorded on the truck maintenance record for future reference.

**Treatment Instructions**

If the concentration is:

**Below 0.3 units per litre** - Add both the normal amount of DCA4 liquid as specified in the respective service chart and the amount specified in the respective ‘Precharge Chart’. Replace the DCA4 coolant filter.

**Between 0.3 and 0.8 units per litre** - Add the normal amount of DCA4 liquid as specified in the respective ‘Service Chart’. Replace the DCA4 coolant filter.

**Above 0.8 units per litre** - Do not replace the DCA4 filter or add liquid DCA4 until the concentration drops below 0.8 units per litre. The concentration must be tested at every subsequent 250 hour service interval until concentration decreases below 0.8 units per litre.

**SPECIAL TOOL AND TEST KIT**

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the refractometer and coolant test kit referenced in this section. These items are available from your dealer.

**SPECIAL TOOLS**

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the coolant test strips and general service tools required. These strips and tools are available from your dealer.

**COOLING SYSTEM DIAGNOSIS CHART**

<table>
<thead>
<tr>
<th>Engine coolant temperature too high</th>
<th>Low coolant level</th>
<th>Fill coolant system to correct fill level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faulty radiator pressure cap</td>
<td></td>
<td>Check for leaks and repair</td>
</tr>
<tr>
<td>Air in cooling system</td>
<td></td>
<td>Check pressure cap, replace if required</td>
</tr>
<tr>
<td>Front of radiator obstructed</td>
<td></td>
<td>Purge air from cooling system</td>
</tr>
<tr>
<td>preventing free flow of air</td>
<td></td>
<td>Remove obstruction and clean radiator</td>
</tr>
<tr>
<td>Fan drive belt broken or slipping</td>
<td></td>
<td>fins</td>
</tr>
<tr>
<td>Thermostats not opening</td>
<td></td>
<td>Adjust or replace fan belt</td>
</tr>
<tr>
<td>Restricted cooling system passages</td>
<td></td>
<td>Replace thermostats</td>
</tr>
<tr>
<td>Faulty engine water pump</td>
<td></td>
<td>Flush cooling system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repair or replace engine water pump</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engine coolant temperature too low</th>
<th>Thermostats remain open or open at too low a temperature</th>
<th>Replace thermostats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leakage around thermostat seals</td>
<td></td>
<td>Replace thermostat seals</td>
</tr>
<tr>
<td>Extremely cold weather</td>
<td></td>
<td>Cover radiator or install radiator shutters</td>
</tr>
</tbody>
</table>

* * * *
**DESCRIPTION**

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

Radiator assembly is mounted in front of the engine cooling fan at the front end of the vehicle. It is fed from header tank (32) located in front of the operators compartment and mounted to the goalpost arrangement.

The radiator assembly consists of an air-to-air charge cooler mounted on top of a radiator, with an air conditioning condenser and a hydraulic oil cooler mounted on the front. Refer to Section 210-0000, COOLING SYSTEM.

Fan plate assembly (9, Fig. 2) improves the engine cooling fan efficiency, provides a more uniform distribution of air over charge air cooler core (1, Fig. 2) and radiator core (2, Fig. 2) and helps restrict recirculation of air within the engine compartment.

Recirculation baffles (11 & 12), incorporated in the hood assembly prevent hot air from the engine cooling fan being reintroduced into the cooling air circuit.
Cooling System - Radiator and Mounting

Section 210-0040

**Fig. 2 - Exploded View of Radiator Assembly**

1 - Charge Air Cooler Core  
2 - Radiator Core  
3 - Top Column  
4 - Bottom Column  
5 - LH Column  
6 - RH Column  
7 - LH Fan Guard  
8 - RH Fan Guard  
9 - Fan Plate Assy  
10 - Fan Cowl Assy  
11 - LH Baffle Plate  
12 - RH Baffle Plate  
13 - Bent Plate

**REMOVAL**

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

**WARNING**

Do not remove the pressure control cap from the radiator header tank or attempt to drain the coolant until the engine has cooled. Once the engine has cooled, use extreme caution when removing the cap. Remove cap slowly as the sudden release of pressure from a heated cooling system can result in a loss of coolant and possible personal injury (scalding) from the hot liquid.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Block all road wheels and place the battery master switch in the ‘Off’ position.

3. Pull on handle to release hood catch mechanism and raise hood.

4. Remove hood assembly from the vehicle. Refer to Section 100-0040, HOOD AND MOUNTING.

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.
5. Disconnect electrical harness from horns, and remove horns and mounting from front of radiator. Disconnect electrical harness from engine cooling fan.

6. Remove filler cap (33) carefully from header tank (32).

7. Remove plug (23) and open shut-off valve (22) at the bottom of radiator assembly and drain coolant into a suitable container. Close shut-off valve (22) when coolant is completely drained and refit plug (23).

8. Remove bolt (4), snubbing washer (5) and nut (7) securing support bracket (8) to the engine bracket.

9. Remove bolts (1), washers (2) and nuts (3) securing support bracket (8) to mounting brackets on radiator assembly. Remove support bracket (8).

10. Ensure air conditioning lines from condenser mounted on front of charge air cooler (1, Fig. 2), and from receiver drier mounted at rear left hand side of radiator assembly are identified for ease of installation. Disconnect air conditioning lines. Fit blanking caps to open lines and ports.

Note: Refer to Section 260-0130, AIR CONDITIONING before disturbing the air conditioning circuit.

11. Ensure hydraulic lines connected to hydraulic oil cooler mounted on front of charge air cooler (2, Fig. 2) are identified for ease of installation and with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to open lines and ports.

12. Disconnect deaeration line (28) from connector (9) in radiator and deaeration lines (30 & 34 ) from elbows (29) in engine and pipe (19). Identify lines for ease of installation and cap open lines and elbows.

13. Disconnect all clips and clamps securing air conditioning lines, hydraulic lines and deaeration lines to radiator assembly. Move all lines away from radiator assembly to prevent fouling on removal of radiator assembly.

14. Remove bolts, washers and nuts securing fan guards (7 & 8, Fig. 2) to radiator assembly. Remove fan guards (7 & 8, Fig. 2) from radiator assembly.

15. Slacken clamps securing cooler hoses to air inlet pipe (2, Fig. 3) and remove air inlet pipe from charge air cooler (1, Fig. 3) and engine turbocharger.

16. Remove nut, washers and clamp securing air outlet pipe (3, Fig. 3).

17. Slacken clamps securing cooler hoses to air outlet pipe (3, Fig. 3) and remove air outlet pipe (3, Fig. 3) from charge air cooler (1, Fig. 3) and inlet pipe (4, Fig. 3).

18. Slacken clamps (14) and remove coolant inlet pipe (19), hoses (15) and clamps (14) from radiator assembly and engine thermostat housing.

19. Slacken clamps (14 & 17) and remove coolant outlet pipe (16), hoses (15 & 18) and clamps (14 & 17) from bottom of radiator assembly and engine water pump inlet.

20. Install two eye bolts in lifting bosses on side of radiator assembly. Using suitable lifting equipment support radiator assembly.

21. Remove bolts (11), washers (10), snubbing washers (40) and mounts (13) securing radiator assembly to the frame.

22. Remove radiator assembly from the vehicle to a clean area for disassembly. Support radiator standing upright to allow access to front and rear of radiator.

Note: If Header Tank (32) requires to be removed, follow steps 23 through 28.
Cooling System - Radiator and Mounting

Section 210-0040

23. Disconnect electrical harness from coolant level sensor at bottom of header tank (32).

24. With a suitable container available to catch leakage, remove drain plug from radiator header tank (32) and drain coolant. Apply Loctite 225 to drain plug and reinstall in header tank.

25. Ensure all cooling lines connected to header tank are identified for ease of installation and with suitable containers available to catch leakage, disconnect deaeration lines (28 & 30) and overflow line (34). Fit blanking caps to all open lines.

26. Slacken clamp (27) and disconnect make-up line (31) from header tank (32). Blank off open line end.

27. Following removal instructions in Section 100-0040, HOOD AND MOUNTING, remove goalpost and header tank (32) as an assembly from the vehicle.

28. Remove bolts (36), nuts (38) and washers (37) securing header tank (32) to goalpost. Remove header tank (32) from goalpost.

DISASSEMBLY
Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Note: Take care not to damage charge air cooler core (1), radiator core (2), condenser core and hydraulic oil cooler core during disassembly.

1. Remove nut (58), bolt (52) and clip (59) from bracket (53) allowing removal of drain cock assembly (12, 20 & 23, Fig. 1) from bottom of radiator core (2). Remove connector (9, Fig. 1) from radiator core (2).

2. Remove receiver drier and mounting from rear of radiator assembly.

3. Remove mounting hardware securing hydraulic oil cooler to radiator assembly. Remove hydraulic oil cooler from radiator assembly.

4. Remove mounting hardware securing air conditioning condenser to radiator assembly. Remove condenser from radiator assembly.

5. Remove bolts, washers and nuts securing fan plate assembly (9) to radiator assembly. Remove fan plate assembly (9) from radiator assembly.

6. Remove bolts and washers securing fan cowl assembly (10) to radiator assembly.

Remove fan cowl assembly (10) from radiator assembly.

7. Remove remaining bolts and washers securing top column (3), LH column (5), RH column (6) and bottom column (4) to charge air cooler core (1) and radiator core (2).

INSPECTION
Numbers in parentheses refer to Fig. 2.

1. Steam clean all parts thoroughly with a suitable solvent.

2. Examine charge air cooler core (1), radiator core (2), condenser core and hydraulic oil cooler core carefully for possible damage. Repair any damage discovered if equipped to do so, or, have repairs made at a reputable radiator repair shop.

ASSEMBLY
Numbers in parentheses refer to Fig. 2, unless otherwise specified.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATION.

1. Fit RH column (6) and LH column (5) to charge air cooler core (1) and radiator core (2), condenser core and hydraulic oil cooler core carefully for possible damage. Repair any damage discovered if equipped to do so, or, have repairs made at a reputable radiator repair shop.

2. Secure mounts (7) to bottom column (4) with bolts removed during 'Disassembly'.

3. Fit top column (3) and bottom column (4) to radiator assembly using fasteners removed during 'Disassembly'.

4. Position fan cowl assembly (10) to radiator assembly and secure with fasteners removed during 'Disassembly'.

5. Position fan plate assembly (9) to radiator assembly and secure with fasteners removed during 'Disassembly'.

Note: When installing radiator, ensure clearance around cooling fan tips to plate assembly is of equal dimension all round.
6. Install air conditioning condenser and hydraulic oil cooler to radiator assembly picking up mounting locations and hardware as identified at 'Disassembly'.

7. Fit connector (9, Fig. 1) to radiator core (2), torque connector (9) to 35 Nm (26 lbf ft).

8. Fit drain cock assembly (12, 20 & 23, Fig. 1) to bottom of radiator core (2). Secure in place using clip (59), bolts (52) nut (58) located on plate (53).

9. Install receiver drier to rear of radiator assembly picking up mounting locations and hardware as identified at 'Disassembly'.

### INSTALLATION

Numbers in parentheses refer to Fig. 1, unless otherwise specified.

**Note:** Tighten all fasteners without special torques specified to standard torques listed in Section 300-0020, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**WARNING**

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position radiator assembly on the frame and secure with bolts (11), washers (10), mounts (13) and snubbing washers (40).

2. Position support bracket (8) on mounting brackets at top of radiator assembly and secure in place with bolts (1), washers (2) and nuts (3).

3. Secure support bracket (8) to engine bracket with bolt (4), snubbing washer (5), rubber mounts (6) and nut (7).

4. Install coolant outlet pipe (16) between radiator outlet port and engine water pump inlet, and secure with hoses (15 & 18) and clamps (14 & 17).

5. Install coolant inlet pipe (19) between radiator inlet port and engine thermostat housing, and secure with hoses (15) and clamps (14).

6. Install air outlet pipe (3, Fig. 3) between engine inlet pipe (4, Fig. 3) and charge air cooler (1, Fig. 3) and secure with hoses and clamps.

7. Secure air outlet pipe (3, Fig. 3) with clamp, nut and washers removed during 'Removal'.

8. Install air inlet pipe (2, Fig. 3) between engine turbocharger and charge air cooler (1, Fig. 3) and secure with hoses and clamps.

9. Feed electrical harness from engine cooling fan through hole in fan plate assembly (9, Fig. 2). Fit grommet if previously removed.

10. Connect engine cooling fan electrical harness to main electrical harness.

11. Install LH and RH fan guards (7 & 8, Fig. 2) to radiator assembly with bolts, washers and nuts removed during 'Removal'.

12. Remove blanking caps from deaeration lines (28, 30 & 34) and connect deaeration line (28) to connector (9) in radiator assembly, deaeration line (30) to connector (29) in engine and deaeration line (34) to pipe (19). Do not clip lines at this point.

13. Remove blanking caps from hydraulic oil cooler lines and fittings. Connect all hydraulic lines to hydraulic oil cooler as identified at removal.

14. Remove blanking caps from air conditioning lines and fittings. Connect air conditioning lines to condenser and receiver drier. Refer to Section 260-0130, AIR CONDITIONING for procedure on charging the system.

15. Secure all lines with clips and clamps as removed during removal. Ensure no lines are chaffing on sharp edges or resting against areas where heat will be evident.

16. Ensure fittings, lines and pipes are securely tightened to prevent leaks at initial fill and start up.

**Note:** If Header Tank (32) was removed and has not yet been installed, proceed from step 17, however, if header tank (32) was not removed or has been reinstalled, proceed from step 24.

17. Fit header tank (32) to goalpost and secure using bolts (36), nuts (38) and washers (37).

18. Following installation instructions in Section 100-0040, HOOD AND MOUNTING, install header tank (32) and goalpost assembly on the vehicle.

19. Remove blanking from make-up line (31) and connect to header tank (32). Secure with clamp (27).
Cooling System - Radiator and Mounting

20. Remove blanking caps from deaeration lines (28 & 30) and connect to appropriate fittings on header tank (32), as noted on removal.

21. Secure all lines with clips and tie clips as removed during removal. Ensure no lines are chaffing on sharp edges or resting against areas where heat will be evident.

22. Connect electrical harness to coolant level sensor at bottom of header tank (32).

23. Refer to Section 210-0000, COOLING SYSTEM for correct selection of coolant. Fill the cooling system through filler in header tank (32) with coolant until coolant level stabilizes at the bottom of filler neck.

24. Check all line and pipe connections for leaks prior to starting the vehicle. Tighten as required.

25. Switch the battery master switch to the 'On' position, start up the engine and check for leaks. Tighten lines and fittings and top up coolant level as required.

26. Install filler cap (33) on header tank (32) after the coolant level has stabilized at the bottom of filler neck.

27. Following installation instructions in Section 100-0040, HOOD AND MOUNTING, install hood assembly on the vehicle.

28. Remove wheel blocks from road wheels.

CLEANING

Internal Cleaning - Water Tubes

If scale deposits are present inside the water tubes of the radiator, it is necessary to use a suitable scale remover such as 'Powdered Scale Solvent', or equivalent. This material is a free-flowing powder, inhibited to prevent attack on the cooling system materials.

![WARNING]

Take care to avoid contact of skin or eyes with the solvent. If contact is made it should be washed off immediately with clean water and medical advice should be taken.

For general cleaning use it is recommended to use a concentration of 50 - 100 kg/m³ of water at a temperature of up to 60° C. Rapid circulation or agitation with compressed air will reduce the time for cleaning.

Note: If scale deposits within the radiator are exceptionally heavy, concentrations up to 200 kg/m³ may be used. The most convenient method of use is to prepare a concentrated solution by mixing the powder in hot water in a tank and then adding the concentrated solution to water contained in the radiator.

Note: The solvent must always be added carefully to water, not water to solvent.

External Cleaning

Note: If a build up of dirt is apparent during routine inspection, the following cleaning procedure should be adopted.

![WARNING]

To prevent possible injury when using compressed air or steam jet, wear adequate eye protection and do not exceed pressure values stated.

1. Direct a steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the faces of the radiator core.

2. Liberally brush a liquid detergent on to those surfaces which were not satisfactorily cleaned at step 1. Leave to soak for at least 1 hour.

3. Apply a high pressure steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the treated surfaces, forcing the fouling material out from the radiator core.

4. Leave radiator core to dry before reinstalling the cooling equipment.

Note: In the case of grossly fouled surfaces which are not cleaned adequately in steps 1 through 4, the following procedure may be used.

5. Ensure that the radiator core is dry.

6. Liberally brush on to both sides of the radiator core an emulsifying cleaner such as 'Gunk', or equivalent, and leave to soak for at least 1 hour.
7. Apply a high pressure steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the treated surfaces, from several different angles, forcing the fouling material out from the radiator core.

8. For surfaces with stubborn deposits, it may be necessary to repeat steps 5 through 7, brushing the surfaces between stages using a stiff bristle brush.

9. Leave radiator core to dry before reinstalling the cooling equipment.

)MAINTENANCE
Refer to Section 210-0000, COOLING SYSTEM for recommended preventive maintenance procedures, service intervals and coolant selection procedures.

SPECIAL TOOLS
There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools and adhesives are available from your dealer.
DESCRIPTION AND OPERATION

Numbers in parentheses refer to Fig. 1, unless otherwise stated.

The transmission oil cooler (1, Fig. 2) is mounted on the right hand side of the tractor, on top of the fuel tank. The transmission oil cooler is an air blast cooler, using hydraulic oil from the main hydraulic circuit to supply the fan motor (21).

Transmission oil to be cooled exits from the side port of transmission bell housing and flows through hose (17) and tube assembly (5) into bottom of cooler (1, Fig. 2). Transmission oil flows through the crossflow core and is cooled by air flow produced by the rotation of fan (4, Fig. 2), which is driven by motor (21). Cooled transmission oil then exits the top of cooler (1, Fig. 2) and flows through tube assembly (4) and hose (3) and into the top port on the rear of the transmission housing.

The fan motor (21) is proportionally controlled by the hydraulic ECU. The higher the transmission temperature, the more hydraulic oil is supplied to the fan motor (21) through hose (18). Refer to Section 215-0050, MAIN HYDRAULIC VALVE. Hydraulic oil leaving the fan motor (21) returns through hose (20) to the hydraulic tank via the hydraulic oil cooler.

An isolation solenoid valve also controls flow to the fan motor (21), preventing hydraulic oil being supplied to the motor (21) until the transmission oil temperature increases to 90° C (194° F). This prevents the transmission oil being overcooled. Refer to Section 215-0050, MAIN HYDRAULIC VALVE.

The isolation solenoid valve, mounted on the right hand fender, is failsafe i.e. if the solenoid fails, the valve will default to an open position, allowing hydraulic oil to the motor (21). The solenoid valve is controlled by the hydraulic ECU (refer to Section 190-0085, HYDRAULIC SYSTEM ECU).
REMOVAL
Numbers in parentheses refer to Fig. 4, unless otherwise specified.

**WARNING**
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering circuit. Operate brake pedal continuously to relieve pressure in the braking system.

2. Block all road wheels and place the battery master switch in the 'Off' position.

3. Pull on handle to release hood catch and raise hood.

4. Remove hood assembly from the vehicle. Refer to Section 100-0040, HOOD AND MOUNTING.

5. Open drain valve (14) at the bottom of the cooler assembly and drain transmission oil into a suitable container. Close drain valve when oil is completely drained.

6. Remove bracket from rear of cooler. It may be possible to remove bracket without disturbing hoses.

7. With a suitable container available to catch leakage, disconnect supply hose (18, Fig. 1), case drain hose

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**Fig. 2 - Exploded View of Transmission Oil Cooler Assembly**

- 1 - Cooler
- 2 - Fan Ring Assy
- 3 - Motor
- 4 - Fan
- 5 - Adaptor
- 6 - Mounting
- 7 - Elbow
- 8 - Bolt
- 9 - Washer
- 10 - Nut
- 11 - Toothed Washer
- 12 - Washer
- 13 - Nut
- 14 - Washer
- 15 - Lockwasher
- 16 - Nut
- 17 - Fan Guard
- 18 - Bolt
- 19 - Lockwasher
- 20 - Washer
- 21 - Bracket
- 22 - Bracket
- 23 - Bolt
- 24 - Washer
- 25 - Seal
- 26 - Beading
- 27 - Elbow
- 28 - Nut
- 29 - Bolt
- 30 - Lockwasher
- 31 - Washer
Cooling System - Transmission Oil Cooler

Section 210-0060

1. Remove clamp (6, Fig. 1) and mounting hardware (12 - 14, Fig. 1) securing tube assembly (4, Fig. 1) to cooler (1).

2. Disconnect tube assembly (4, Fig. 1) from elbow (16, Fig. 1) and remove. Remove elbow (16, Fig. 1) from cooler (1), noting orientation.

3. Remove clamp (7, Fig. 1) and mounting hardware (12 - 14, Fig. 1) securing tube assembly (5, Fig. 1) to cooler (1).

4. With a suitable container available to catch leakage, disconnect transmission hoses (3 & 17, Fig. 1) from tube assemblies (4 & 5, Fig. 1). Fit blanking caps to open lines and ports.

5. Support transmission oil cooler assembly with suitable lifting equipment.

6. Remove nuts (11), bolts (1), hardened washers (8 & 9), isolators (5) and washers (10) from cooler brackets (2) and support plate (6).

7. Using suitable lifting equipment, remove transmission oil cooler from machine to a clean area for disassembly.

8. With a suitable container available to catch leakage, disconnect transmission hoses (3 & 17, Fig. 1) from tube assemblies (4 & 5, Fig. 1). Fit blanking caps to open lines and ports.

9. Support transmission oil cooler assembly with suitable lifting equipment.

10. Remove nuts (11), bolts (1), hardened washers (8 & 9), isolators (5) and washers (10) from cooler brackets (2) and support plate (6).

11. Using suitable lifting equipment, remove transmission oil cooler from machine to a clean area for disassembly.

DISASSEMBLY

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

Note: Take care not to damage cooler core during disassembly.

1. Remove clamp (6, Fig. 1) and mounting hardware (12 - 14, Fig. 1) securing tube assembly (4, Fig. 1) to cooler (1).

2. Disconnect tube assembly (4, Fig. 1) from elbow (16, Fig. 1) and remove. Remove elbow (16, Fig. 1) from cooler (1), noting orientation.

3. Remove clamp (7, Fig. 1) and mounting hardware (12 - 14, Fig. 1) securing tube assembly (5, Fig. 1) to cooler (1).
4. Disconnect tube assembly (5, Fig. 1) from elbow (16, Fig. 1) and remove. Remove elbow (16, Fig. 1) from cooler (1), noting orientation.

5. Remove bolts (18), lockwashers (19) and washers (20) securing fan guard (17) to fan ring assembly (2), and remove fan guard (17).

6. Remove bolts (18), lockwashers (19) and washers (20) securing mounting (6) to cooler (1). Remove mounting (6) complete with motor (3), fan (4) and adaptor (5).

7. Remove nut (13), toothed washer (11) and washer (12) securing fan (4) and adaptor (5) to motor (3) shaft. Pull fan (4) and adaptor (5) from motor (3) shaft.

8. Remove bolts (8), washers (9) and nuts (10) securing fan (4) to adaptor (5).

9. Remove bolts (8) and washers (9) securing motor (3) to mounting (6), and remove motor (3).

10. Remove nuts (16), lockwashers (15) and washers (14) securing fan ring assembly (2) to cooler (1). Remove fan ring assembly (2) from cooler (1).

11. Remove bolts (23) and washers (24) securing brackets (21 & 22) to cooler (1).

12. Remove mounting hardware securing cowl assembly (6, Fig. 3) to cooler (1), and remove cowl assembly (6, Fig. 3).

13. Remove mounting hardware securing end columns (7 & 8, Fig. 3) to top and bottom channels (4 & 5, Fig. 3).
14. Remove remaining mounting hardware to allow end columns (7 & 8, Fig. 3), side columns (2 & 3, Fig. 3) and baffles (9 - 11, Fig. 3) to be removed.

15. Remove mounting hardware securing top and bottom channels (4 & 5, Fig. 3) to cooler core (1, Fig. 3), and remove channels (4 & 5, Fig. 3).

**ASSEMBLY**

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Secure top and bottom channels (4 & 5, Fig. 3) to cooler core (1, Fig. 3) using mounting hardware removed previously.

2. Fit end columns (7 & 8, Fig. 3), side columns (2 & 3, Fig. 3) and baffles (9 - 11, Fig. 3) to cooler core (1, Fig. 3) and secure using mounting hardware removed previously.

3. Secure cowl assembly (6, Fig. 3) to cooler (1) using mounting hardware removed previously.

4. Secure brackets (21 & 22) to cooler (1) using bolts (23) and washers (24).

5. Secure fan ring assembly (2) to cooler (1) using nuts (16), lockwashers (15) and washers (14).

6. Fit motor (3) to mounting (6) using bolts (8) and washers (9).

7. Assemble fan (4) to adaptor (5) using bolts (8), washers (9) and nuts (10).

8. Press fan (4) and adaptor (5) onto motor (3) shaft, ensuring key is fitted.

9. Secure fan (4) and adaptor (5) using washer (12), toothed washer (11) and nut (13).

10. Install mounting (6) complete with motor (3), fan (4) and adaptor (5) to cooler (1).

**Note:** When installing mounting, ensure clearance around fan (4) tips to fan ring assembly (2) is of equal dimension all round.

11. Secure fan guard (17) to fan ring assembly (2) using bolts (18), lockwashers (19) and washers (20).

12. Fit elbows (16, Fig. 1) to cooler (1) in correct orientation.

13. Fit bracket (6, Fig. 1) to cooler. Fit tube assembly (4, Fig. 1) to top elbow (16, Fig.1) and secure with clamp (12, Fig. 1), plate (13, Fig. 1) and screws (14, Fig. 1).

14. Fit bracket (7, Fig. 1) to cooler. Fit tube assembly (5, Fig. 1) to bottom elbow (16, Fig.1) and secure with clamp (12, Fig. 1), plate (13, Fig. 1) and screws (14, Fig. 1).

**INSTALLATION**

Numbers in parentheses refer to Fig. 4, unless otherwise specified.

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**WARNING**

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position transmission oil cooler assembly on machine and secure to cooler brackets (2) and support plate (6) with nuts (11), bolts (1), hardened washers (8 & 9), isolators (5) and washers (10).

2. Connect transmission hoses (3 & 17, Fig. 1) to tube assemblies (4 & 5, Fig. 1).

3. If removed, secure hose (3 Fig. 1) to transmission housing using bracket assembly (22 Fig. 1) and mounting hardware (23 - 28, Fig. 1).

4. Connect supply hose (18, Fig. 1), case drain hose (19, Fig. 1) and return hose (20, Fig. 1) to fan motor (21, Fig. 1).

5. Following installation instructions in Section 100-0040, HOOD AND MOUNTING, install hood assembly on the vehicle.

6. Fill transmission oil cooler with transmission oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 120-0010,
Cooling System - Transmission Oil Cooler

Section 210-0060

TRANSMISSION AND MOUNTING, for filling procedure and level check.

7. Top up hydraulic tank as necessary with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM.

8. Check all line and pipe connections for noticeable leaks prior to starting the vehicle.

9. Switch the battery master switch to the 'On' position, start up the engine and check for leaks. Tighten lines and fittings and top up systems as required.

10. Lower hood assembly and remove wheel blocks.

MAINTENANCE

Motor Overhaul
Internal parts of the motor are lubricated by the operating fluid itself; therefore preventive maintenance is limited to keeping the fluid in the system clean. Dirt should not be allowed to accumulate on the motor or around the shaft seal. Check frequently that all fittings and bolts are tight.

Every 10 Hours
Check cooling fan for cracks and damage. Check fan mounting and tighten if required. Replace cooling fan if damaged.

Check lines and components for leaks and damage.

Check the fan and motor for debris or damage. Clean or replace as required.

Note: The fan is a non-serviceable component. However, the following instructions must be strictly adhered to:

1. DO NOT clean around fan drive with steam or high pressure jet.

2. DO NOT add any fluids or lubricants to the drive.

3. DO NOT restrict fan rotation during engine operation for ANY reason.

4. DO NOT operate a machine with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.

5. IMMEDIATELY investigate and correct ANY operator complaint involving drive or cooling performance.

Every 250 Hours
Inspect the transmission oil cooler fins and, if necessary, clean with a quality detergent (see Cleaning).

Note: Fuel oil, kerosene or gasoline should not be used to clean fins.

Note: It may be necessary to clean cooler fins more frequently if the machine is being operated in extremely dusty or dirty areas.

CLEANING

External Cleaning
Numbers in parentheses refer to Fig. 2.

Note: If a build up of dirt is apparent during routine inspection, the following cleaning procedure should be adopted.

![WARNING]

To prevent possible injury when using compressed air or steam jet, wear adequate eye protection and do not exceed pressure values stated.

1. Direct a steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the faces of the cooler core (1).

2. Liberally brush a liquid detergent on to those surfaces which were not satisfactorily cleaned at step 1. Leave to soak for at least 1 hour.

3. Apply a high pressure steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the treated surfaces, forcing the fouling material out from the cooler core (1).

Note: In the case of grossly fouled surfaces which are not cleaned adequately in steps 1 through 3, the following procedure may be used.

4. Ensure that the cooler core (1) is dry.

5. Liberally brush on to both sides of the cooler core (1) an emulsifying cleaner such as ‘Gunk’, or equivalent, and leave to soak for at least 1 hour.
6. Apply a high pressure steam jet at 100 - 300 kN/m², or compressed air at 500 - 700 kN/m² on to the treated surfaces, from several different angles, forcing the fouling material out from the core.

7. For surfaces with stubborn deposits, it may be necessary to repeat steps 4 through 6, brushing the surfaces between stages using a stiff bristle brush.

**Internal Cleaning - Tubes**

In the event of a major mechanical failure, the transmission oil cooler assembly should be cleaned thoroughly or replaced.

1. Clean transmission oil cooler before sludge hardens. After transmission oil cooler is completely drained, circulate a solution of Agmasol PS40 through the cooler core (1) to remove sludge.

2. If cooler tubes are badly clogged, circulate an oakite or alkaline solution through cooler (1). Solution should be circulated through cooler (1), in the reverse direction to normal flow, for approximately 15 minutes, after soaking for 10 minutes. The duration of circulation depends on how badly clogged the cooler is. Flush thoroughly with clean hot water.

**SERVICE TOOLS**

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools are available from your dealer.
DESCRIPTION AND OPERATION

Numbers and letters in parentheses refer to Fig. 1.

The air cooled hydraulic oil cooler is mounted on the front of the radiator assembly, with the purpose of cooling hydraulic oil circulating through the hydraulic tank. Hydraulic oil from the transmission oil cooler motor enters hydraulic oil cooler (1) through inlet line (10).

The hydraulic oil is cooled by the air flow through the fins and exits through outlet line (11) and flows back to the hydraulic tank.

REMOVAL

Numbers in parentheses refer to Fig. 1.

**WARNING**

To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering circuit. Operate brake pedal continuously to relieve pressure in the braking system.

2. Block all road wheels and place the battery master switch in the 'Off' position.

3. Remove drain plug from hydraulic tank remote drain fitting. Drain oil in the hydraulic tank into a suitable container and reinstall drain plug.

4. Remove mounting hardware securing front grille on the hood assembly. Remove front grille from the hood.

5. Remove inlet line (10) from elbow (9) and connector (8) in hydraulic oil cooler (1). Drain oil from inlet line (10) into a suitable container. Plug inlet line and cap port to prevent ingress of dirt.
6. Remove outlet line (11) from elbow (9) and connector (8) in hydraulic oil cooler (1). Drain oil from outlet line (11) into a suitable container. Plug outlet line and cap port to prevent ingress of dirt.

7. Remove mounting hardware securing hydraulic oil cooler (1) to bracket assemblies (2 & 3). Remove hydraulic oil cooler (1) from its mounting.

8. If required, remove horns along with bolts (4 & 6) and hardened washers (5) securing bracket assemblies (2 & 3) to the radiator assembly.

CLEANING AND INSPECTION
1. Inspect fins on hydraulic oil cooler carefully, for trapped debris and damage. If hydraulic oil cooler fins show signs of leakage or are excessively damaged, it must be replaced as an assembly.

2. Check connectors in hydraulic oil cooler ports for damaged threads. Replace if required.

3. After hydraulic oil cooler is completely drained, circulate a solution of Agmasol PS40 through the cooler tubes.

4. If cooler tubes are badly clogged, circulate an oakite or alkaline solution through the hydraulic oil cooler, in the reverse direction to normal flow, for approximately 15 minutes. The duration of circulation depends on how badly clogged the cooler tubes are. Flush thoroughly with clean hot water.

INSTALLATION
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all ‘O’ rings where used.

To prevent personal injury and property damage, be sure wheel blocks and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. If removed, secure bracket assemblies (2 & 3) to the radiator assembly with bolts (4 & 6) and hardened washers (5), and install horns.

2. Secure hydraulic oil cooler (1) to bracket assemblies (2 & 3) with mounting hardware, as removed at 'Removal'.

3. Install inlet line (10) and outlet line (11) in their respective ports, as removed at 'Removal'.

4. Fill hydraulic tank with oil. Refer to Section 230-0040, HYDRAULIC TANK, for correct fill level and Section 300-0020, LUBRICATION SYSTEM for specifications of oil to be used.

5. Place the battery master switch in the ‘On’ position, start engine and operate the body hydraulics several times to circulate the oil. Check hydraulic oil cooler (1) and lines for leaks. Tighten fittings as required.

6. Install front grille assembly to the hood with mounting hardware, as removed at 'Removal'.

7. Remove wheel blocks from all road wheels.

MAINTENANCE
Check and clean hydraulic oil cooler every 4 000 hours, or more frequently, if required. Debris in the cooling fins can restrict the flow of air through the cooler which significantly reduces the cooling effect.

Note: In the event of a hydraulic failure, hydraulic oil cooler should be removed and cleaned to prevent clogging.

SERVICE TOOLS
There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools are available from your dealer.
DESCRIPTION

Numbers in parentheses refer to Fig. 2

The Main Hydraulic Valve Assembly is mounted on the left hand side of the tractor frame next to the transmission.

The Main Hydraulic Valve Assembly controls the following functions:

(a) System relief protection for main pump.
(b) Priority function
(c) Steering function.
(d) Brake charging function.
(e) Park/emergency function.
(f) Body control function.
(g) Transmission cooler fan drive.
(h) Cold start function.

Valves that control all the above functions are integrated into the Main Hydraulic Valve Assembly and are identified in Figs. 2 through 7.

System Relief

The system relief valve (14) protects the main hydraulic valve assembly components against pressure spikes. This system relief valve is pre-set at 265 bar (3850 lbf/in²) and is non-adjustable.

Priority Function

This function automatically ensures that the steering and brake charging circuits are given preference over the fan and body tipping functions.

When the pump is not running, the priority valve (15) is closed. As the main pump starts rotating it builds up residual pressure and the priority valve opens, feeding the main pump pressure through to the fan drive (17 & 18) & body tipping (5 & 29) valves.

During the body tipping operations and whilst the fan is running, if the demand pressure at the brake charging or the steering circuit is less than these functions, the priority valve (15) remains open, but the oil takes the path of the least resistance and the requirements of the charging or steering circuits are met.

If the demand pressure for charging or steering is higher than that demanded by the fan drive or body tipping function, this higher pressure will be fed to the main pump load sense line via the shuttle valves (21 & 25) and therefore enable the main pump to meet the charging or steering pressure requirements. At the same time the higher load sense pressure assists the spring in the priority valve (15), the priority valve will then close to reduce the flow to the fan or body tipping circuit and therefore making sure the brake charging & steering always has priority over the other functions.

Steering Function

Refer to Section 220-0000, STEERING SYSTEM

Steering actuation pressure is controlled by steering load sense orifice (20). The steering load sense orifice (20) controls main pump pressure in the steering load sense line. As pressure increases through steering load sense orifice (20), main pump pressure increases lifting steering check valve (24) allowing steering actuation pressure to access the steering orbitrol control valve.

Emergency Steering

Refer to Section 220-0000, STEERING SYSTEM.

The emergency valve (19) forms part of the emergency steering system. It is connected to the main output line of the wheel driven Emergency Steering Pump mounted on the transmission.

Brake Charging Function

Refer to Section 250-0000, BRAKE SYSTEM.

Brake charge valve (8) and brake pressure reducer valve (7) are integral valves that form part of the brake charging function. Brake charge valve (8) ensures that there is sufficient load sense pressure to the main pump to allow the charge pressure to be generated. Brake pressure reducer valve (7) maintains a safe
Fig. 2 Main Hydraulic Valve Assembly Schematic - Based on Engine Shutdown
operating pressure within the front and rear brake accumulators.

**Park/Emergency Brake Function**
Refer to Section 250-0000, BRAKE SYSTEM.

Park/Emergency brake solenoid (6) is the integral valve that controls hydraulic pressure to the park and emergency brake function of the truck.

**Body Control Function**
Refer to Section 230-0000, BODY SYSTEM

Proportional pressure control valve (5) is the integral valve that controls the body tipping function. This valve is operated via the body control lever located in the operators cab. The body control lever sends an electrical signal to the hydraulic ECU. (Refer to Section 190-0085). The hydraulic ECU processes this signal and delivers an actuating electrical signal to the proportional pressure control valve (5). The proportional pressure control valve (5) converts this electrical signal into a pilot pressure, that then is allowed to stroke the body control spool to the lift position.

Proportional pressure control valve (29) is the integral valve that controls the body lower function. This valve is operated via the body control lever located in the operators cab. The body control lever sends an electrical signal to the hydraulic ECU (Refer to Section 190-0085). The hydraulic ECU processes this signal and delivers an actuating electrical signal to the proportional pressure control valve (29). The proportional pressure control valve (29) converts this electrical signal into a pilot pressure, that then is allowed to stroke the body control spool to the lower position.

Body relief valve (47) is located on the raise side of the circuit and prevents pressure spikes at maximum extension of the cylinders when the body is raised at maximum engine speed. Relief valve (47) is set at 230 bar (3355 lbf/in²).

**Transmission Cooler Fan Drive**
The transmission cooler fan speed is modulated by proportionally controlling the pressure at the fan motor. Fan speed is a function of the pressure at the fan motor.

On a cold start, the transmission cooler fan will not rotate. A fan drive solenoid valve, mounted on the right hand fender next to the transmission cooler, will remain closed, blocking actuating pressure until the transmission oil temperature reaches 90°C (195°F).

The hydraulic ECU receives an electrical signal from the transmission cooler fan drive temperature switch, mounted on the transmission retarder housing. Once an electrical signal reflecting a transmission oil temperature of 90°C (195°F) has been received, the hydraulic ECU sends a signal to de-energise the fan drive solenoid valve, allowing actuation pressure to access the fan drive circuit. This fan drive solenoid valve is a fail safe system. If power or connection is lost the fan drive solenoid valve will de-fault to the open (de-energised) condition.

The hydraulic ECU (Refer to Section 190-0085) sends an electrical signal from Pin C1:24 to the fan drive solenoid valve. This signal de-energises the fan drive solenoid, opening the transmission cooler fan drive circuit.

The transmission cooler fan speed pressure is controlled by the Electro-Hydraulic Proportional Control Valve (17). A varying current input into this valve of between 150 to 210 mA controls the pressure between 34 bar (490 psi) and 87 bar (1260 psi). This pressure then acts upon the Shuttle Valve (22) and onto the main pump load sense connection via Shuttle Valve (25). This pressure acts upon the spring chamber of the Logic Valve (18) that controls the pressure at the fan.

![Fig. 3 - Trans. Cooler Fan Drive Temperature Switch](image-url)
The hydraulic ECU receives an analog input from the Transmission Cooler Fan Drive Temperature Switch at Pin C1:3. The temperature sensor output is calibrated against actual temperature within the hydraulic ECU. The hydraulic ECU converts the analog signal into a varying current output. This varying current output, from Pin C1:19, controls Electro-Hydraulic Proportional Control Valve (17) increasing and decreasing pressure at the fan motor. The fan speed increases and decreases proportionally between transmission oil temperatures of 90 to 140°C (195 to 285°F).

The Fan Drive Solenoid will remain de-energised until the transmission oil temperature falls to 87°C (188°F). At this point the oil flow to the transmission cooling fan will stop.

Refer to troubleshooting charts.

**Cold Start Function**

Cold Start Solenoid (16) is the integral valve that controls the cold start function of the Main hydraulic valve assembly.

Cold start solenoid (16) energises when starter motor signal is high, this dumps all load sense pressure from the main hydraulic pump, rendering the pump off-load. This reduces parasitic losses during engine cranking procedure.

There is about a 2 second delay before de-energising cold start solenoid (16) (starter motor signal low). This function prevents brake charging during engine start up, which is particularly important in cold climates.

A starter motor high signal is received by the hydraulic ECU at Pin C1:9. The hydraulic ECU converts this high signal into digital output signal at Pin C1:22, energising the cold start solenoid (16). The signal to energise the cold start solenoid (16) will remain on until a starter motor low signal is received by the hydraulic E.C.U. at Pin C1:9, this will negate the digital output signal from Pin C1:22.

(Refer to section 190-0085 for full Hydraulic E.C.U. detail.)
**Transmission Cooler Fan Drive Trouble Shooting**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan will not rotate once transmission oil temperature is &gt;90°C (195°F).</td>
<td>Hydraulic E.C.U. no receiving appropriate signal from transmission cooler fan drive temperature switch, when transmission oil is &gt;90°C (195°F). Fan drive solenoid, located on right hand fender remains closed. Check for output fault at hydraulic E.C.U. Fan control logic valve (18) sticking in the open position. Contamination in load sense orifices (44 &amp; 45) and/or shuttle valves (22 &amp; 25).</td>
<td>Replace transmission cooler fan drive temperature switch. (Ref. Fig. 3) (a) Check signal from hydraulic E.C.U. - Pin C1:24. Should be low signal. (b) Check electrical connections. (c) Replace fan drive solenoid. Replace fan control logic valve (18). Disconnect fan at main hydraulic valve assembly and plug port DF. Raise and lower the body several times to flush out system. If this is unsuccessful, replace main hydraulic valve assembly. Ref. Output from Pin C1:19. Ref. Section 190-0085 Hydraulic E.C.U.</td>
</tr>
</tbody>
</table>

**Fig. 5 - Main Hydraulic Valve Assembly - Transmission Cooler Fan Valves**

15 - Priority Valve
21 - Shuttle Valve
25 - Shuttle Valve
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan will not modulate its speed over the desired temperature range.</td>
<td>Residual current at hydraulic proportional valve (17).</td>
<td>Check current at valve (17).</td>
</tr>
<tr>
<td></td>
<td>No voltage at hydraulic proportional valve (17).</td>
<td>(a) Check electric connections at valve (17).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Check analog signal from Trans. Cooler Fan Drive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temperature Switch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Check output signal from Hydraulic E.C.U. Pin C1:19.</td>
</tr>
<tr>
<td></td>
<td>Fan Proportional Solenoid Valve (17) Faulty.</td>
<td>Replace Valve (17).</td>
</tr>
<tr>
<td></td>
<td>Contamination or Air in Load Sense Drillings or Shuttle Valves (22 &amp; 25)</td>
<td>Disconnect the fan and plug port DF. Raise and lower the body several times to flush out the system. If this does not work change the whole manifold block.</td>
</tr>
<tr>
<td></td>
<td>Fan Pressure Modulating Valve (18) Faulty.</td>
<td>Replace valve (18).</td>
</tr>
<tr>
<td></td>
<td>Contamination in Orifices (44 &amp; 45).</td>
<td>Clean Orifices (44 &amp; 45).</td>
</tr>
<tr>
<td></td>
<td>Faulty Fan Motor.</td>
<td>Replace Fan Motor. Ref. Section 210-0060 Transmission Oil Cooler</td>
</tr>
<tr>
<td>Fan unstable over the speed range when another function is selected.</td>
<td>Orifices (44 or 45) Blocked.</td>
<td>Clean Orifices</td>
</tr>
<tr>
<td></td>
<td>Fan Proportional Pressure Solenoid (17) Faulty.</td>
<td>Replace Valve (17).</td>
</tr>
<tr>
<td></td>
<td>Fan Pressure Modulating Logic Valve (18) Faulty.</td>
<td>Replace Valve (18).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check Main Pump setting. Ref. Section 230-0050 Main Hydraulic Pump</td>
</tr>
</tbody>
</table>
REMOVAL

**WARNING**
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Turn battery master switch to the 'off' position. Relieve stored pressure in accumulators (x3). This is achieved by pressing and releasing foot brake pedal continuously until all accumulator pressure is relieved.

**WARNING**
Accumulators are charged with Nitrogen. The service pressure is 95 bar (1380 lbf/in²) at 20° C (68° F). To prevent personal injury and property damage do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved.

2. Block all road wheels and place battery master switch in the 'Off' position.

3. Remove blanking cap from remote drain line at the bottom of the hydraulic tank. Install a length of hose on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap.

4. Main hydraulic valve assembly is accessed by raising the operator cab. (Refer to Section 260-0010, CAB AND MOUNTING.)

**WARNING**
Never work under or near an unsupported raised operator cab assembly. Always ensure cab safety prop is in correct position.

5. Clean outer area of the main hydraulic valve assembly with a suitable cleaning solvent. Ensure all hydraulic lines connected to the main hydraulic valve assembly are identified for ease of installation. With suitable containers catch any oil leakage when disconnecting hydraulic lines. Install blanking caps to all open lines and fittings.

6. Install M10 eye bolt into clamp mounting hole at port 'T' located on top of main hydraulic valve assembly. Support main hydraulic valve assembly with suitable lifting equipment, using eye bolt.

7. Disconnect mounting hardware securing main hydraulic valve assembly to vehicle.

DISASSEMBLY

All integral valves on the main hydraulic valve assembly can easily be removed. On removal of all integral valve assemblies, clean and examine for wear or damage.

If integral valve is badly damaged, inspect bore of main hydraulic valve housing. If the main hydraulic valve housing is damaged, the main hydraulic valve assembly will have to be completely replaced.

Always replace all o-rings and seals after inspection.

ASSEMBLY

All integral valves must be re-installed into correct locations on the main hydraulic valve assembly. All integral valves must be torqued to correct value.

1. Re-install O.R.F.S. connectors into correct ports. Replace o-rings and seals. Ref. Fig. 6

2. Install M10 eye bolt into clamp mounting hole at port 'T' located on top of main hydraulic valve assembly. Support main hydraulic valve assembly with suitable lifting equipment, using eye bolt.

3. Manoeuvre main hydraulic valve assembly into position and secure to vehicle with mounting hardware.

4. Remove blanking caps from all hydraulic lines and fittings. Re-connect hydraulic lines to correct fittings astagged at removal.

5. Lower operator cab and secure. Ref. Section 260-0010, CAB AND MOUNTING.

6. Fill hydraulic tank with hydraulic oil as described in Section 300-0020, LUBRICATION SYSTEM. Ensure
area around fill area is clean. Install filler cap on hydraulic tank.

7. Turn battery master switch to 'on' position, remove any wheel blocks, start engine. Operate body and steering systems. Check hydraulic lines and fittings for leaks. Tighten where required.

8. Check hydraulic tank oil level and replenish if required.


<table>
<thead>
<tr>
<th>Valve No.</th>
<th>Description</th>
<th>Qty.</th>
<th>Tighten Torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Directional Control Bleed Down Valve</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Check Valve</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Check Valve</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Body Raise Solenoid Valve</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Park Brake Valve</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>24 Volt Coil</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Coil Nut</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>7</td>
<td>Brake Accumulator Pressure Valve</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>8</td>
<td>Brake Pressure Low Setting</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>9</td>
<td>Servo Pressure Reducing Valve</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>Check Valve</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>M6 Orifice Screw</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>M6 Orifice Screw</td>
<td>1</td>
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<tr>
<td>13</td>
<td>Float Solenoid Valve</td>
<td>1</td>
<td>30</td>
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<tr>
<td></td>
<td>24 Volt Coil</td>
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<td>3</td>
</tr>
<tr>
<td></td>
<td>Coil Nut</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>14</td>
<td>Shock Relief Valve (265 Bar)</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>15</td>
<td>System Press. Generating Logic Valve</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>16</td>
<td>Cold Start Solenoid Valve</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>24 Volt Coil</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Coil Nut</td>
<td>1</td>
<td>3</td>
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</tbody>
</table>
### Main Hydraulic Valve Assembly - Integral Valve Tightening Torques

<table>
<thead>
<tr>
<th>Valve No.</th>
<th>Description</th>
<th>Qty.</th>
<th>Tighten Torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Fan Proportional Press. Control Valve</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>CoilNut</td>
<td>1</td>
<td>3.5</td>
</tr>
<tr>
<td>18</td>
<td>Fan Control Logic Valve</td>
<td>1</td>
<td>115</td>
</tr>
<tr>
<td>19</td>
<td>Emergency Steering Valve</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>Steering Pressure LS Orifice</td>
<td>1</td>
<td>115</td>
</tr>
<tr>
<td>21</td>
<td>Shuttle Valve</td>
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<td>10</td>
</tr>
<tr>
<td>22</td>
<td>Shuttle Valve</td>
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<td>10</td>
</tr>
<tr>
<td>23</td>
<td>Check Valve</td>
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<td>100</td>
</tr>
<tr>
<td>24</td>
<td>Check Valve</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>25</td>
<td>Shuttle Valve</td>
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<td>10</td>
</tr>
<tr>
<td>26</td>
<td>Body Raise LS – Relief Valve</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>27</td>
<td>Emergency Steering Relief Valve</td>
<td>1</td>
<td>60</td>
</tr>
<tr>
<td>29</td>
<td>Body Lower Solenoid Valve</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>31</td>
<td>Plug – G1/8&quot;</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>32</td>
<td>Plug – G1/4&quot;</td>
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<td>30</td>
</tr>
<tr>
<td>33</td>
<td>Plug – G3/8&quot;</td>
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<td>34</td>
<td>Plug 9/16 UNF</td>
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<td>35</td>
<td>Plug – G1/4&quot;</td>
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<td>40</td>
<td>Nut – M12</td>
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<tr>
<td>44</td>
<td>M6 Orifice Screw</td>
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<td>M6 Orifice Screw</td>
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<td>3</td>
</tr>
<tr>
<td>47</td>
<td>Relief Valve</td>
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<td>80</td>
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</tbody>
</table>
MAIN HYDRAULIC VALVE - Main Hydraulic Valve Assembly

1 - Orifice
2 - Bleed Down Sequence Valve
3 - Check Valve
4 - Check Valve
5 - Proportional Pressure Control Valve
6 - Park/Emergency Brake Solenoid
7 - Pressure Reducing Valve
8 - Brake Charge Valve
9 - Pressure Reducing Valve
10 - Check Valve
11 - Orifice
12 - Orifice
13 - Float Solenoid
14 - Relief Valve
15 - Priority Valve
16 - Cold Start Solenoid
17 - Hydraulic Proportional Control Valve
18 - Pressure Compensating Valve
19 - Emergency Steer Valve
20 - Orifice
21 - Shuttle Valve
22 - Shuttle Valve
23 - Check Valve
24 - Check Valve
25 - Shuttle Valve
26 - Body System Relief Valve
27 - Emergency Steer Relief Valve
28 - Proportional Pressure Control Valve
44 - Orifice
45 - Orifice
47 - Relief Valve

Fig. 7 - Main Hydraulic Valve Assembly - Integral Valve Positions
DESCRIPTION
Numbers in parentheses refer to Fig. 1

Steering Orbitrol Valve (1)
Refer to Section 220-0090, STEERING VALVE

Mounted off the underside of the cab floor, the steering valve is connected to the steering column and controls hydraulic oil flow to the steering cylinders.

The steering valve is of a closed centre design, indicating oil is dead headed at the valve until it is operated.
STEERING SYSTEM - Steering System Schematic

Section 220-0000

Steering Cylinders (2)
Refer to Section 220-0120, STEERING CYLINDER.

There are two single stage, double acting cushioned steering cylinders on the machine. The cylinder base end is connected to the front frame, and, the piston rod end is connected to the articulation and oscillation pivot. Single stage double acting means that the piston rod can have oil applied to either side, extending or retracting the piston rod.

Cylinder mounting is by pins, spacers, seals and, spherical bearings secured with circlips. Spherical bearings permit a limited amount of cylinder misalignment when travelling over rough terrain.

Emergency Steering Pump (3)
The emergency steering ground driven pump, mounted on the transmission, provides flow to the steering circuit in the event that the Main Pump (4) can no longer function effectively.

Main Hydraulic Pump (4)
Refer to Section 230-0050, MAIN HYDRAULIC PUMP.

Mounted off the transmission power takeoff, the main hydraulic pump supplies hydraulic oil for operating the steering, body, brakes and transmission cooler fan drive circuits.

The main hydraulic pump is an axial piston, variable displacement type, with load sense and pressure regulator.

Valves 14, 15, 19, 20, 23, 24, 25 & 27
These valves for part of the steering and emergency steering circuit and are an integral part of the main hydraulic valve assembly, mounted on the left hand side of the tractor frame. Refer to Section 215-0050, MAIN HYDRAULIC VALVE ASSEMBLY.

Diagnostic Test Point
Steering and load sense pressures can be checked at the diagnostic check points located inside the battery box. Refer to Fig. 2.

Steering system pressure is set at 240 bar (3500 lbf/in²)

Load Sense (LS) pressure is set 25 bar (360 lbf/in²) below steering system pressure, i.e. at maximum setting LS pressure will be 215 bar (3120 lbf/in²).

OPERATION

PRIORITY FUNCTION
Numbers in parentheses refer to Fig. 1

The priority function automatically ensures that the steering and brake charging circuits are given preference over the transmission cooler fan and tipping functions.

When the main pump (4) is not running, the priority valve (15) is closed. As the main pump (4) starts rotating it builds up residual pressure entering the main hydraulic valve assembly at port P1. The pressure opens priority valve (15), feeding the main pump pressure through to the transmission cooler fan drive & lift valve.

During the tipping operations and whilst the transmission cooler fan is running, if the demand pressure at the brake charging or the steering circuit is less than these functions, the priority valve (15) remains open, but the oil takes the path of the least resistance and the requirements of the brake charging or steering circuits are met.

If the demand pressure for brake charging or steering circuit is higher than that demanded by the transmission cooler fan drive or tipping function, this higher pressure will be fed to the main pump load sense line via the shuttle valves (21 & 25) and therefore enable the main pump (4) to meet the brake charging or steering circuit pressure requirements. At the same time the higher load sense pressure assists the spring in the priority valve (15). The priority valve (15) will then close to reduce the flow to the transmission cooler fan or tipping circuit and therefore making sure the brake charging & steering circuit always has priority over the other vehicle functions.

PRIORITY FLOW CONTROL TO STEERING

This function ensures that the flow from the steering valve (1) is maintained at all times regardless of the other pressure demand within the system.

To achieve this function the pressure at the steering valve (1) has to be at a level equal to that demanded by the steering plus the differential control pressure set by the steering valve.

The pressure demanded by the steering is fed back to the main pump (4) & the priority valve (15) via shuttle
valve (21). The priority valve (15) will close & the main pump will increase its displacement to make sure there is enough flow & pressure available to meet that demanded by the steering.

The steering load sense orifice (20) feeds oil from the main pump supply, to boost the load sense pressure back to the main pump during the steering operation. This is to make sure an adequate flow is always available from the main pump (4) to meet that demanded by the steering. This is commonly known as a dynamic load sense system.

Note: The maximum steer pressure is set by the pressure cut off (compensator) on the main hydraulic pump (240 bar (3500 lbf/in²)). Refer to Section 230-0050 MAIN HYDRAULIC PUMP.

EMERGENCY STEERING

The emergency steering ground driven pump (3) provides flow to the steering circuit in the event that the main pump (4) can no longer function effectively.

Engine failure, transmission failure or internal failure of the main pump (4) could cause ineffective performance.

The emergency steering pump (3) will also assist with flow from the main pump to articulate the vehicle if the main pump cannot deliver the flow required by the steering circuit. This can happen at low engine speed when the vehicle is moving and the operator attempts to articulate the vehicle rapidly.

To protect the ground driven emergency steering pump (3) the maximum pressure at the pump is set by the relief valve (27) to 179 bar (2600 lbf/in²).

The emergency steering valve (19) is sensing the main pump (4) pressure and the load sense pressure at the spring end of the valve (19). During normal operation the differential pressure between the main pump (4) outlet and the load sense line will be approximately 25 bar (360 lbf/in²) and the emergency steering valve (19) will stroke against its spring dumping the emergency steer pump (3) flow to tank.

In the event of the main pump (4) not been able to supply sufficient flow for the steering, the differential pressure between the main pump (4) outlet and the load sense line will be reduced. As soon as the differential pressure drops below 8.5 bar (125 lbf/in²) the emergency steering valve (19) will close and the ground driven pump (3) flow will be diverted across check valve (23) and supply the steering system.

Check valve (24) prevents the emergency steer flow going towards the main pump (4), which may already have failed.

STEERING PRESSURE SETTING

WARNING
Machine has to fully articulate to set steering pressure, therefore steering lock bar cannot be 'Locked'. To prevent personal injury and property damage, exercise extreme caution while working around articulation and oscillation pivot area.

The maximum steer pressure is set by the pressure cut off (compensator) on the main pump (240 bar (3500 lbf/in²)). Refer to Section 230-0050, MAIN HYDRAULIC PUMP.

Steering pressure can be checked at the diagnostic check point located inside the battery box (refer to Fig. 2). Install pressure gauge capable of reading at least 240 bar (3500 lbf/in²) to correct diagnostic check point.

Steer truck over relief (against steering stops) to observe maximum cut-off pressure of 240 bar (3500 lbf/in²). Adjust pressure cut-off screw on main pump (4) if necessary. Refer to Section 230-0050, MAIN HYDRAULIC PUMP.
Fig. 3 - Steering System Valves Integral to Main Hydraulic Valve Assembly

14 - Relief Valve
15 - Priority Valve
19 - Emergency Steer Valve
20 - Steering Load Sense Orifice
23 - Check Valve
24 - Check Valve
25 - Shuttle Valve
27 - Emergency Steering Relief Valve
'O' RING FACE SEALS (ORFS)

Where hydraulic lines are fitted with ORFS connections, the following procedure should be carried out during 'Installation'. Refer to Fig. 4.

a. Ensure 'O' ring/seal is in place and that the joining surfaces are clean. If necessary, retain 'O' ring/seal in place with a light coating of grease or vaseline.

b. Initially, the nuts should be tightened by hand.

c. Where a hose is fitted, ensure that it is not twisted or kinked when the nuts are tightened so that it is allowed to adopt a natural position.

d. Where a tube is fitted, ensure that the connection is aligned correctly.

e. Tighten the nut a further 1/4 to 1/2 a turn using the correct size spanner (wrench).

f. Check that a satisfactory hose or tube routing has been achieved.

---

WARNING

Do not operate the machine until all air is bled from the oil.

b. When the oil in the tank is clear (not cloudy or creamy), the system is free of air.

Note: Slight creep or drift of the steering wheel is normal.

c. Fill hydraulic tank to the recommended level and install the filler cap.

Hydraulic Oil

The steering system should be kept filled with hydraulic oil as listed in Section 300-0020, LUBRICATION SYSTEM.

MAINTENANCE

Maintenance instructions, intervals and warnings, in the individual steering and body hydraulic component sections of this manual, should be adhered to at all times.

SERVICE TOOLS

It is recommended that the following service tools are used when carrying out pressure and temperature checks during maintenance procedures. These tools, along with other general service tools, are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of these tools.

Multi-Gauge

The multi-gauge, 15269784, is basically four pressure gauges in one. Continuous system pressure readings are indicated on one of three simultaneously reading gauges through a pressure range of 30 in of vacuum to 5,000 lbf/in².

The following items should be added to the multi-gauge to enable the gauge to be used on the diagnostic pressure check points:
15018226 Diagnostic Coupling
00118748 Connector (2 off)
15004085 Hose Assembly (-04 HP, 2130 mm long)

Non-contact Infrared Thermometer

The infrared thermometer, 15269785, can be used to spot heat problems early in electrical, mechanical and hydraulic systems. Hand held and easy to use, you...
simply aim, pull the trigger, and read the temperature. Since there is no need to touch what you are measuring, temperatures of hard-to-reach or moving components can be taken without getting burned or shocked.

### O' Ring Face Seals (ORFS) - Seal Kit

The steering system utilizes ‘O’ Ring Face Seal (ORFS) connectors. An ORFS kit, 15271082, is available. This kit contains a minimum stock requirement of all sizes of ORFS type seal.

### Steering System Trouble Shooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>System does not reach the maximum operating pressure</td>
<td>Fault with main pump or pressure cut-off incorrectly set</td>
<td>Refer to Section 230-0050, MAIN HYDRAULIC PUMP</td>
</tr>
<tr>
<td></td>
<td>Faulty relief valve (14)</td>
<td>Replace valve (14)</td>
</tr>
<tr>
<td></td>
<td>Priority valve (15) sticking open or wrong spring setting</td>
<td>Replace valve (15)</td>
</tr>
<tr>
<td></td>
<td>Fault in LS orifice (20)</td>
<td>Replace/clean orifice (20)</td>
</tr>
<tr>
<td>Heavy steering due to not enough flow being available at the steering valve but differential pressure between the main pump outlet and the load sense port is between 15 - 22 bar (218 - 319 lb/in²)</td>
<td>Fault with main pump or standby pressure incorrectly set</td>
<td>Refer to Section 230-0050, MAIN HYDRAULIC PUMP</td>
</tr>
<tr>
<td></td>
<td>Faulty steer valve</td>
<td>Refer to Section 220-0090, STEERING VALVE</td>
</tr>
<tr>
<td></td>
<td>Priority valve (15) - sticking open or wrong spring setting</td>
<td>Replace valve (15)</td>
</tr>
<tr>
<td></td>
<td>Fault in LS orifice (20)</td>
<td>Replace/clean (20)</td>
</tr>
<tr>
<td></td>
<td>Leaking shuttle valve (21)</td>
<td>Replace valve (21)</td>
</tr>
<tr>
<td>No steering flow available whilst the vehicle is still travelling and engine is switched off</td>
<td>Ground driven pump faulty</td>
<td>Replace ground driven pump at transmission.</td>
</tr>
<tr>
<td></td>
<td>Emergency steer valve (19) sticking open</td>
<td>Replace valve (19)</td>
</tr>
<tr>
<td></td>
<td>Emergency steer relief valve (27) pressure setting too low.</td>
<td>Replace valve (27)</td>
</tr>
<tr>
<td>With no functions operated pressure at ground driven pump too high.</td>
<td>Emergency steer valve (19) spool sticking closed.</td>
<td>Replace valve (19)</td>
</tr>
</tbody>
</table>
DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The steering valve can be identified as item 1 in Section 220-0000, STEERING SYSTEM SCHEMATIC.

The steering valve, mounted off the underside of the cab floor and connected to the steering column, controls hydraulic flow in the steering system. The steering valve is of a closed centre design, which means that the valve does not have any flow through it when it is in the neutral or no steering position. The steering valve has integral cylinder relief valves which relieve shock loads on the steering cylinders by transferring excessive pressure applied to the oil by the road shock, to the opposite end of the cylinders. This shock, if left unchecked, might damage steering linkage components.

The main components of the steering valve are valve housing (7), gerotor housing (4), gerotor gear (19), driveshaft (6), sleeve (8) and spool (16).

There are five ports on valve housing (7) as follows:

Port 'P' - Supply from main hydraulic valve
Port 'T' - Return to tank
Port 'R' - Cylinder supply for right hand turn
Port 'L' - Cylinder supply for left hand turn
Port 'LS' - Load Sensing to main hydraulic valve
Steering System - Steering Valve

Turning action of the steering wheel is transmitted through the steering column to sleeve (8) and driveshaft (6), which is fastened to the sleeve with centring pin (10). Rotation of driveshaft (6) causes gerotor gear (19) to rotate in gerotor housing (4). When gerotor gear (19) rotates, oil in gerotor housing (4) pockets (see Fig. 2) is forced out and flows through spool (16) and sleeve (8) to the steering cylinder port.

Spool (16) contains porting matched to sleeve (8) and rotates within sleeve (8) to provide directional control of the oil. See Fig. 3.

OPERATION
Numbers in parentheses refer to Fig. 1.

When the operator turns the steering wheel a certain number of degrees for either a left or right hand turn, the movement is transmitted through the steering column to spool (16). After a minimum rotation of 2.5 degrees, the ports in spool (16) start to align with ports in sleeve (8). When the steering wheel is rotated to a maximum of 10 degrees the ports are fully aligned allowing full oil flow. After 10 degrees of travel in either direction the spool and sleeve rotate as an assembly through centring pin (10).

Oil from the priority valve flows into valve housing (7) at port 'P' and is channelled through sleeve (8) and spool (16) to gerotor housing (4). Porting in gerotor housing (4) permits oil to flow into pockets formed by gerotor housing (4) and gerotor gear (19). As spool (16) rotates, driveshaft (6) also rotates which, in turn, rotates gerotor gear (19) to which it is splined. When gerotor gear (19) rotates it progressively forces oil out of the pockets (see Fig. 2) of gerotor housing (4). The oil is channelled through sleeve (8) and spool (16) and exits valve housing (7) through port 'R' for a right hand turn, or port 'L' for a left hand turn. Oil then travels through steering lines to the steering cylinders.

As the steering cylinder pistons move, oil forced out of the steering cylinders returns to valve housing (7). The return oil passes through sleeve (8) and spool (16) and exits through port 'T' to tank.

When the steering effort is released, centring spring (11) which was put under tension by the rotation of spool (16), forces sleeve (8) to rotate back to its original position. This puts the ports out of alignment and stops pump oil flow to the steering cylinders. The vehicle stops turning further but will hold the present turning radius until spool (16) is rotated past the 2.5 degree minimum.

REMOVAL
Numbers in parentheses refer to Fig. 4.

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering circuit. Operate brake pedal continuously to relieve pressure in the braking system.

2. Block all road wheels and place the battery master switch in the ‘Off’ position.

3. Remove hydraulic tank remote drain plug and drain
6. Slide bellows (13) over steering shaft (14) to gain access to bottom joint (12) and loosen bolt which tightens joint (12) onto stub shaft (8).

7. Support steering valve (1) and remove bolts (7), locknuts (2) and washers (3 & 6) securing mounting plate (5) to cab floor. Remove steering valve (1) and mounting plate (5) to a clean area for disassembly. Remove nitrile seal (9) and discard rubber mounts (4), if damaged.

4. Pull floor mat back to allow access to bolts (7). Raise cab and secure with prop. Refer to Section 260-0010, CAB AND MOUNTING.

5. Clean outer area of steering valve (1) with a suitable solvent. Ensure all hydraulic lines connected to steering valve (1) are identified for ease of installation and with suitable containers available to catch leakage, disconnect hydraulic lines. Cap all lines and plug all ports to prevent entry of dirt.

hydraulic oil into a suitable container. Reinstall drain plug in hydraulic tank remote drain fitting.

Fig. 4 - Exploded View of Steering Valve Installation

1 - Steering Valve  9 - Nitrile Seal  16 - Beading
2 - Locknut  10 - Bolt  17 - Steering Column Assy
3 - Washer  11 - Lockwasher  18 - Bracket
4 - Rubber Mount  12 - Joint  19 - Column Cover
5 - Mounting Plate  13 - Bellows  20 - Steering Wheel
6 - Washer  14 - Steering Shaft  21 - Nut
7 - Bolt  15 - Lever  22 - Cap

SM 2193 1-03  3
DISASSEMBLY

Numbers in parentheses refer to Fig. 5, unless otherwise specified.

**Note:** Steering valves fitted with anti-cavitation valves must be disassembled and assembled in the vertical position to prevent ball valves (24) becoming trapped in the wrong cavities within the valve housing (7).

1. Remove bolts (10, Fig. 4) and washers (11, Fig. 4) securing mounting plate (5, Fig. 4) to steering valve (1, Fig. 4).

2. Clamp steering valve assembly horizontally in a soft jawed vice and break loose the seven capscrews (1). With capscrews (1) loosened, place steering valve...
Steering System - Steering Valve

vertically in vice, end cap (2), up.

**Note:** Hidden pin. If tension on this pin is released before these parts are fully disengaged and the pin is not horizontal, the pin can drop and lockup can occur.

3. Remove cap screws (1) securing end cap (2), gerotor housing (4) and spacer plate (5) to valve housing (7). Remove end cap (2) from valve housing (7) and discard ‘O’ ring (3).

4. Remove gerotor housing (4) and gerotor gear (19) from valve housing (7). Remove and discard ‘O’ ring (21) from gerotor housing (4).

5. Remove spacer plate (5) from valve housing (7).

6. Remove and discard ‘O’ ring (22) from valve housing (7).

7. Using a cloth to protect the hand, place gerotor gear (19) over end of drive shaft (6) and engage special tool with splined end of spool (16). Refer to Fig. 6.

8. Hold gerotor gear (19) and prevent drive shaft (6) from turning. Twist special tool to compress centering spring (11) radially CW or CCW, decreasing the coil diameter of the centering spring (11) allowing spool and sleeve assembly to be removed. Refer to Fig. 7.

9. With drive held stationary and centering spring (11) compressed, carefully push spool (16), sleeve (8), ball checks (9), drive shaft (6), pin (10), bearing races (13), retainer (20) and needle thrust bearing (12), as a complete assembly, from valve housing (7). Refer to Fig. 8.

10. Remove bearing race (13) and needle thrust bearing (12) from spool and sleeve assembly.

11. Using suitable pliers, remove retainer (20) and bearing race (13) from spool (16) and sleeve (8) assembly. Refer to Fig. 9.

12. Remove centering spring (11) from spool (16) and sleeve (8) assembly. Refer to Fig. 9.

13. Remove pin (10) and slide drive shaft (6) from spool (16) and sleeve (8) assembly. Refer to Fig. 9.

14. Carefully remove spool (16) and ball checks (9) from sleeve (8). Refer to Fig. 9.

15. Use a soda straw as a guide tool to remove the roll pin (23) and ball valve (24) from the anti-cavitation valve ports. Insert two soda straws, one in each anti-cavitation valve bore. Remove valve housing (7) from
vice and tilt until roll pins (23) and ball valves (24) slide through the straws and out of the valve housing (7). Refer to Fig. 10.

16. Remove and discard 'O' ring (14), seal (17) and backup ring (18) from valve housing (7).

17. Using a thin blade screwdriver, pry dust seal (15) from valve housing (7). Take care not to damage dust seal seat.

INSPECTION

1. Clean all metal parts in a suitable solvent and blow dry with compressed air. Do not wipe dry with cloth or paper towel as lint or other matter may get into the hydraulic system and cause damage.

2. Check all mating surfaces and replace any parts that have scratches or burrs that could cause leakage.

3. Do not use course grit or try to file any metal parts.

Note: Replace all 'O' rings and seals with new 'O' rings and seals at 'Assembly'. Lubricate all 'O' rings and seals with a petroleum jelly.

ASSEMBLY

Numbers in parentheses refer to Fig. 5, unless otherwise specified.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Steering valves fitted with anti-cavitation valves must be disassembled and assembled in the vertical position to prevent ball valves (24) becoming trapped in the wrong cavities within the valve housing (7).

1. Use a soda straw as a guide tool to insert the roll pin (23) and ball valve (24) into the anti-cavitation valve ports. Insert soda straw into anti-cavitation valve bore. Drop ball valve (24) through straw into bore. Remove straw and drop roll pin (23) into bore. Repeat for second anti-cavitation valve bore. Refer to Fig. 11.

2. Apply a light coating of clean hydraulic fluid to spool (16). Slide spool (16) and ball checks (9) into sleeve (8). Refer to Fig. 12.
3. Insert drive shaft (6) into spool (16) in sleeve (8) carefully so that holes line up. Install pin (10) through sleeve (8), spool (16) and drive shaft (6) assembly until pin (10) becomes flush at both sides of sleeve (8). See Figs. 12 & 13.

4. Position one end of centring spring (11) into slotted end of spool (16). Compress centring spring (11) radially (CCW) and engage free end of spring into slot in spool (16). See Fig. 14.

5. Install bearing race (13) onto spool (16). Using suitable pliers install retainer (20) onto spool (16). See Fig. 14.

6. Apply a light coating of petroleum jelly to the inside diameter of dust seal (15) and install in valve housing (7).

7. Apply a light coating of petroleum jelly to needle thrust bearing (12), bearing race (13), 'O' ring (14), seal ring (17) and backup ring (18). Install each item onto spool (16), as shown in Fig. 15.

**Note:** Needle thrust bearing is positioned between the two bearing races (13) and must be centered around retainer (20).

**Note:** Clamp steering valve housing (7) vertically in a soft jawed vice.
8. Using a cloth to protect the hand, place gerotor gear (19) over end of drive shaft (6). Insert special tool through valve housing (7) and engage with splined end of spool (16) and sleeve (8) assembly. Twist tool to compress centering spring (11) radially CW or CCW. Refer to Fig. 16.

9. Keep centering spring (11) compressed and carefully insert assembled parts into valve housing (7), as shown in Fig. 17.

10. Release tension on centering spring (11) and remove special tool and gerotor gear (19).

11. Lubricate and install new 'O' ring (22) in groove in valve housing (7). Refer to Fig. 18.

12. Install spacer plate (5) with the 'O' ring groove up, on valve housing (7). Align bolt holes in spacer plate (5) with tapped holes in valve housing (7). Refer to Fig. 18.

13. Lubricate and install new 'O' ring (21) in groove in spacer plate (5). Refer to Fig. 18.

14. Install gerotor housing (4) on valve housing (7). Align bolt holes in gerotor housing (4) with tapped holes in valve housing (7). Refer to Fig. 18.

15. Align gerotor gear (19) on driveshaft (6) and gerotor housing (4), as shown in Fig. 18.

16. Lubricate and install new 'O' ring (3) in groove in gerotor housing (4).

17. Install end cap (2) on gerotor housing (4), as shown in Fig. 18.
18. Align cap screw (1) holes and install seven dry cap screws (1) in end cap (2). Pre-tighten cap screws (1) to 17 Nm (12.5 lbf ft) then tighten to a torque of 34 Nm (25 lbf ft), in the sequence shown in Fig. 19.

19. Using bolts (10, Fig. 4) and washers (11, Fig. 4) secure mounting plate (5, Fig. 4) to steering valve (1, Fig. 4).

INSTALLATION

Numbers in parentheses refer to Fig. 4.

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**Note:** Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

**WARNING**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Make certain area of installation is clean.

2. Install rubber mounts (4) if removed, and secure steering valve (1) and mounting plate (5) to cab floor with bolts (7), washers (3 & 6) and locknuts (2).

3. Install nitrile seal (9) to steering shaft (14).

4. Slide bottom joint (12) of steering shaft (14) over stub shaft (8) and secure by tightening bolt. Slide bellows (13) down over bottom joint (12) and stub shaft (8).

5. Remove plugs from steering valve ports and caps from steering lines and install steering lines to steering valve (1), as identified at removal.

6. Lower cab and secure with pins. Refer to Section 260-0010, CAB AND MOUNTING.

7. Fill hydraulic tank with hydraulic oil, as specified in Section 300-0020, LUBRICATION SYSTEM. Refer to 'Filling and Bleeding The Steering System'.

8. Remove wheel blocks from all road wheels, place the battery master switch in the 'On' position and start the engine. Operate the steering and check hydraulic lines for leaks. Tighten lines and fittings as required.

**FILLING AND BLEEDING THE STEERING SYSTEM**

1. Fill hydraulic tank to Maximum level. Be ready to add oil when the engine is started. Do not let oil drop below the pump suction line to prevent air entering the system.

2. Start engine and let it idle. Immediately add oil to the hydraulic tank as required. When no more oil can be added and oil is clear, proceed as follows:

   a. Turn the steering wheel from lock to lock to bleed the air in the steering cylinders and lines.

   **Note:** Immediately upon valve spool actuation oil must be added to the hydraulic tank to replenish the oil moving into the circuit.

   **WARNING**

   Do not operate the vehicle until all air is bled from the oil.

   b. When the oil in the tank is clear (not cloudy or creamy), the system is free of air.

   **Note:** Slight creep or drift of the steering wheel is normal.

   c. Fill hydraulic tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Refer to Section 230-0040, HYDRAULIC TANK, for correct fill level. Install filler cap on tank.
SPECIAL TOOLS
Refer to Section 300-0070, SERVICE TOOLS, for details of the centring spring installation tool referenced in this section. This tool is available from your dealer.

SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Nm</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Capscrew</td>
<td>34</td>
</tr>
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</table>

STEERING CONTROL DIAGNOSIS

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>REASON</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steering wheel does not centre</td>
<td>Binding in steering linkage to valve</td>
<td>Align as required</td>
</tr>
<tr>
<td></td>
<td>Worn gerotor</td>
<td>Replace parts</td>
</tr>
<tr>
<td></td>
<td>Broken centring springs</td>
<td>Replace centring springs, drain and flush system</td>
</tr>
<tr>
<td></td>
<td>Burrs on sleeve or spool</td>
<td>Disassemble and repair or replace parts</td>
</tr>
<tr>
<td>Apparent inability to steer when</td>
<td>Dirt in system</td>
<td>Drain and flush system. Refill with clean oil</td>
</tr>
<tr>
<td>wheel is turned slowly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slow steering</td>
<td>Excessive wear in sleeve and spool</td>
<td>Replace sleeve and spool</td>
</tr>
<tr>
<td></td>
<td>Excessive wear in gerotor</td>
<td>Replace gerotor</td>
</tr>
<tr>
<td>Hard steering</td>
<td>See 'Slow Steering'</td>
<td></td>
</tr>
<tr>
<td>Opposite steering</td>
<td>Lines hooked up incorrectly</td>
<td>Reconnect correctly</td>
</tr>
<tr>
<td></td>
<td>Wrong orientation between gerotor and gerotor drive</td>
<td>Realign per instructions</td>
</tr>
<tr>
<td>Steering wheel rocking back and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>forth</td>
<td>See 'Opposite Steering'</td>
<td></td>
</tr>
<tr>
<td>Steering wheel continues to turn</td>
<td>Input linkage binding</td>
<td>Align as required</td>
</tr>
<tr>
<td></td>
<td>Burr on sleeve or spool</td>
<td>Disassemble and repair or replace</td>
</tr>
<tr>
<td></td>
<td>Dirt in system</td>
<td>Drain and flush system. Refill with clean oil</td>
</tr>
<tr>
<td></td>
<td>Broken centring springs</td>
<td>Replace centring springs, drain and flush system</td>
</tr>
<tr>
<td>No steering action</td>
<td>Sleeve and spool locked together</td>
<td>Disassemble and repair or replace</td>
</tr>
</tbody>
</table>
DESCRIPTION

Numbers in parentheses refer to Fig. 1.

The steering cylinders can be identified as item 2 in Section 220-0000, STEERING SYSTEM SCHEMATIC.

There are two single stage, double acting cushioned steering cylinders on the machine. The piston rod (2) end is connected to the articulation and oscillation pivot, and, the cylinder base end is connected to the front frame. Single stage double acting means that piston rod (2) can have oil applied to either side, extending or retracting the piston rod.

Rod end cylinder mounting is by pins (17), spacers (21, 22 & 23) and spherical bearings (13) secured with circlips (14). Spherical bearings (13) permit a limited amount of cylinder misalignment when travelling over rough terrain.

OPERATION

When the operator turns the steering wheel for a steering operation, movement of the piston rod generates force required to pivot the tractor frame.

In the neutral position, with the steering valve centralized, oil movement between the steering cylinders and the steering valve is stopped. Trapped oil in the system locks both steering cylinders and the angle of steering set by the operator is maintained. Refer to Section 220-0090, STEERING VALVE, for operation of the steering valve.
Steering System - Steering Cylinder
Section 220-0120

REMOVAL
Numbers in parentheses refer to Fig. 1.

![WARNINGS]
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Hydraulic fluid pressure will remain within the system after engine shutdown. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the hydraulic system or serious injury could result.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine. Turn steering wheel several times to relieve any pressure in the steering circuit. Operate brake pedal continuously to relieve pressure in the braking system.

2. Place steering lock bar in the 'Locked' position. Block all road wheels and place the battery master switch in the 'Off' position.

3. Identify, tag and with a suitable container in position to catch the spillage, disconnect all hydraulic lines on one steering cylinder. Cap all lines and fittings to prevent ingress of dirt.

4. Support steering cylinder with a suitable lifting device.

5. Remove bolt (20), lockwasher (19) and hardened washer (18) securing pin (17) at base end of the cylinder. Remove pin (17) securing base end to the front frame.

6. Remove bolt (20), lockwasher (19) and hardened washer (18) securing pin (17) at piston rod (2) end of the cylinder. Remove pin (17) securing piston rod (2) end to the articulation and oscillation pivot.

7. Remove cylinder assembly from the machine. Spacers (21, 22 & 23) will come free at this time.

8. Remove cylinder assembly to a clean area for disassembly. Drain oil from cylinder assembly into a suitable container.

9. Repeat steps 3 through 8 for opposite steering cylinder assembly.

DISASSEMBLY
Numbers in parentheses refer to Fig. 1.

![WARNING]
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Ensure clean working conditions, remove any port plugs thus allowing easy entry of air into the cylinder, preventing a vacuum when parts are withdrawn from cylinder body (1).

2. Remove circlips (14) from base end of cylinder body (1) and piston rod (2) end. Press out spherical bearings (13).

3. Using special tool which can be fabricated as shown in Fig. 2, unscrew end cap (3) until thread is disengaged from cylinder body (1).

4. Pull end cap (3) and piston rod (2) out of cylinder body (1) as an assembly.

5. Place piston rod (2) on supports which will not damage the chrome piston rod diameter.

6. Remove and discard piston seal (12) and wear rings (11) from piston (9).

7. Remove grub screw (10) from wear ring groove in piston (9).

8. Provide an anti-torsion device through piston rod (2) eye to allow unscrewing of piston (9). Using special tool which can be fabricated as shown in Fig. 3, unscrew piston (9) from piston rod (2).

9. Remove and discard 'O' ring (5) from piston (9). Remove and retain cushion sleeve (8) from piston rod (2).

10. Pull end cap (3) assembly off piston rod (2). Remove and discard back up ring (15) and 'O' ring (16) from end cap (3) outer grooves. Remove and discard wiper (7) and rod seal (6) from end cap (3) inner grooves.

11. If damaged, remove lube fittings (4) from cylinder body (1) and piston rod (2).
INSPECTION
Numbers in parentheses refer to Fig. 1

1. Clean all parts of the cylinder with a suitable solvent and dry with clean, lint-free cloths. Clean all grooves carefully to remove any foreign material.

2. Check cylinder body (1), end cap (3) grooves and outer diameter of piston (9) for scratches, cracks or other signs of damage. Remove ridges, nicks and scratches with a fine stone and re-clean. Replace any components which cannot be repaired.

3. Inspect piston rod (2) for distortion, cracks or other defects. Replace piston rod (2) if defective area is irreparable.

4. Check spherical bearings (13) for wear and replace if necessary.

ASSEMBLY
Numbers in parentheses refer to Fig. 1.

1. Press spherical bearings (13) in base end of cylinder body (1) and piston rod (2) end. Secure spherical bearings (13) with circlips (14).

2. Install new rod seal (6) into bore of end cap (3) with the lip pointing towards the internal face of end cap (3). Install new wiper (7) in bore of end cap (3).

3. Install new back up ring (15) and ‘O’ ring (16) in external groove of end cap (3).

4. Guide end cap (3) assembly onto piston rod (2), taking care not to damage rod seal (6) on the thread.

5. Install cushion sleeve (8) into piston rod (2) counter bore. Note correct orientation, spigot face abuts counter bore face (see Fig. 1).

6. Install new ‘O’ ring (5) into internal groove of piston (9).

7. Using special tool which can be fabricated as shown in Fig. 3, screw piston (9) on piston rod (2). Tighten piston (9) to a torque of 746 - 813 Nm (550 - 600 lbf ft).

8. Insert piston grub screw (10), through wear ring groove in piston (9), into groove machined in piston rod (2). Tighten grub screw (10) to a torque of 13 - 20 Nm (10 - 15 lbf ft). Ensure the extreme of grub screw (10) is below the level of wear ring groove.

9. Insert new piston seal (12) and new wear rings (11) in piston (9) external grooves.

10. Fully grease piston (9) OD and ’O’ ring (16) in end cap (3).

11. Ensure bore of cylinder is well lubricated with hydraulic oil. Carefully insert piston rod (2) and end cap (3) assembly into cylinder body (1).

12. Engage end cap (3) /cylinder body (1) thread and screw up fully. Using special tool which can be fabricated as shown in Fig. 2, tighten end cap (3) to a torque of 542 - 610 Nm (400 - 450 lbf ft).

13. Replace lube fittings (4) if required.

INSTALLATION
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 220-0000, STEERING SYSTEM SCHEMATIC. Renew all ‘O’ rings where used.

1. Install a suitable strap, or other lifting device, around one cylinder assembly and position cylinder assembly on the vehicle, with piston rod (2) end of cylinder ready for mounting.

2. Install spacers (22) either side of piston rod (2) end of cylinder. Note: Install spacers (21 & 23) in correct order and side of piston rod as shown. Now insert pin (17). Secure pin (17) to articulation and oscillation pivot with bolt (20), lockwasher (19) and hardened washer (18).
Steering System - Steering Cylinder

Section 220-0120

3. Install seals spacers (22) either side of base end of cylinder and insert pin (17). Secure pin (17) to front frame with bolt (20), lockwasher (19) and hardened washer (18).

4. Connect hydraulic lines to steering cylinder ports, as tagged during removal.

5. Repeat steps 1 through 4 for installation of opposite steering cylinder.

6. Lubricate pins (17) through lube fittings (4) with lubricant, as specified in Section 300-0020, LUBRICATION SYSTEM.

7. Check oil level in hydraulic tank and add oil if low. Refer to Section 230-0040, HYDRAULIC TANK, for correct fill level. Refer to Section 300-0020, LUBRICATION SYSTEM, for the type of oil used.

8. Place the steering lock bar in the 'Stowed' position and remove wheel blocks.

9. Place the battery master switch in the 'On' position, start the engine and operate the steering, from lock to lock several times, to purge air out of the hydraulic lines. Check hydraulic lines and fittings for leaks. Tighten lines and fittings as required.

MAINTENANCE

Inspect steering cylinders regularly for leaks or damage, repair as required. Lubricate cylinder pins every 250 hours, as specified in Section 300-0020, LUBRICATION SYSTEM.

SPECIAL TOOLS

Special tools can be fabricated as shown in Figs. 2 & 3. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

Fig. 2 - End Cap Torque Tool
Fig. 3 - Piston Torque Tool

SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>Nm</td>
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<tr>
<td>1</td>
<td>9</td>
<td>Piston</td>
<td>746 - 813</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>End Cap</td>
<td>542 - 610</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>Grub Screw</td>
<td>13 - 20</td>
</tr>
</tbody>
</table>

* * * *
DESCRIPTION

Numbers in parentheses refer to Figs. 1 through 9. Other useful reference reading: Sections 190-0000 CIRCUIT DIAGRAMS, 215-0050 MAIN HYDRAULIC VALVE ASSEMBLY and 230-0081 BODY CONTROL LEVER.

The body hydraulic system enables the operator to lift and lower the body in a safe manner with an electric output from the body control lever.

A brief description of the individual components used in the body hydraulic system are listed below. Detailed service and operating instructions can be found in the relevant component sections of this manual.

Body Control Lever

Refer to Section 230-0081, BODY CONTROL LEVER.

The body control lever is mounted on the right hand side dash panel inside the operators cab. The body control lever is manually operated to control the lift and lower function of the body assembly.
BODY SYSTEM - Body System Schematic

Section 230-0000

Body Cylinders (1)
Refer to Section 230-0130, BODY CYLINDER.

There are two single stage, double acting body hoist cylinders, cushioned at both ends of the stroke, on the vehicle. The cylinder base end is connected to the trailer frame and piston rod eye end is connected at the body. Single stage double acting means that the piston rod can have oil applied to either end, extending or retracting the piston rod. The cushioning effect when the cylinder is being extended is obtained by a tapered spear on the piston rod passing through a cushioned sleeve. This gradually slows the piston which in turn helps to control destructive shock effects when the piston reaches the full extent of its travel.

The cushioning effect when the cylinder is being retracted is obtained by a tapered spear at the base end of the cylinder body entering a cavity in the piston rod through a cushioning ring. This gradually slows the piston which in turn helps to control destructive shock effects when the piston bottoms.

Cylinder mounting is by pins, spacers and spherical bearings secured in place by circlips. Spherical bearings permit a limited amount of cylinder misalignment.

Accumulators (18)
Refer to Section 250-0060, ACCUMULATOR.

The primary accumulators mounted inside the battery box located on the front left hand side of the tractor. The primary accumulator supports the service brake system and the body pilot pressure system. The primary accumulator is of the piston type and precharged with nitrogen to 95 bar (1380 lbf/in²). It consists of a charging valve assembly, cylinder assembly and piston. The charging valve is equipped with a locking feature which, when opened, will allow precharge to be checked or accumulator charged.

The piston acts as a separator dividing the cylinder assembly into two sections. The section nearest the charging valve contains the nitrogen precharge. Hydraulic oil from the accumulator charge valve flows through accumulator check valves in the brake manifold valve and into the other section of the accumulator.

Accumulator pressure is monitored by pressure switches in the brake lines (Ref. Section 250-0000, BRAKING SYSTEM).

Valves 5, 9, 13, 15, 21, 22, 25, 26, 29, 30, 31, 32, 33, 46 & 47
These valves form part of the brake circuit and are an integral part of the main hydraulic valve assembly, mounted on the left hand side of the tractor frame. Refer to Section 215-0050, MAIN HYDRAULIC VALVE ASSEMBLY.

OPERATION

LIFTING THE BODY
Refer also to Sections 190-0000 CIRCUIT DIAGRAMS and 215-0050 MAIN HYDRAULIC VALVE ASSEMBLY.

When the operator pulls back on the body control lever a voltage between 0 and 5 volts is sent to the hydraulic ECU, Pin C1:8. The hydraulic ECU converts this signal to an output current at Pin C1:17 to between 250 & 800 mA dependent upon how far the lever is selected. This current is delivered to the Electro-Hydraulic Proportional Pressure Control Valve (5) which converts this current into a pilot pressure.

The primary accumulator (18) pressure is reduced to a 35 bar (508 lbf/in²) pilot control pressure by pressure reducing valve (9). This pilot control pressure acts upon the proportional pressure control valve (5) which reduces the pilot pressure to between 4 bar (58 lbf/in²) and 25 bar (363 lbf/in²), depending on the current output form the hydraulic ECU. This pilot pressure then selects the main spool (30) in the lift valve section of the main hydraulic valve assembly to the raise position.

When the main spool (30) has been stroked to the raise position, oil from the main pump flows through the control spool (30) out of port 'A' on the main hydraulic valve, onto the tip cylinders (1).

The load sense pressure created by copy spool (31) is controlled to a maximum of 195 bar (2830 lbf/in²) by relief valve (26). This will result in a maximum main pump delivery pressure for the body raise circuit of 220 bar (3200 lbf/in²). This is a result of the 195 bar (2830 lbf/in²) maximum load sense pressure, plus the 25 bar
this signal to an output current at Pin C1:31 between 250 and 800 mA dependent upon how far the lever is selected. This current is seen at the Electro-Hydraulic Proportional Pressure Control Valve (29) that converts this current into a pilot pressure.

The pilot control pressure of 35 bar (508 lbf/in²), created by pressure reducing valve (9) is reduced by the proportional pressure control valve (29) to between 4 bar (58 lbf/in²) & 25 bar (363 lbf/in²), depending on the current output from the hydraulic ECU. This pilot pressure selects the main spool (30) in the lift valve section of the main hydraulic valve assembly to the lower position.

When the main spool (30) has been stroked to the lower position, oil from the main pump flows through the control spool (30) out of port 'B' on the main hydraulic valve, onto the tip cylinders (1).

When oil from the main pump flows through control spool (30), a pressure is created at the head of copy spool (31). The copy spool (31) strokes down allowing a load sense pressure to be fed back to the load sense port of the main pump via shuttle valves (22 & 25). The main pump then increases its displacement and flow passes to port 'B' lowering the body. Returning flow from the tipping cylinders (1) passes to Port 'A', through the control spool (30) back to tank.

During lowering the operator can fully select the body control lever onto an electric detent within the lever base which is connected to the hydraulic ECU pin C1:35, This detent holds the lever in the power down position allowing the operator to drive the vehicle whilst the body is still lowering.

Located on the chassis is a proximity switch which supplies a 24 Volt signal to the hydraulic ECU pin C1:6. When the body reaches the proximity switch the 24 Volt signal is switched off, this tells the hydraulic ECU to de-energise the electric detent allowing the lever to spring back to the mid position. At the same time the hydraulic ECU ramps back the current to proportional pressure control valve (29) to de-select the main spool (30) and energises the coil on the float solenoid valve (13) allowing the body to float down to the chassis over the last few centimeters of travel.

To prevent damage to the body hinge points or the tip cylinders (1) the float solenoid valve (13), which is connected to Pin C1:23 on the hydraulic ECU is energised all the time the body is on the chassis and the engine is running. This ensures that the head side of the tip cylinders (1) is always vented to tank and the body is sitting firmly on the chassis.

LOWERING THE BODY

When the operator pushes forward on the body control lever a voltage between 0 and 5 volts is sent to the hydraulic ECU, Pin C1:12. The hydraulic ECU converts (360 lbf/in²) stand by pressure of the main pump. Refer to Section 230-0050, MAIN HYDRAULIC PUMP.

Body relief valve (47) is located on the raise side of the circuit and prevents pressure spikes at maximum extension of the cylinders when the body is raised at maximum engine speed. Relief valve (47) is set at 230 bar (3 335 lbf/in²).
5 - Proportional Control Valve (Raise)
9 - Pressure Reducing Valve - Pilot Pressure
13 - Float Solenoid
15 - Priority Valve
21 - Shuttle Valve
22 - Shuttle Valve
25 - Shuttle Valve
26 - Relief Valve - Body Raise Pressure LS
29 - Proportional Control Valve (Lower)
31 - Copy Spools
32 - Load Sense Dump Valve
46 - Orifice
47 - Relief Valve

Valve (5 & 29) Coil Rating
<table>
<thead>
<tr>
<th>Ohms</th>
<th>Amps</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1.1</td>
<td>25</td>
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</table>

Voltage: 24V

Valve (13) Coil Rating
<table>
<thead>
<tr>
<th>Ohms</th>
<th>Amps</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>0.6</td>
<td>15</td>
</tr>
</tbody>
</table>

Voltage: 24V

Fig. 4 - Main Hydraulic Valve Assembly - Body Control Valve Locations
When the body meets the proximity switch on the chassis the control spool is de-selected and reverts to the neutral position. This action closes the copy spool (31). The load sense dump valve (32) allows a controlled load sense pressure drain back to the hydraulic tank.

When the control spool (30) moves to the neutral position, oil delivery from the main pump is blocked. To compensate for this over the last few centimeters of travel, make up check valve (33) opens allowing a controlled oil flow via port ‘B’ to the lower side of the tip cylinders (1). The make up check valve (33) opening safeguards the system against cavitation when the main pump flow is blocked during the lowering procedure of the body.

**CHECKING SYSTEM PRESSURES**

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks and blocking materials are properly secured and of adequate capacity to do the job safely.

Hydraulic fluid pressure will remain within the system after engine shut down. Operate the brake treadle pedal continuously until the pressure has dissipated before carrying out any work on the system or serious injury could result.

**CHECKING MAIN BODY SYSTEM PRESSURE**

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the brake treadle valve continuously to relieve pressure in the accumulators. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. This following procedure will check that the body raise pressure is properly set. Connect a hydraulic gauge, capable of recording a pressure of 0 - 345 bar (0 - 5 000 lbf/in²), to body system pressure diagnostic pressure point inside battery box (8, Fig. 5).

4. Place the battery master switch in the 'On' position, start the engine and allow all systems to be charged normally.

5. Pull back body control lever. Allow body to raise over relief. The pressure observed on the pressure gauge should be 220 bar (3200 lbf/in²).

6. Pressure setting can be adjusted by adjusting relief valve (26) on the main hydraulic valve assembly. Relief valve (26) actually sets the load sense pressure for the body circuit, controlling the load sense to a maximum of 195 bar (2830 lbf/in²). This will result in a maximum main pump delivery pressure for the body raise circuit of 220 bar (3200 lbf/in²). This is due to the 195 bar (2830 lbf/in²) maximum load sense pressure, plus the 25 bar (360 lbf/in²) stand by pressure of the main pump. Refer to Section 230-0050, MAIN HYDRAULIC PUMP. The operator cab will require to be raised to access relief valve (26). Refer to Section 260-0010, CAB AND MOUNTING.

7. Adjust relief valve (26) until 220 bar (3200 lbf/in²) is observed on the pressure gauge, while raising the body over relief.

8. Shut off the engine and remove the pressure gauge from diagnostic check point.
9. Remove wheel blocks, place the steering lock bar in the 'Stowed' position, start the engine and check the body system for proper operation.

CHECKING PILOT CONTROL PRESSURE

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the brake treadle valve continuously to relieve pressure in the accumulators. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. The operators cab has to be raised at this stage so that port 'DL' on the main hydraulic valve can be accessed. Refer to Section 260-0010, CAB AND MOUNTING.

4. Connect a hydraulic gauge, capable of recording a pressure of 0 - 345 bar (0 - 5 000 lbf/in²), into port 'DL' on the main hydraulic valve assembly.

5. Place the battery master switch in the 'On' position, start the engine and allow all systems to be charged normally.

6. A hydraulic pressure of 35 bar (500 lbf/in²) should be observed on the pressure gauge.

7. Pressure setting can be adjusted by adjusting pressure reducing valve (9) on the main hydraulic valve. Adjust pressure reducing valve (9) until 35 bar (500 lbf/in²) is observed on the pressure gauge.

8. Check body system for proper operation.

9. Shut off the engine and remove the pressure gauge from port 'DL'.

10. Operators cab should be lowered into travel position. Check hydraulic lines for any leakage.

11. Remove wheel blocks, place the steering lock bar in the 'Stowed' position, start the engine and check the body system for proper operation.

'O' RING FACE SEALS (ORFS)

Where hydraulic lines are fitted with ORFS connections, the following procedure should be carried out during 'Installation'. Refer to Fig. 6.

a. Ensure 'O' ring/seal is in place and that the joining surfaces are clean. If necessary, retain 'O' ring/seal in place with a light coating of grease or vaseline.

b. Initially, the nuts should be tightened by hand.

c. Where a hose is fitted, ensure that it is not twisted or kinked when the nuts are tightened so that it is allowed to adopt a natural position.

d. Where a tube is fitted, ensure that the connection is aligned correctly.

e. Tighten the nut a further 1/4 to 1/2 a turn using the correct size spanner (wrench).

f. Check that a satisfactory hose or tube routing has been achieved.

HYDRAULIC OIL

The braking system should be kept filled with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM.

Whenever there is a hydraulic system failure, the oil should be drained, the entire system flushed, oil filters replaced, oil screens thoroughly cleaned and clean hydraulic oil added to eliminate all metal particles or foreign matter.

SERVICE TOOLS

It is recommended that the following service tools are used when carrying out pressure and temperature checks during maintenance procedures. These tools, along with other general service tools, are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of these tools.
Multi-Gauge
The multi-gauge, 15269784, is basically four pressure gauges in one. Continuous system pressure readings are indicated on one of three simultaneously reading gauges through a pressure range of 30 in of vacuum to 5 000 lbf/in².
The following items should be added to the multi-gauge to enable the gauge to be used on the diagnostic pressure check points;
15018226 Diagnostic Coupling
00118748 Connector (2 off)
15004085 Hose Assembly (-04 HP, 2130 mm long)

Non-contact Infrared Thermometer
The infrared thermometer, 15269785, can be used to spot heat problems early in electrical, mechanical and hydraulic systems. Hand held and easy to use, you simply aim, pull the trigger, and read the temperature. Since there is no need to touch what you are measuring, temperatures of hard-to-reach or moving components can be taken without getting burned or shocked.

O’ Ring Face Seals (ORFS) - Seal Kit
The braking system utilizes ‘O’ Ring Face Seal (ORFS) connectors. An ORFS kit, 15271082, is available. This kit contains a minimum stock requirement of all sizes of ORFS type seal.
## Body System Trouble Shooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body will not lift</td>
<td>Pressure Level in the system not high enough</td>
<td>Check pressure at the pump and re-adjust Relief Valve (26). Refer to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Section 230-0050, MAIN HYDRAULIC PUMP.</td>
</tr>
<tr>
<td></td>
<td>No electric current at the proportional control valve (5)</td>
<td>Check voltage at the electric connector of for Valve (5) when pulling back on the lever in the cab. If no voltage present refer to Sections 190-0085 HYDRAULIC ECU and 230-0081, BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Proportional control valve (5) faulty</td>
<td>Replace Valve (5)</td>
</tr>
<tr>
<td></td>
<td>Control lever in the cab faulty</td>
<td>Check output from lever. Refer to Sections 190-0085 HYDRAULIC ECU and 230-0081, BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Main control spool (30) in the lift section of the main hydraulic valve assembly sticking</td>
<td>Replace lift section of the main hydraulic valve assembly</td>
</tr>
<tr>
<td></td>
<td>Copy spool (31) sticking</td>
<td>Check condition of copy spool, replace if necessary. Replace Main Hydraulic Valve Assembly</td>
</tr>
<tr>
<td></td>
<td>Contamination in the load sense drillings and the orifice (46)</td>
<td>Clean orifice (46). Replace Main Hydraulic Valve Assembly</td>
</tr>
<tr>
<td></td>
<td>Main pump faulty</td>
<td>Refer to Section 230-0050 MAIN HYDRAULIC PUMP, for correct setting procedures</td>
</tr>
<tr>
<td>Lift function too slow</td>
<td>Proportional control valve (5) current not high enough</td>
<td>Check output from body control lever. Refer to Sections 190-0085 HYDRAULIC ECU and 230-0081, BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Main control spool (30) not fully selecting.</td>
<td>Replace lift section of main hydraulic valve assembly.</td>
</tr>
<tr>
<td></td>
<td>Contamination in the load sense drillings and the orifice (46).</td>
<td>Clean orifice (46). Replace Main Hydraulic Valve Assembly.</td>
</tr>
<tr>
<td></td>
<td>Main pump faulty.</td>
<td>Refer to Section 230-0050 MAIN HYDRAULIC PUMP, for correct setting procedures</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Remedy</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lift function too slow (cont.)</td>
<td>Control lever in the cab faulty.</td>
<td>Check lever outputs. Refer to Sections 190-0085 HYDRAULIC ECU and 230-0081 BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Engine RPM too low.</td>
<td>Can affect pump delivery. Check throttle pedal for correct signals.</td>
</tr>
<tr>
<td>Body will not lower.</td>
<td>Supply fuse to hydraulic ECU blown.</td>
<td>Check that green LED on the hydraulic ECU is illuminated. Replace fuse F48 located inside fuse box. Refer to Section 190-0000 CIRCUIT DIAGRAMS</td>
</tr>
<tr>
<td></td>
<td>No electric current at proportional control valve (29)</td>
<td>Check link between body control lever and hydraulic ECU and hydraulic ECU and proportional control valve (29). Refer to Sections 190-0085 HYDRAULIC ECU and 230-0081 BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Proportional control valve (29) faulty.</td>
<td>Check connections. Replace proportional control valve (29).</td>
</tr>
<tr>
<td></td>
<td>Control lever in the cab faulty.</td>
<td>Check for output from control lever. Refer to Sections 190-0085 HYDRAULIC ECU and 230-0081 BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Proximity switch on chassis reading LOW (float condition)</td>
<td>Check connections/replace proximity switch.</td>
</tr>
<tr>
<td>Body lowers too slow.</td>
<td>Not enough electric current at the proportional control valve (29)</td>
<td>Check output from body control lever. Refer to Sections 190-0085 HYDRAULIC ECU and 230-0081 BODY CONTROL LEVER</td>
</tr>
<tr>
<td></td>
<td>Pilot pressure not high enough</td>
<td>Re-set pilot pressure at pressure reducing valve (9). If it cannot be reset replace pressure reducing valve (9).</td>
</tr>
<tr>
<td></td>
<td>Main control spool (30) sticking.</td>
<td>Replace lift section of the main hydraulic valve assembly.</td>
</tr>
<tr>
<td></td>
<td>Faulty main pump.</td>
<td>Refer to Section 230-0050 MAIN HYDRAULIC PUMP, for correct setting procedures.</td>
</tr>
<tr>
<td></td>
<td>Contamination in the load sense drillings and the orifice (46).</td>
<td>Clean orifice (46). Replace main hydraulic valve assembly.</td>
</tr>
</tbody>
</table>
## Body System Trouble Shooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body will not hold</td>
<td>Oil by-pass between control spool (30) and valve body</td>
<td>Replace lift section of main hydraulic valve assembly</td>
</tr>
<tr>
<td></td>
<td>Oil by-pass body lift cylinders (1)</td>
<td>Repair lift cylinders (1)</td>
</tr>
<tr>
<td></td>
<td>Control spool (30) not centering</td>
<td>Check that there is zero pilot pressure at both ends of control spool (30). Either of proportional control valves (5/29) could remain active</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check body control lever. Should be zero output signal from control lever when in the neutral position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control spool (30) damaged. Replace control spool (30)</td>
</tr>
<tr>
<td>Power down available when body is on the chassis</td>
<td>Faulty proximity switch on chassis</td>
<td>Check connections. Replace proximity switch. Refer to Section 190-0085 HYDRAULIC ECU, for check tool</td>
</tr>
<tr>
<td>Body fails too slow down when reaching the proximity switch on the chassis</td>
<td>Faulty proximity switch on chassis</td>
<td>Check gap between body plate and proximity switch. Max. gap 15mm. Replace proximity switch</td>
</tr>
<tr>
<td></td>
<td>Faulty hydraulic ECU or connections</td>
<td>Refer to Section 190-0085 HYDRAULIC ECU for check procedure.</td>
</tr>
<tr>
<td></td>
<td>Main spool (30) sticking</td>
<td>Replace main hydraulic valve assembly</td>
</tr>
<tr>
<td></td>
<td>Faulty float solenoid valve (13)</td>
<td>Check connections. Replace valve(13). Refer to Section 190-0085 HYDRAULIC ECU</td>
</tr>
<tr>
<td>Body fails too go into float and stops before it reaches the chassis</td>
<td>No voltage at the float solenoid valve (13)</td>
<td>Check connections at valve (13) and hydraulic ECU. Refer to Section 190-0085 HYDRAULIC ECU</td>
</tr>
</tbody>
</table>

* * * * *
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

The hydraulic tank (1) is the common reservoir for the steering, braking, body hoist and transmission oil cooler fan drive systems. It is mounted off the frame at the rear right hand side of the tractor.

Integral with hydraulic tank (1) assembly are filter assembly (2), oil level sight gauge (5) and access cover (21). Located on top of the tank is filler cap (12), breather (17) and filter restriction gauge (14).

OPERATION
Numbers in parentheses refer to Fig. 2.

Oil is added to the hydraulic tank (4) through filter assembly (2). The hydraulic oil is drawn from hydraulic tank (4) by main hydraulic pump (1) and pumped to the main hydraulic valve to supply the various hydraulic
Body System - Hydraulic Tank

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Emergency steering oil is drawn from hydraulic tank (4) by emergency pump (2), mounted off transmission, and is also pumped to the main hydraulic valve. Should a failure occur at the main hydraulic pump (1) the emergency pump (2) will supply the steering system with oil to enable the vehicle to be brought to a safe halt. Refer to Section 220-0000, STEERING SYSTEM SCHEMATIC.

Return oil from the hydraulic systems flows through hydraulic oil cooler (3) (if fitted) and filter assembly (5) before entering the tank storage area. The filter assembly has a bypass valve which allows oil to bypass element (3, Fig. 1) when it is cold or when the filter element is plugged. The bypass valve opens at a pressure differential of 1.5 bar (22 lb/in²). Filter restriction gauge (14, Fig. 1) shows red when element (3, Fig. 1) requires to be changed.

**MAINTENANCE**

Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**WARNING**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

**Checking Oil Level**

1. Operate the body hoist and steering systems several times to bring the oil to correct operating temperature.

2. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel in both directions several times to relieve any pressure in the
steering circuit. Operate treadle valve continuously to discharge accumulators.

3. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

4. Check oil level and add if low. Oil should at least reach the minimum level in the sight gauge (5). If oil is required, remove filler cap (12) from hydraulic tank (1) and fill hydraulic tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (12) on hydraulic tank (1) and tighten.

**Replacing Hydraulic Oil**

Hydraulic oil should be changed every 2,000 hours. Refer to Section 300-0020, LUBRICATION SYSTEM, for hydraulic oil used in the system.

**Note:** When replacing the hydraulic oil due to a hydraulic failure, or at recommended change interval, element (3) must be replaced and hydraulic tank (1) cleaned thoroughly using a suitable solvent.

**Replacing Breather**

Every 1,000 hours of operation, or sooner if the vehicle is being operated in extremely dusty conditions, the hydraulic tank breather should be replaced.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel in both directions several times to relieve any pressure in the steering circuit. Operate treadle valve continuously to discharge accumulators.

2. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Unscrew breather (17) and remove from tank (1). Discard 'O' ring (9).

4. Install new 'O' ring (9) and breather (17) to tank (1).

**Replacing Filter Element**

Every 2,000 hours of operation or when filter restriction gauge (14) shows red, whichever comes first, clean filter assembly (2) and install new element (3).

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel in both directions several times to relieve any pressure in the steering circuit. Operate treadle valve continuously to discharge accumulators.

2. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Remove blanking cap from remote drain valve (7) on the bottom of hydraulic tank (1). Install a hose adaptor (15) on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap on remote drain valve (7).

4. Remove bolts (6 & 18) and washers (19) securing guard (25) and cover plate (11) to top of hydraulic tank (1). Remove guard (25), cover plates (11) and gasket (10) from hydraulic tank (1). Discard gasket (10).

5. Remove filter assembly (2) from hydraulic tank (1).

6. Remove and discard element (3) from filter assembly (2). Discard 'O' ring (4).

7. Remove bolts (18) and lockwashers (16) securing access cover (21) to tank (1). Remove access cover (21) and discard 'O' ring (20).

**WARNING**

*Splashing liquid. Wear a suitable face shield when using compressed air to dry hydraulic tank and components.*

8. Clean out the inside of hydraulic tank (1) with a suitable solvent and dry with compressed air.

9. Install new element (3) in filter assembly (2).

10. Install filter assembly (2) in tank (1), complete with new 'O' ring (4).

11. Place new gasket (10), cover plate (11) and guard (25) on hydraulic tank (1). Secure with bolts (6 & 18) and washers (19).

12. Install new 'O' ring (20) and secure access cover plate (21) on hydraulic tank (1) with bolts (18) and lockwashers (16).

13. Remove filler cap (12) from hydraulic tank (1) and fill hydraulic tank with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (12) on hydraulic tank (1) and tighten.
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14. Place the battery master switch in the 'On' position and the steering lock bar in the 'Stowed' position, remove all wheel blocks, start the engine and operate the steering, braking and body hoist systems to circulate the oil.

15. Switch off the engine, check for leaks and check oil level as described under 'Checking Oil Level'.

TANK ASSEMBLY
Inspection
Numbers in parentheses refer to Fig. 1.

**WARNING**
Splashing liquid. Wear a suitable face shield when using compressed air to dry hydraulic tank and components.

1. Clean hydraulic tank (1) and components with a suitable solvent and dry with compressed air.

2. Inspect hydraulic tank (1) for weld cracks and security of internal pipes and weld fitments.

3. Inspect breather (17), filter restriction gauge (14) and filter assembly (2) for damage. Replace if required.

Installation
Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**Note:** Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all 'O' rings where used.

**WARNING**
To prevent personal injury and property damage, ensure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel in both directions several times to relieve any pressure in the steering circuit. Operate treadle valve continuously to discharge accumulators.

2. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Remove blanking cap from remote drain valve (7) on the bottom of hydraulic tank (1). Install a length of hose on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap on remote drain valve (7).

4. Ensure all hydraulic lines connected to hydraulic tank (1) are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps and plugs to all open lines and fittings.

5. Remove two bolts (18) and washers (19) from top of hydraulic tank (1) and install eyebolts. Attach a suitable lifting device to eyebolts and remove nuts (27), lockwashers (28) and bolts (26) securing hydraulic tank (1) to fender and support bracket.

6. Carefully remove hydraulic tank (1) assembly from the unit to a clean work area for inspection.

1. Using a suitable lifting device, position hydraulic tank (1) in position on the vehicle and secure with bolts (26), lockwashers (28) and nuts (27).

2. Remove eyebolts that were installed to lift hydraulic tank (1). Reinstall two bolts (18) and washers (19) on top of tank (1).

3. Install new 'O' rings and install all hydraulic lines and fittings to hydraulic tank (1), as tagged at removal.

4. Remove filler cap (12) and fill hydraulic tank (1) with hydraulic oil specified in Section 300-0020, LUBRICATION SYSTEM. Install filler cap (12) on hydraulic tank (1) and tighten.

1. Clean hydraulic tank (1) and components with a suitable solvent and dry with compressed air.

2. Inspect hydraulic tank (1) for weld cracks and security of internal pipes and weld fitments.

3. Inspect breather (17), filter restriction gauge (14) and filter assembly (2) for damage. Replace if required.

**WARNING**
To prevent personal injury and property damage, ensure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Place the battery master switch in the 'On' position and the steering lock bar in the 'Stowed' position, remove all wheel blocks, start the engine and operate the steering, braking and body hoist systems to circulate the oil.

15. Switch off the engine, check for leaks and check oil level as described under 'Checking Oil Level'.

TANK ASSEMBLY
Removal
Numbers in parentheses refer to Fig. 1.

**WARNING**
To prevent personal injury and property damage, ensure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine. Turn steering wheel in both directions several times to relieve any pressure in the steering circuit. Operate treadle valve continuously to discharge accumulators.

2. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Remove blanking cap from remote drain valve (7) on the bottom of hydraulic tank (1). Install a length of hose on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap on remote drain valve (7).

4. Ensure all hydraulic lines connected to hydraulic tank (1) are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps and plugs to all open lines and fittings.

5. Remove two bolts (18) and washers (19) from top of hydraulic tank (1) and install eyebolts. Attach a suitable lifting device to eyebolts and remove nuts (27), lockwashers (28) and bolts (26) securing hydraulic tank (1) to fender and support bracket.

6. Carefully remove hydraulic tank (1) assembly from the unit to a clean work area for inspection.
5. Place the battery master switch in the 'On' position and the steering lock bar in the 'Stowed' position, remove all wheel blocks, start the engine and operate the steering, braking and body hoist systems to circulate the oil.

6. Switch off the engine, check for leaks and check oil level as described under 'Checking Oil Level'.

**SPECIAL TOOLS**

There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.
DESCRIPTION

Numbers in parentheses refer to Figs. 1 & 7.

The Hydraulic Pump can be identified as item 5 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

The hydraulic pump is mounted off the rear of the transmission. It is an axial piston, variable displacement pump with load sense and pressure regulator to match the flow and pressure to the demand. The pump displaces 140cc/rev, and the pressure regulator is set to 240 bar (3500 lbf/in²).

The pump supplies hydraulic oil for the steering, braking and body hoist systems, as well as the transmission oil cooler fan drive system.

The components of the pump can be divided into three sub-groupings:

Rotating Group - Provides the main rotary pumping action. Consists of driveshaft (80), cylinder block (42), piston and shoe (46), set plate (45), spherical bush (44) and cylinder springs (43).

Swash Plate Group - Varies the pump’s delivery flow.
rate. Consists of swash plate (49), shoe plate (47), swash plate support (50), tilting bush (48), tilting pin (66), servo piston (61) and servo assist springs (70 & 71).

Valving Cover Group - Provides the switching of oil between suction and delivery ports. Consists of valve cover (1), valve plate (41) and valve plate pin (65).

**OPERATION**

Numbers in parentheses refer to Figs. 1, 2 & 7. Refer to Figs. 4 - 6 for hydraulic schematics of pump.

When the pump's driveshaft (80) rotates, the cylinder block (42) being spline coupled to the shaft will also rotate. If the swash plate (49) has been tilted, the pistons and shoes (46) arranged in the cylinder block (42) due to the shoes being retained on the shoe plate (47) will both rotate with the cylinder block and reciprocate once per revolution.

Paying attention to one such piston, then it will move away from the valve plate (41) for half a rotation (suction stroke), and move towards the valve plate (41) for the second half of rotation (delivery stroke). The larger the tilt angle of the swash plate (49), the longer the piston (46) stroke and the higher the pump's displacement. As the swash plate (49) tilting angle approaches zero, the piston (46) does not stroke and
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therefore delivers minimum displacement. (Refer to Fig. 3).

Pressure Regulator

Numbers in parentheses refer to Figs. 1 & 7.

Pressure regulator (6) is a pilot operated differential pressure type spool regulator for load sense control. The load sense feedback signal from the main hydraulic valve is fed to load sense port \( (P_l) \) on top of the pressure regulator (6) (see Fig. 8). This feedback signal acts on the spring chamber end of the spool (23).

Unregulated Condition - Refer to Fig. 4. Pump pressure is low and the load sense signal is wide open. The cut-off pressure spool spring (18 & 20) preload shifts the cut-off pressure spool (24) to its extreme right position. Since the pressure drop across the main hydraulic valve is low, both sides of the differential pressure spool (23) see the same pressure and therefore the spool (23) remains in the extreme right position. This condition causes the oil at the servo piston (61) to be vented, causing spring (70 & 71) force to move servo piston (61) and swash plate (49) to maximum pump displacement.

Regulated Condition - Refer to Fig. 5. Pump pressure is still relatively low but the pressure drop across the main hydraulic valve increases. The cut-off pressure spool spring (18 & 20) preload still retains the spool (24) in its extreme right position. However, since the pressure drop is increased, the pressure on the right hand side of the differential pressure spool (23) (pump delivery pressure) overcomes the combination of spring (17 & 19) preload and pressure in the load sense line in the left hand side of the differential pressure spool (23). Therefore the spool (23) moves to the left, blocking vent line and causing pressure at large side of servo piston (61) to increase, overcoming spring (70 & 71) force. This reduces the swash plate (49) angle and hence pump displacement.

This will continue until the pump flow across the main hydraulic valve reduces the pressure drop to the value determined by the differential spool spring (17 & 19) preload.

Standby Condition - Refer to Fig. 6. When no hydraulic operations are required, the pump standby condition is reached. The load sense line is vented to tank. Differential pressure spool (23) shifts to the extreme left due to pump outlet pressure. This allows oil pressure to pass through cut-off pressure spool (24) and reach the large side of servo piston (61).
overcoming spring (70 & 71) force and reducing swash plate (49) angle to zero.

The pump also has a pressure limiting function, used for example when steering cylinder reaches the end of its stroke. In this condition the delivery pressure will rise, and the load sense control will try to raise delivery pressure above the now 'dead head' pressure. This causes differential pressure spool (23) to shift to the extreme left, allowing oil pressure to pass through cut-off pressure spool (24) and reach the large side of servo piston (61), overcoming spring (70 & 71) force and reducing swash plate (49) angle to zero.

**REMOVAL**

Numbers in parentheses refer to Figs. 1 & 7.

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the treadle valve continuously to relieve pressure in the braking system. Block all road wheels and place battery master switch in the 'Off' position. Place steering lock bar in the 'Locked' position.

3. Remove blanking cap from remote drain line at the bottom of the hydraulic tank. Install a length of hose on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap.

4. Clean pump housing and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to pump are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines and fittings.

5. Support pump assembly with suitable lifting equipment. It is possible to set up a sling arrangement using exhaust cradle. Remove bolts (56) and lockwashers (57) securing pump to transmission. Remove pump from transmission.

6. Remove O’ring from pump. Wash the outside of pump thoroughly with a suitable solvent and move to a clean work area for disassembly. Discard O’ring.

**DISASSEMBLY**

Numbers in parentheses refer to Figs. 1 & 7.

**Note:** Discard and replace all O’ rings and seals removed during disassembly.

1. Remove drain plug (53) and drain oil from pump casing (51).

2. Remove bolts (26) and then remove regulator casing (25) from pump casing (51). Ensure O’ring does not drop from the gasket surface of the regulator. Fit blanking caps to all open ports.

3. Remove bolts (2 & 3) securing valve cover (1) to pump casing (51).

4. Separate valve cover (1) from casing (51). Valve plate (41) may detach from valve cover. Ensure contact faces of valve cover (1) and casing (51) are not damaged.

5. If necessary remove needle bearing (40) and valve plate (41) from valve cover (1). Only remove needle bearing (40) if it is nearing the end of its life. Do not loosen nut (4) as this will affect delivery flow rate.

6. Pull cylinder block (42) out from pump casing (51) straight over driveshaft (80). Pull out pistons and shoes (46), set plate (45), spherical bush (44) and cylinder springs (43) at the same time. Be careful not to damage sliding surfaces of components.

7. Cover splined end of shaft with plastic tape to prevent oil seal (81) being damaged. Remove bolts (84) and seal cover (83), ensuring oil seal (81) is not damaged.

8. Hold front of driveshaft (80) and using a plastic hammer, tap driveshaft (80) out of pump casing (51). Do not remove roller bearing (79) unless it is considered to be near the end of its expected life.

9. Push down servo piston (61), and remove shoe
Fig. 7 - Exploded View Of Hydraulic Pump
Body System - Main Hydraulic Pump

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Plate (47) and swash plate (49).

10. Remove swash plate support (50) from pump casing (51).

11. If necessary, remove servo piston (61), tilting pin (66), outer spring (70), inner spring (71), spring seat (69) and plug (76). Ensure servo piston (61) and tilting pin (66) are not damaged when being removed.

Pressure Regulator

1. Remove plug (9) and then remove springs (17 & 19) and spring seat (21). Be careful not to drop spool (23) after removing plug (9). Do not remove nut (8), set screw (7) or stopper (13) unless required.

2. Remove plug (10) and then remove springs (18 & 20) and spring seat (22). Be careful not to drop spool (24) after removing plug (10). Do not remove nut (8), set screw (7) or stopper (14) unless required.

3. Loosen plug (33) and remove spools (23 & 24).

4. If necessary, remove plugs (27, 31, 34 & 36) and orifice (28 & 35).

ASSEMBLY

Numbers in parentheses refer to Figs. 1 & 7.

This is largely the reverse sequence to disassembly, but note the following:-

a) Ensure that all damaged parts are fixed or replaced before assembly.

b) Before assembly wash each part with clean oil and dry with compressed air. Assemble pump in a clean work area to prevent contamination.

c) When assembling apply clean oil on the sliding surfaces and bearings.

d) When assembling parts that easily detach, like an ‘O’ ring, apply clean grease to prevent them dropping out.

1. Install servo piston (61), tilting pin (66), outer spring (70), inner spring (71), spring seat (69) and plug (76) in pump casing (51). Apply adhesive on thread of servo piston (61).

2. Fit swash plate support (50) in pump casing (51). Make sure that pin (64) enters into the slit of swash plate support (50). Be careful not to install swash plate support (50) in oblique.

3. Push down servo piston (61) and insert tilting pin (66) into tilting bush (48) of swash plate (49). Install swash plate (49) and shoe plate (47) into groove of swash plate support (50) correctly.

4. Insert driveshaft (80) into pump casing (51), tapping driveshaft (80) lightly so that the end of roller bearing (79) is slightly above the surface of pump casing (51). This prevents the swash plate support (50) being displaced.
5. Cover the splined end of the driveshaft (80) with plastic tape. Apply grease on lip of oil seal (81) installed in seal cover (83). Insert seal cover (83) slightly into pump casing (51). Tighten bolts (84) uniformly to locate seal cover (83), then tighten bolts to standard torque.

6. Sub-assemble cylinder block (42), pistons and shoes (46), spherical bush (44), set plate (45) and cylinder springs (43).

7. Place pump casing (51) horizontally with surface of regulator downward. Install piston-cylinder sub-assembly into pump casing (51).

8. Install valve plate (41) on valve cover (1). When installing valve plate (41), ensure that pin (65) enters into the slit of valve plate (41). If stopper (58), max flow set screw (5) and max flow set screw lock nut (4) have been removed, reinstall these parts on valve plate (41) beforehand.

9. Install valve cover (1) on pump casing (51) and secure using bolts (2 & 3).

10. Install regulator casing (25) to pump casing (51) and secure with bolts (26).

**Pressure Regulator**

1. If removed, install plugs (27, 31, 34 & 36) and orifice (28 & 35) into regulator casing (25).

2. Install plug (33) and insert spools (23 & 24). When inserting spools, care should be taken not to damage the sliding surface of the spools.

3. If removed, install nut (8), set screw (7) and stopper (13). Insert springs (17 & 19) and spring seat (21) into plug (9).

4. Install plug (9) into regulator casing (25).

5. If removed, install nut (8), set screw (7) and stopper (14). Insert springs (18 & 20) and spring seat (22) into plug (10).

6. Install plug (10) into regulator casing (25).

7. Ensure ‘O’ rings (38) are in place and install regulator casing (25) on pump casing (51) using bolts (26).

**INSTALLATION**

Numbers in parentheses refer to Figs. 1 & 7.

**Note:** Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all ‘O’ rings where used.

**WARNING**

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Install new ‘O’ ring to pump.

2. Push pump inward to engage with coupling in transmission. Secure pump assembly to transmission with bolts (56) and lockwashers (57). Tighten bolts (56) to a torque of 230 Nm (170 lbf ft).

3. Remove caps and connect outlet, inlet and load sense lines to pump. Before connecting case drain line, fill pump casing through drain port with clean hydraulic oil as used in the hydraulic tank. Connect the case drain line to pump. Fill hydraulic tank with oil specified in Section 300-0020, LUBRICATION SYSTEM.

**Note:** It is very important that pump casing is completely filled with hydraulic oil. This will ensure proper lubrication of the internal parts of pump when it is initially operated. Fill the pump casing through the drain port. Filling only the suction line is totally insufficient.

4. Refer to ‘PUMP STARTING PROCEDURE’ for proper start-up procedure.

**PUMP STARTING PROCEDURE**

1. Be sure the pump case drain line is free from obstructions that restrict the pump case drain flow back to tank and cause high case drain pressure which can lead to an early pump failure.

2. Ensure that all hydraulic controls are set to a neutral position, the steering lock bar is in the ‘Locked’ position and place the battery master switch in the ‘On’ position. Start the engine and allow the pump to run unloaded for a period to ensure that all residual air within the system is released.

3. Check for external leakage, abnormal noise and vibrations.
4. Remove wheel blocks and place the steering lock bar in the 'Stowed' position. Start the engine and check hydraulic systems for proper operation.

**PRESSURE CHECKS**

To check pump delivery pressure (cut-off pressure) the steering should be operated full lock against the stops. The pump is checked against the steering system as this is the highest pressure requirement in the hydraulic circuit.

⚠️ **WARNING**

Machine has to fully articulate to check pump pressures, therefore steering lock bar cannot be 'Locked'. To prevent personal injury and property damage, exercise extreme caution while working around articulation and oscillation pivot area.

**Delivery Pressure (cut-off pressure)**

Install a pressure gauge capable of at least 240 bar (3500 lbf/in²) into STR diagnostic checkpoint in battery box (5, Fig. 8). When steering against stops, pressure should be 240 bar (3500 lbf/in²).

**Differential Pressure (load sense pressure)**

Install a pressure gauge capable of at least 240 bar (3500 lbf/in²) into STR diagnostic checkpoint in battery box (5, Fig. 8). Install a pressure gauge capable of at least 240 bar (3500 lbf/in²) into LS VAL diagnostic checkpoint in battery box (1, Fig. 8). With steering in neutral position, pressure at STR gauge should be 25 bar (360 lbf/in²) greater than pressure at LS VAL gauge.

If these pressures are not observed, then pump may need to be reset (refer to Troubleshooting).

**TROUBLESHOOTING**

If steering cannot be operated or is excessively heavy, then pump delivery pressure is likely to be low and pump setting should be checked.

If the difference (ΔP) between delivery pressure and load sense pressure is equal to 25 bar (360 lbf/in²), proceed to 'Pump Setting Procedure - Pump Delivery Pressure Setting'.

However, if ΔP is not equal to 25 bar (360 lbf/in²) carry out complete 'Pump Setting Procedure'.

**PUMP SETTING PROCEDURE**

**Note:** It is very important that pump casing is completely filled with hydraulic oil before pump is operated. Fill the pump casing through the drain port. Filling only the suction line is totally insufficient.

**Differential Pressure Setting**

Numbers in parentheses refer to Figs. 1 & 7, unless otherwise stated.

1. Install a pressure gauge capable of at least 240 bar (3500 lbf/in²) into STR diagnostic checkpoint in battery box (5, Fig. 8) to measure pump delivery pressure (cut-off pressure) (Gauge A).

2. Install a pressure gauge capable of at least 240 bar (3500 lbf/in²) into LS VAL diagnostic checkpoint in battery box (1, Fig. 8) to measure load sense pressure setting (Gauge B).

3. Ensure that all hydraulic controls are set to a neutral position, the steering lock bar is in the 'Locked' position and place the battery master switch in the 'On' position. Start the engine and allow to run at low idle. This allows the pump to run unloaded for a period to ensure that all residual air within the system is released. Check for external leaks.

4. Check readings on both pressure gauges. Pump delivery pressure (Gauge A) should always be greater than load sense pressure (Gauge B). This differential pressure (ΔP) should be equal to 25 bar (360 lbf/in²). If
Body System - Main Hydraulic Pump

Section 230-0050

the $\Delta P$ pressure differs from 25 bar (360 lbf/in$^2$), then carry out steps 5 through 9.

Note: Typical readings -
STR = 34 - 38 bar (500 - 550 lbf/in$^2$)
LS Val = 11 - 13 bar (160 - 180 lbf/in$^2$)

Note: If the pump delivery pressure (Gauge A) is less than 25 bar (360 lbf/in$^2$), disconnect transmission oil cooler fan solenoid, causing solenoid valve to default to an open position, allowing hydraulic oil to the fan motor. This will place a demand on the pump, causing pump delivery pressure to increase.

5. At differential pressure (load sense) port (see Fig. 9), unlock nut (8) and turn set screw (7) clockwise (looking straight at set screw) to increase $\Delta P$ pressure, or counter-clockwise to decrease $\Delta P$ pressure.

Note: Adjustment of $\Delta P$ pressure = 5 bar (70 lbf/in$^2$) increase per quarter turn of set screw (7). This is a result of an increase of 7 bar (100 lbf/in$^2$) on the pump delivery pressure and an increase of 2 bar (30 lbf/in$^2$) on the LS pressure.

Note: Pressure should always be adjusted on the increase. Hence if $\Delta P$ pressure is too high, set screw (7) should be turned counter-clockwise approximately 2 turns, then turn set screw (7) clockwise to attain 25 bar (360 lbf/in$^2$).

6. Recheck readings on both pressure gauges. Pump delivery pressure (Gauge A) should be 25 bar (360 lbf/in$^2$) greater than load sense pressure (Gauge B).

7. Once correct $\Delta P$ is achieved, tighten nut (8) at differential pressure (load sense) port to 16 Nm (12 lbf ft).

8. The differential pressure ($\Delta P$) is now set. Switch off the engine and relieve system pressures as described in 'Removal'.

9. Remove pressure gauges from diagnostic checkpoints in battery box.

Pump Delivery Pressure Setting
Numbers in parentheses refer to Figs. 1 & 7, unless otherwise stated.

! WARNING
Machine has to fully articulate to set pump, therefore steering lock bar cannot be 'Locked'. To prevent personal injury and property damage, exercise extreme caution while working around articulation and oscillation pivot area.

There should be no requirement to adjust the set screw (7) at delivery pressure (cut-off pressure) port (see Fig. 9) as this is factory set. The cut-off pressure sets the pump delivery pressure. If the set screw (7) or nut (8) has been moved, to reset the pump delivery pressure follow the procedure below:

1. Install a pressure gauge capable of at least 240 bar (3 500 lbf/in$^2$) into STR diagnostic checkpoint in battery box to measure pump delivery pressure (cut-off pressure).

2. Start the engine and run at full throttle. Steer full lock against the stops. Observe pressure on gauge. This cut-off pressure should be 240 bar (3 500 lbf/in$^2$). If the pressure reading differs or the steering is excessively heavy, then carry out steps 3 through 8.

Note: Steering has to be operated over relief (against stops) as this is the maximum pressure the pump must deliver. Setting pump against any other operation would result in the pump being set at a lower maximum delivery pressure.

3. At delivery pressure (cut-off pressure) port (see Fig. 9), unlock nut (8) and turn set screw (7) clockwise to increase cut-off pressure, or counter-clockwise to
decrease cut-off pressure (adjustment 90 bar (1 305 lbf/in²) per turn).

Note: Pressure should always be adjusted on the increase. Hence if cut-off pressure is too high, set screw (7) should be turned counter-clockwise to decrease cut-off pressure below 240 bar (3 500 lbf/in²), then turn set screw (7) clockwise to attain 240 bar (3 500 lbf/in²).

4. Once correct cut-off pressure has been attained, revert steering to neutral position, then steer full lock against the stops. Observe gauge to confirm cut-off pressure is set to 240 bar (3 500 lbf/in²).

Note: A change in pump tone should be heard when cut-off pressure is reached, as pump de-strokes to standby condition.

5. If no change in pump tone is heard, cut-off pressure is too high. Return to step 3 of procedure. If problem persists, refer to Section 220-0000, STEERING SYSTEM SCHEMATIC.

6. Tighten nut (8) at cut-off pressure port to 16 Nm (12 lbf ft).

7. The differential pressure (load sense) and cut-off pressure are now set. Switch off the engine and relieve system pressures as described in 'Removal'.

8. Remove pressure gauge from diagnostic checkpoint in battery box.

Note: If there are still problems with the pump pressures after completing the 'Pump Setting Procedure', ensure set screw (5) has not been adjusted. As a dimensional check, the distance between the end of set screw (5) to the face of nut (4) should be 16 mm (0.63 ").

LUBRICATION

Refer to Section 300-0020, LUBRICATION SYSTEM, for recommended periodic oil change periods and oil specifications.

All pump parts are lubricated by the hydraulic oil therefore the oil must be kept clean to minimize pump wear. Whenever there is a hydraulic system failure, the oil should be drained, the entire system flushed, oil filter replaced and clean hydraulic oil added to eliminate all metal particles or foreign matter.

PUMP WEAR LIMITS

Before reassembling the pump after disassembly, the Pump Wear Limits table should be consulted to establish which components should be replaced.

SPECIAL TOOLS

There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

PUMP WEAR LIMITS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>INITIAL VALUE</th>
<th>LIMIT FOR REPLACING</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearance between cylinder (42) bore and piston (46)</td>
<td>0.039 mm</td>
<td>0.067 mm</td>
<td>Replace piston/cylinder</td>
</tr>
<tr>
<td>Endplay between piston and shoe (46)</td>
<td>0.1 mm</td>
<td>0.3 mm</td>
<td>Replace piston-shoe assembly</td>
</tr>
<tr>
<td>Thickness of shoe</td>
<td>4.9 mm</td>
<td>4.7 mm</td>
<td>Replace piston-shoe assembly</td>
</tr>
<tr>
<td>Free height of cylinder spring (43)</td>
<td>39.5 mm</td>
<td>38.8 mm</td>
<td>Replace cylinder spring</td>
</tr>
<tr>
<td>Combined height of set plate (45) and spherical bush (44)</td>
<td>23.0 mm</td>
<td>22.0 mm</td>
<td>Replace set plate</td>
</tr>
</tbody>
</table>

SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE Nm</th>
<th>lbf ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>Nut</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>56</td>
<td>Bolt</td>
<td>230</td>
<td>170</td>
</tr>
</tbody>
</table>

* * * *
BODY SYSTEM - Body Control Lever

DESCRIPTION AND OPERATION

The body control lever is mounted on the right hand side dash panel, next to the transmission shift controller.

When the body control lever is operated, a voltage is sent to the hydraulic ECU, which converts voltage to current. This current controls the body raise and lower proportional pressure control valves, producing a pilot pressure to shift the control spool in the main hydraulic valve. This allows the flow of oil to reach the body cylinders, to either raise or lower the body. Refer to Section 230-0000, BODY SYSTEM SCHEMATIC and Section 215-0050, MAIN HYDRAULIC VALVE.

The three operating positions of the joystick from front to rear are as follows:

**Power Down** - Pushing the lever forward provides hydraulic force to power-down the body. Pushing the lever fully forward will engage the electric detent. When the body reaches the body proximity switch, the lever springs back to 'NEUTRAL' and power down is ramped back to allow the body to float down onto the chassis.

**Neutral** - If the body is above the body proximity switch, the lever in this position will stop and hold the body at any desired height. If the body is below the proximity switch, the hydraulic ECU defaults the control spool in the main hydraulic valve to the neutral position and energises the float solenoid, allowing the body to float down onto the chassis. The body should be fully lowered and in the 'NEUTRAL' position while the machine is in motion. The lever will remain in the 'NEUTRAL' position when released.

**Raise** - Pulling the lever back and holding it in this position directs oil to extend the body hoists and raise the body. When released, the lever will spring back to the 'NEUTRAL' position.

A body lower emergency switch in the cab is connected directly to the float solenoid, within the main hydraulic valve, to enable the lowering of the body in the event of an engine, hydraulic or hydraulic ECU failure. The cause of the failure must be investigated and corrected.

**Note:** The body must remain lowered with lever in the 'NEUTRAL' position until it is necessary to operate the body again. Failure to comply to this could result in overheating the hydraulic oil and failure of the hydraulic system components.

---

**WARNING**

Always disconnect body control lever before welding on the machine.

**MAINTENANCE**

The body control lever is a non-serviceable item and should be replaced completely, if damaged, as follows:

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Hydraulic fluid pressure will remain within the system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the hydraulic system or serious injury could result.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.
2. Operate the treadle valve continuously to relieve pressure in the hydraulic system.

3. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

4. Disconnect body control lever harness from main harness.

5. Support body control lever and remove screws securing body control lever on the right hand dash panel.

6. Remove body control lever from mounting location.

7. Secure new body control lever on the right hand dash panel with screws.

**Note:** Ensure harness from body control lever is at the front when lever is installed.

8. Reconnect main harness to body control lever harness.

9. Place the battery master switch in the 'On' position, start the engine and bring hydraulic oil to operating temperature. Operate the body control lever to ensure correct operation.

10. Remove wheel blocks and place the steering lock bar in the 'Stowed' position.

**TROUBLESHOOTING**

A faulty body control lever will cause an input error at the hydraulic ECU. Refer to Section 190-0085, HYDRAULIC SYSTEM ECU.

**SPECIAL TOOLS**

There are no special tools required for procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

* * *
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

There are two single stage, double acting body hoist cylinders, cushioned at both ends of the stroke on the vehicle. The cylinder base end is connected to the trailer frame and piston rod (2) end is connected at the body. Single stage double acting means that piston rod (2) can have oil applied to either side, extending or retracting the piston rod.

Cylinder mounting is by pins (24 & 29), spacers (25) and spherical bearings (20) secured in place with circlips (21). Spherical bearings (20) permit a limited amount of cylinder misalignment.

REMOVAL
Numbers in parentheses refer to Fig. 1.

⚠️ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

⚠️ Hydraulic fluid pressure will remain within the body hoist system after engine shutdown. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the hydraulic system or serious injury could result.
**Body System - Body Cylinder**

Section 230-0130

**DISASSEMBLY**

Numbers in parentheses refer to Fig. 1.

---

**WARNING**

Exercise extreme caution when lowering the cylinders from the body. The cylinders will swing out sharply as they leave their mountings.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine.

2. Press and hold down body hoist bleed down switch and operate the body control joystick continually to relieve pressure in the body hoist system.

3. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

4. Install a suitable strap around the cylinder and attach to a lifting device.

5. Position a suitable container at the base end of one cylinder. Identify and remove the hydraulic lines. Cap hydraulic lines and cylinder ports to prevent entry of dirt.

6. Remove bolt (26), lockwasher (27), washer (28) and upper pin (24) connecting piston rod (2) end of the cylinder to the body. If due to lack of maintenance the upper pin can not be removed from the front, there is plate on the inside of the body that can be removed to allow access to the rear of the pin to ease removal. This plate is tack welded in place so a grinder is required to remove it.

7. Lower cylinder slowly and remove spacers (25).

**Note:** Cylinder will swing out sharply as it leaves its mounting.

8. Remove bolt (26), lockwasher (27), washer (28) and lower pin (29) connecting base end of the cylinder to the frame.

9. Remove spacers (25) and remove cylinder assembly to a clean area for disassembly.

10. Repeat steps 4 through 9 for opposite cylinder.

---

**WARNING**

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Ensure clean working conditions, remove any port plugs thus allowing easy entry of air into cylinder body (1), preventing a vacuum when parts are withdrawn from cylinder body (1).

2. Remove circlips (21) from base end of cylinder body (1) and piston rod (2) end. Press out spherical bearings (20).

3. Remove lock ring (10) from end cap (3).

4. Using special tool which can be fabricated as shown in Fig. 2, unscrew end cap (3) until thread is disengaged from cylinder body (1).

5. Support piston rod (2) at the rod eye and withdraw piston rod (2) from cylinder body (1). Ensure centre lines of piston rod (2) and cylinder body (1) remain coincidental during removal of piston rod (2).

6. Place piston rod (2) on supports which will not damage the piston rod diameter.

7. Remove and discard piston seals (13) and wear rings (14) from piston (12).

8. Remove grub screw (15) from wear ring (14) groove in piston (12).

9. Provide an anti-torsion device through piston rod (2) eye to allow unscrewing of piston (12). Using special tool which can be fabricated as shown in Fig. 3, unscrew piston (12) from piston rod (2).

10. Remove cushion spear (11) and 'O' rings (16) from piston rod (2). Discard 'O' rings (16).

11. Remove cylinder end cap (3) from piston rod (2). Remove and discard cushion sleeve (4), circlip (5), rod seal (6), nylon ring (22), wiper (7), 'O' rings (8 & 9) and back up ring (17).
INSPECTION

Numbers in parentheses refer to Fig. 1

1. Clean all parts of the cylinder with a suitable solvent and dry with clean, lint-free cloths. Clean all grooves carefully to remove any foreign material.

2. Check cylinder body (1) and outer diameter of piston (12) for scratches, cracks or other defects. Remove ridges, nicks and scratches with a fine stone and re-clean. Replace any components which cannot be repaired.

3. Inspect piston rod (2) for distortion, cracks or other defects. Replace piston rod if defective area is irreparable.

4. Check spherical bearing (20) for wear and replace if necessary.

ASSEMBLY

Numbers in parentheses refer to Fig. 1.

WARNING

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Press spherical bearing (20) in base end of cylinder body (1) and piston rod (2) end. Secure spherical bearings (20) with circlips (21).

2. Install new cushion sleeve (4), circlip (5), rod seals (6), nylon ring (22), ‘O’ rings (8 & 9) and back up (17) in end cap (3). Load end cap (3) over piston rod (2) thread, taking care not to damage rod seal (6) on the thread.

3. Install new ‘O’ rings (16) on piston rod (2) and replace cushion spear (11).

4. Apply Loctite 243 to first two threads of piston (12). Using special tool which can be fabricated as shown in Fig. 3, screw on piston (12) and tighten to a torque of 1 356 Nm (1 000 lbf ft).

5. Insert piston grub screw (15) through wear ring (14) groove in piston (12) and into groove machined in piston rod (2). Tighten grub screw (15) to a torque of 49 Nm (36 lbf ft). Ensure the extreme of grub screw (15) is below the level of wear ring (14) groove.

6. Ensure cushion sleeve (18) and circlip (19) are secure in piston (12).

7. Insert new piston seal (13) and new wear rings (14) in piston (12).

8. Fully grease piston (12) OD and ‘O’ rings (8 & 9) in end cap (3).

9. Sling assembled piston rod (2) in a manner to allow careful leading of the assembled piston rod into cylinder body (1). Take care not to damage piston seal (13) on cylinder body (1) threads.

10. After piston (12) is inserted in cylinder body (1), push the piston rod assembly into cylinder body (1) maintaining coincidental centre lines of piston rod and cylinder body.

11. Before piston rod (2) is fully home and, with slings still taking some of piston rod (2) weight, engage end cap (3) thread and screw home.

12. Push piston rod (2) to the fully retracted position and tighten end cap (3) to a torque of 237 Nm (175 lbf ft).

13. Re-drill end cap (3) for lock ring (10), 3 x 12 mm (0.125 x 0.50 in) deep, if necessary. Insert lock ring (10) in end cap (3).

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 230-0000, BODY SYSTEM SCHEMATIC. Renew all ‘O’ rings where used.

WARNING

To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Install a suitable strap around the cylinder and position cylinder on unit with base end of cylinder ready for mounting.

2. Install spacers (25) in base end of cylinder and insert lower pin (23) through mounting bores, spacers (25) and cylinder. Secure lower pin (23) with washer (28), lockwasher (27) and bolt (26). Tighten bolt (26) to a torque of 66 Nm (49 lbf ft).
Body System - Body Cylinder

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3. Install spacers (25) in rod end of cylinder, align spherical bearing with bores in body and install upper pin (24) through mounting bores, spacers (25) and cylinder. Secure upper pin (24) with washer (28), lockwasher (27) and bolt (26). Tighten bolt (26) to a torque of 66 Nm (49 lbf ft).

4. Connect the hydraulic oil lines to the cylinder ports as tagged during removal.

5. Lubricate pins at lube fittings (22) with lubricant as specified in Section 300-0020, LUBRICATION SYSTEM.

6. Check oil level in hydraulic tank and add if low. Refer to Section 230-0040, HYDRAULIC TANK, for correct fill level. Refer to Section 300-0020, LUBRICATION SYSTEM, for the type of oil used.

7. Place the battery master switch in the 'On' position, start the engine, operate the body and check cylinder lines for leaks. Tighten lines and fittings as required.

8. Remove wheel blocks from road wheels.

MAINTENANCE

Every 250 hours: Lubricate cylinder pins as described in Section 300-0020, LUBRICATION SYSTEM. Inspect cylinders for leaks, if leaks are found, replace seals with seals contained in the Service Repair Kit, as specified in the parts book.

SPECIAL TOOLS

Special tools can be fabricated as shown in Figs. 2 & 3. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools required. These tools are available from your dealer.

Fig. 2 - End Cap Torque Tool
SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
<th>Nm</th>
<th>lbf ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>End Cap</td>
<td></td>
<td>237</td>
<td>175</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>Piston</td>
<td></td>
<td>1356</td>
<td>1000</td>
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<tr>
<td>1</td>
<td>15</td>
<td>Grub Screw</td>
<td></td>
<td>49</td>
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<tr>
<td>1</td>
<td>26</td>
<td>Bolt</td>
<td></td>
<td>66</td>
<td>49</td>
</tr>
</tbody>
</table>

* * * *
DESCRIPTION

Numbers in parentheses refer to Figs. 1, 2 and 9.

The hydraulic braking system is of closed centre design wherein constant pressure is stored in accumulators and is regulated as required to retard or stop the machine.

A brief description of the individual components used in the braking system are listed below. Detailed service and operating instructions can be found in the relevant component sections of this manual.

Service Brakes

Refer to Section 165-0010, BRAKE PARTS.

The service brakes are of the calliper disc-type. The calliper head is designed for use with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. DO NOT use BRAKE FLUID (J 1703).

The brake head is bolted to a mounting plate on the axle housing and the brake disc is bolted to the wheel. There are 2 brake heads and one brake disc at each of the six road wheels.

1 - Orifice  6 - Park Brake Solenoid Valve  11 - Orifice  16 - Cold Start Solenoid Valve
2 - Directional Control Valve  7 - Brake System Relief Valve  12 - Orifice  17 - Brake Accumulators
3 - Check valve  8 - Brake System Charge Valve  13 - Pressure Switch  18 - Primary Accumulator
4 - Check Valve  9 - Brake Treadle Valve  14 - Pressure Switch  19 - Pressure Switch
5 - Main Hydraulic Pump  10 - Check Valve  15 - Priority Valve  21 - Shuttle Valve

Fig. 1 - Brake System Schematic
Each brake head assembly consists of a torque plate, two brake pads (one on each side of the brake disc) and four brake pistons (two on each side of the brake disc). The piston bores on each side of the torque plate are interconnected by internal passages.

When the treadle valve is actuated, hydraulic oil enters the brake head and forces the pistons against the brake pads which are in turn forced against each side of the brake disc slowing or stopping the brake disc and wheel rotation.

In an emergency situation, application of the park/ emergency valve will actuate the service brakes and the parking brake to bring the machine to a halt. In this condition, a restriction in the 'PB' line will slow oil flow from the parking brake allowing the service brakes to actuate momentarily ahead of the parking brake.

**Parking Brake**
Refer to Section 170-0010, PARKING BRAKE AND MOUNTING.

The parking brake consists of a sliding calliper acting on a brake disc on a rear driveline and is of 'Inverted Design' i.e. requiring pressure to hold it off.

Operation is by a spring applied/hydraulically released actuator. The actuator is connected through a slack adjuster to the power screw shaft that is screwed into the piston in the calliper head assembly. The calliper head assembly slides on anchor plate guides in a bracket assembly bolted to the trailer frame.

A push control on the right hand dash panel activates the park brake solenoid valve (6) on the main hydraulic valve assembly, controlling oil pressure from the rear brake circuit accumulator to the actuator. Application of the push control releases oil from the actuator allowing internal springs in the actuator to apply the parking brake. Pulling out the push control directs oil pressure from the rear brake circuit accumulator to the actuator, compressing internal springs, to release the parking brake.

In an emergency situation, application of the park/ emergency valve will actuate the service brakes and the parking brake to bring the machine to a halt. In this condition, a restriction in the 'PB' line will slow oil flow from the parking brake allowing the service brakes to actuate momentarily ahead of the parking brake.

**Hydraulic Tank**
Refer to Section 230-0040, HYDRAULIC TANK.

The hydraulic tank is the common reservoir for the steering, braking and body hoist systems. It is mounted off the frame and fender bracket on the rear right hand side of the tractor.

Integral with the hydraulic tank assembly are the hydraulic oil filter, oil strainer and oil level sight gauge. Located on the top of the tank assembly is the filler cap and breather.

**Main Hydraulic Pump (5)**
Refer to Section 230-0050, MAIN HYDRAULIC PUMP.

Mounted off the transmission power takeoff, the main hydraulic pump supplies hydraulic oil for operating the steering, body, brakes and transmission cooler fan drive circuits.

The main hydraulic pump is an axial piston, variable displacement type, with load sense and pressure regulator.

**Parking Brake Pressure Switch (14)**
Located on the main hydraulic valve assembly it senses pressure in the parking brake (PB) line. The pressure switch closes at a pressure of 5 bar (70 lbf/in²) and sends a signal to illuminate the parking brake indicator light when the parking brake is applied.

**Brake Circuit Pressure Switches (13)**
Front and rear brake circuit pressure switches are both located on the main hydraulic valve assembly. The pressure switches sense pressure in the front and rear brake circuits and sends a signal to warning lights on the dash (a buzzer also sounds) when the pressure drops below 122 bar (1 770 lbf/in²). The warning lights will remain illuminated until the pressure rises above 135 bar (1 960 lbf/in²).

**Brake Accumulators (17/18)**
Refer to Section 250-0060, ACCUMULATOR.

There are three accumulators mounted inside the battery box located on the front left hand side of the tractor; one for the front brake system and one for the rear. The front and rear brake accumulators are supplemented by a third (primary) accumulator (18), also mounted inside the battery box. The primary accumulator supports the service brake system and
Advanced Retarder Braking

Mounted on the brake treadle valve is a potentiometer and brake pedal interface module.

The first 5° movement of the brake pedal engages the transmission retarder, providing that the transmission 'Stop' warning light is OUT, the transmission is in 'lockup' and the oil temperature is within safe operating range. Further movement of the brake pedal applies the service brakes in addition to the transmission retarder. The transmission retarder will disengage when the brake pedal is released, or when any of the operating conditions become out of range.

Valves 1, 2, 3, 4, 6, 7, 8, 10, 11, 12, 15, 16, 21 & 25

These valves form part of the brake circuit and are an integral part of the main hydraulic valve assembly, mounted on the left hand side of the tractor frame. Ref. Section 215-0050, MAIN HYDRAULIC VALVE ASSEMBLY.

OPERATION

Numbers in parentheses refer to Figs. 1, 2 and 9.

Brake Charging

The valves integral of the main hydraulic valve assembly automatically maintain the brake accumulator pressures between a lower and upper limit.

Accumulators (17) are charged from accumulator (18) via brake system relief valve (7), to limit the pressure in these accumulators to 155 bar (2248 lbf/in²) and then via check valves (3 & 4) respectively.

If the pressure in accumulator (18) is below the lower charge limit of 165 bar (2390 lbf/in²) the brake system charge valve (8) spring closes the brake system charge valve (8). The pressure then builds up in the load sense line from brake system charge valve (8) to the shuttle valve (21) and onto the priority valve (15) spring chamber where it helps this valve to close, ensuring flow priority is to the brake charging. At the same time it also acts upon the main hydraulic pump load sense line via shuttle valve (25) to supply enough flow to charge the accumulators.

As soon as the pressure in accumulator (18) reaches the upper charge limit of 185 bar (2680 lbf/in²) the brake system charge valve (8) opens and unloads the load sense line to tank. This action unloads the main hydraulic pump back to its standby pressure of 25 bar.

Brake Treadle Valve (9)

Refer to Section 250-0070, TREADLE VALVE.

The treadle valve controls the level of hydraulic fluid pressure applied to front and rear brakes and the maximum pressure available to these circuits. It is operated by a foot pedal in the operators cab and, with the engine running, is automatically applied by the park brake solenoid valve (6) on the main hydraulic valve.

the body pilot pressure system. All three accumulators are of the piston type and are precharged with nitrogen to 95 bar (1 380 lbf/in²). It consists of a charging valve assembly, cylinder assembly and piston. The charging valve is equipped with a locking feature which, when opened, will allow precharge to be checked or accumulator charged.

The piston acts as a separator dividing the cylinder assembly into two sections. The bottom section nearest the charging valve contains the nitrogen precharge. Hydraulic oil from the main hydraulic pump flows through check valves in the main hydraulic valve and into the top section of the accumulators. Accumulator pressure is monitored by pressure switches (13) in the brake lines.
The accumulators (17 & 18) are also automatically charged every time the pressure at the main hydraulic pump rises above the pressure in accumulator (18). It is therefore possible to achieve pressures up to the main hydraulic pump cut off pressure of 240 bar (3,500 lbf/in²) in this accumulator (18) (eg. when steering over relief). The brake system relief valve (7) will still limit the pressure in accumulators (17) to 155 bar (2,248 lbf/in²).

Orifice (12) is rated at 6 l/min and would protect all three accumulators (17/18) against abnormally high pressure spikes. However, accumulator (18) can see system pressure if any of the main hydraulic functions are held over relief for a period of time.
Braking System - Braking System Schematic

Section 250-0000

Brake Apply

The minimum pressure required at the brake treadle valve is 105 bar (1500 lbf/in²) and the accumulator pre-charge pressure is 90% of this at 95 bar (1380 lbf/in²).

The brake treadle valve controls the level of hydraulic pressure applied to front and rear brakes and the maximum pressure available to these circuits. It is operated by the foot pedal in the operators cab and in an emergency with the engine running, is automatically applied by the park brake solenoid valve (6) in the main hydraulic valve assembly (Ref. Park/Emergency Brake Function).

Mounted on the side of the brake treadle valve is a potentiometer. This potentiometer links with the brake pedal interface module, mounted on a dashboard support, on the underside of the dashboard. The brake pedal interface module converts voltage signals from the potentiometer to activate transmission retarder and rear brake lamps. The brake pedal interface module energises K50, brake lamp relay and K51, transmission retarder select relay. Both relays are located in operator cab fuse box. When these relays are energised an electrical circuit is complete to energise appropriate lamps and solenoids.

The potentiometer works on a 0 to 5 Volt scale. K50 and K51 relays are activated when the output from the potentiometer is greater than 1 Volt. This allows a 24 Volt signal from the busbar to activate the rear brake lamps and the transmission retarder solenoid valve. The relays are de-activated when the output from the potentiometer is less than 1 Volt.

The first 5° movement of the brake pedal activates the rear brake lamps and the transmission retarder, providing that the transmission 'Stop' warning light is OUT, the transmission is in 'lockup' and the oil temperature is within safe operating range. Further movement of the brake pedal applies the service brakes in addition to the transmission retarder. The transmission retarder will disengage when the brake pedal is released, or when any of the operating conditions become out of range.

Park/Emergency Brake Function

The park/emergency brake function is designed to electrically operate the park brake and with the engine running automatically actuates the service brakes also during this operation.

When the engine is running, a transmission hydraulic pilot pressure acts against the spring at the directional control valve (2). The directional control valve (2) creates an open circuit between the main hydraulic valve assembly and port 'PP' on the brake treadle valve. This permits a flow of oil to either energise the 'PP' port at the treadle valve, or, exhaust the 'PP' port through the main hydraulic valve assembly to tank, dependant on operation of the park brake solenoid valve (6). The park brake solenoid valve (6) is controlled by the park/emergency control switch inside the operators cab.

When the park/emergency control switch is activated (pushed in), the electrical signal between the switch and park brake solenoid valve (6) is opened. This action de-energizes the park brake solenoid valve (6). Oil flows through park brake solenoid valve (6) and through the directional control valve (2). The oil travels

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**Fig. 6 - Brake Treadle Valve Porting Arrangement**

- A(f) - Pressure to Front Brakes
- A(r) - Pressure to Rear Brakes
- P(f) - Pressure from Front Brake Accumulator
- P(r) - Pressure from Rear Brake Accumulator
- T(f) - Tank Return - Front Brakes
- T(r) - Tank Return - Rear Brakes
- PP - Emergency/Park Pilot Pressure
through the directional control valve and into the 'PP' port in the treadle valve for an emergency brake application.

Return oil from the parking brake circuit enters the main hydraulic valve assembly. The oil flows through park brake solenoid valve (6) and exits the main hydraulic valve assembly to the hydraulic tank. With no pressure in the parking brake circuit to hold the parking brake off, the parking brake is applied.

When the emergency brake switch is deactivated (pulled out), the electrical signal between the switch and park brake solenoid valve (6) is closed, energizing the parking brake solenoid valve (6). Oil flows through park brake solenoid valve (6) and exits the main hydraulic valve assembly to release the parking brake.

Return oil from the 'PP' port on the brake treadle valve flows through the directional control valve (2) to move to the right under the influence of the compressed spring. This movement links the 'PP' port at the brake treadle valve with the hydraulic tank through the main hydraulic valve assembly. This action results in a controlled bleed down of the applied service brakes to hydraulic tank. This controlled bleed down permits a synchronised service brake release/mechanical park brake application.

When the engine is shut down, the park brake solenoid valve (6) is automatically de-energised (fail safe). Park brake hold off pressure is allowed to return to tank through the park brake solenoid valve (6), causing park brake to apply (spring applied). The vehicle is now held with park brake only.

CHECKING SYSTEM PRESSURES

Numbers in parentheses refer to Figs. 1, 2 and 9, unless otherwise stated.

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the brake treadle valve continuously to relieve pressure in the braking system. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Connect a hydraulic gauge, capable of recording a pressure of 0 - 345 bar (0 - 5000 lbf/in²), to park brake diagnostic pressure point (4, Fig. 7) inside battery box.

4. Place the battery master switch in the 'On' position, start the engine and release park/emergency button (pull out), to energise the park brake line. Monitor system pressure gauge. Pressure setting should be

---

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks and blocking materials are properly secured and of adequate capacity to do the job safely.

Hydraulic fluid pressure will remain within the system after engine shut down. Operate the brake treadle pedal continuously until the pressure has dissipated before carrying out any work on the system or serious injury could result.
155 bar (2 248 lbf/in²).

5. If necessary, pressure setting can be adjusted via brake system relief valve (7) on the main hydraulic valve assembly. The operator cab will require to be raised to access brake system relief valve (7). Refer to Section 260-0010, CAB AND MOUNTING.

6. Connect a hydraulic gauge, capable of recording a pressure of 0 - 345 bar (0 - 5 000 lbf/in²), to front brake diagnostic pressure point (2, Fig. 7) inside battery box.

7. Place the battery master switch in the 'On' position, start the engine and apply park/emergency brake (push button in), to apply service brakes. Monitor system pressure gauge. Brake actuating pressure for the front brake circuit is 105 ± 5.1 bar (1500 ± 75 lbf/in²).

8. Repeat steps 6 & 7 at rear brake diagnostic pressure point (3, Fig. 7) inside battery box. Brake actuating pressure for the rear brake circuit is 105 ± 5.1 bar (1500 ± 75 lbf/in²).

Note: When brakes are released, a residual pressure of 0.5 bar (7 lbf/in²) should remain.

9. If necessary, pressure setting can be adjusted via brake system relief valve (7) on the main hydraulic valve assembly. The operator cab will require to be raised to access brake system relief valve (7). Refer to Section 260-0010, CAB AND MOUNTING.

10. Shut off the engine and remove the pressure gauge from diagnostic check point.

11. Remove wheel blocks, place the steering lock bar in the 'Stowed' position, start the engine and check the braking system for proper operation.

BLEEDING THE BRAKING SYSTEM
Refer to Section 165-0010, BRAKE PARTS.

'O' RING FACE SEALS (ORFS)
Where hydraulic lines are fitted with ORFS connections, the following procedure should be carried out during 'Installation'. Refer to Fig. 8.

a. Ensure 'O' ring/seal is in place and that the joining surfaces are clean. If necessary, retain 'O' ring/seal in place with a light coating of grease or vaseline.

b. Initially, the nuts should be tightened by hand.

c. Where a hose is fitted, ensure that it is not twisted or kinked when the nuts are tightened so that it is allowed to adopt a natural position.

d. Where a tube is fitted, ensure that the connection is aligned correctly.

e. Tighten the nut a further 1/4 to 1/2 a turn using the correct size spanner (wrench).

f. Check that a satisfactory hose or tube routing has been achieved.
HYDRAULIC OIL
The braking system should be kept filled with hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM.

Whenever there is a hydraulic system failure, the oil should be drained, the entire system flushed, oil filters replaced, oil screens thoroughly cleaned and clean hydraulic oil added to eliminate all metal particles or foreign matter.

SERVICE TOOLS
It is recommended that the following service tools are used when carrying out pressure and temperature checks during maintenance procedures. These tools, along with other general service tools, are available from your dealer. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of these tools.

Multi-Gauge
The multi-gauge, 15269784, is basically four pressure gauges in one. Continuous system pressure readings are indicated on one of three simultaneously reading gauges through a pressure range of 30 in of vacuum to 5 000 lbf/in².

The following items should be added to the multi-gauge to enable the gauge to be used on the diagnostic pressure check points:

15018226 Diagnostic Coupling
00118748 Connector (2 off)
15004085 Hose Assembly (-04 HP, 2130 mm long)

Non-contact Infrared Thermometer
The infrared thermometer, 15269785, can be used to spot heat problems early in electrical, mechanical and hydraulic systems. Hand held and easy to use, you simply aim, pull the trigger, and read the temperature. Since there is no need to touch what you are measuring, temperatures of hard-to-reach or moving components can be taken without getting burned or shocked.

O' Ring Face Seals (ORFS) - Seal Kit
The braking system utilizes ‘O’ Ring Face Seal (ORFS) connectors. An ORFS kit, 15271082, is available. This kit contains a minimum stock requirement of all sizes of ORFS type seal.
Fig. 9 - Brake System Valves Integral to Main Hydraulic Valve Assembly

<table>
<thead>
<tr>
<th>Valve (6) Coil Rating</th>
<th>Ohms</th>
<th>Amps</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage: 24V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - Orifice</td>
<td>42</td>
<td>0.6</td>
<td>15</td>
</tr>
<tr>
<td>2 - Directional Control Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 - Check valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - Check Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 - Park/Emergency Solenoid Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 - Brake System Relief Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 - Brake System Charge Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 - Check Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 - Orifice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 - Orifice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 - Priority Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 - Shuttle Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 - Shuttle Valve</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Braking System - Braking System Schematic

## Braking System Trouble Shooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front and Rear Brake Accumulators (17) not reaching the correct hydraulic charge pressure</td>
<td>Brake System Relief Valve (7) not set correctly or faulty</td>
<td>Re-set valve (7) to the correct setting or replace if faulty</td>
</tr>
<tr>
<td></td>
<td>Pressure at Primary Accumulator (18) not high enough due to Brake System Charging Valve (8) not being set correctly</td>
<td>Set the Charge Valve (8) to the correct setting. Replace valve (15)</td>
</tr>
<tr>
<td></td>
<td>Pre-charge gas pressure in the accumulator not at the correct level</td>
<td>Check Pre-charge gas pressure in the accumulator. Refer to Section 250-0060, ACCUMULATOR</td>
</tr>
<tr>
<td>Front and Rear Brake Accumulators (17) do not hold their charge pressure</td>
<td>Check Valves (3) or (4) leaking</td>
<td>Replace Check Valves (3) or (4)</td>
</tr>
<tr>
<td></td>
<td>Pre-charge gas pressure in the accumulator not at the correct level</td>
<td>Check Pre-charge gas pressure in the accumulator. Refer to Section 250-0060, ACCUMULATOR</td>
</tr>
<tr>
<td></td>
<td>Faulty seal in the piston of the accumulator</td>
<td>Replace the accumulator/seals.</td>
</tr>
<tr>
<td></td>
<td>Brake Treadle Valve leaking</td>
<td>Refer to Section 250-0070, TREADLE VALVE</td>
</tr>
<tr>
<td>Brake Charging System Fails to charge at initial engine start up</td>
<td>Cold Start Solenoid Valve (16) remains open</td>
<td>Replace Valve (16). Refer to Section 215-0050, MAIN HYDRAULIC VALVE ASSEMBLY</td>
</tr>
<tr>
<td></td>
<td>Faulty Brake System Charge Valve (8)</td>
<td>Replace valve (8)</td>
</tr>
<tr>
<td></td>
<td>Contamination in orifice(11)</td>
<td>Replace orifice (11)</td>
</tr>
<tr>
<td></td>
<td>Air or contamination in the Load Sense System, especially when first running the truck after new main hydraulic valve is fitted.</td>
<td>Lift the body of the truck up and down several times to purge the system.</td>
</tr>
<tr>
<td>Primary Accumulator (18) does not hold its charge pressure</td>
<td>Front and Rear Brake Accumulators (17) are not holding their charge.</td>
<td>See previous symptoms.</td>
</tr>
<tr>
<td></td>
<td>Pre-charge gas pressure in the accumulator not at the correct level</td>
<td>Check Pre-charge gas pressure in the accumulator. Refer to Section 250-0060, ACCUMULATOR</td>
</tr>
<tr>
<td></td>
<td>Leakage across the Valves (10, 9, 5 or 29) is too high.</td>
<td>Replace each valve one at a time (in order stated) until the fault is found.</td>
</tr>
<tr>
<td></td>
<td>Accumulator Piston Seal leaking</td>
<td>Replace the accumulator</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Remedy</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ineffective Park Brake</td>
<td>Fault with Park Brake caliper</td>
<td>Refer to Section 170-0010, PARKING AND MOUNTING</td>
</tr>
<tr>
<td></td>
<td>Park Brake Solenoid Valve (6) not functioning. Sticking in the selected position</td>
<td>Check if there is hydraulic pressure at the Park Brake port. If there is pressure present, replace Valve(6).</td>
</tr>
<tr>
<td>Park Brake fails to release.</td>
<td>No voltage at Park Brake Solenoid Valve (6) when the switch is activated in the cab.</td>
<td>Check park/emergency switch in operators cab.</td>
</tr>
<tr>
<td></td>
<td>Park Brake Solenoid Valve(6) fails to operate due to fault.</td>
<td>Check wiring between park/emergency switch and park brake solenoid (6).</td>
</tr>
<tr>
<td></td>
<td>Insufficient hydraulic charge pressure in rear brake accumulator</td>
<td>Replace valve(6).</td>
</tr>
<tr>
<td>Service brakes fail to come on when Parking Brake is selected when the engine is running.</td>
<td>Faulty Brake Treadle Valve. Spool not stroking when pressure at port 'PP'.</td>
<td>Refer to Section 250-0070, TREADLE VALVE.</td>
</tr>
<tr>
<td></td>
<td>No transmission pressure at Port TS on main hydraulic valve assembly.</td>
<td>Check piping and see instructions for the transmission.</td>
</tr>
<tr>
<td></td>
<td>Directional Control Valve (2) not selecting.</td>
<td>Replace Valve (2).</td>
</tr>
<tr>
<td></td>
<td>Fault with Park Brake System</td>
<td>See previous trouble-shooting</td>
</tr>
<tr>
<td>Service Brakes come on when Parking Brake is selected and Engine is not running.</td>
<td>Directional Control Valve (2) sticking in the selected position.</td>
<td>Replace Valve (2).</td>
</tr>
<tr>
<td>Inadequate Braking.</td>
<td>Low system pressure.</td>
<td>Check hydraulic oil level.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check oil condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check for major leakage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check accumulator pressures. Refer to Section 250-0060, ACCUMULATORS</td>
</tr>
</tbody>
</table>
## Braking System Trouble Shooting

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate Braking (cont.)</td>
<td>Brake treadle valve delivery pressure below normal setting. Insufficient brake surfaces.</td>
<td>Check front and rear brake pressure. Check brake treadle valve operation. Refer to Section 250-0070, TREADLE VALVE. Check brake disc/pads for wear. Refer to Section 165-0010, BRAKE PARTS. Replace seals and pistons as required. Refer to Section 165-0010, BRAKE PARTS.</td>
</tr>
</tbody>
</table>
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

The accumulators can be identified as items 17 and 18, and the pressure switches as items 13 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

There are three accumulators mounted inside the battery box located on the front left hand side of the tractor; one for the front brake system and one for the rear. The front and rear brake accumulators are supplemented by a third (primary) accumulator. Refer to Fig. 2. The primary accumulator supports the service brake system and the body pilot pressure system. All three accumulators are of the piston type and are precharged with nitrogen to 96 bar (1392 lbf/in²). Each accumulator consists of a charging valve assembly (3), end cap (17), cylinder (8) and piston (9). Charging valve (3) is equipped with a locking feature. Loosening locknut (26) will open the valve so that the precharge can be checked or the accumulator charged.

OPERATION
Numbers in parentheses refer to Fig. 1.

Piston (9) acts as a separator dividing cylinder (8) into two sections. The bottom section nearest charging valve (3) contains the nitrogen precharge. Hydraulic oil from the main hydraulic pump flows through check valves in the main hydraulic valve and into the top section of the accumulators.

Accumulator pressure is monitored by pressure switches located in the main hydraulic valve, which send a signal to illuminate warning lights in the dash panel when the pressure drops below 122 bar (1769 lbf/in²). The warning lights will remain illuminated until the pressure rises above 135 bar (1958 lbf/in²).
Testing Charging Valve For Leakage

Numbers in parentheses refer to Fig. 1.

1. Remove cover plate from bottom of battery box.

2. Remove cap (24) from charging valve (3) and loosen locknut (26). Coat open end of charging valve (3) with soapy water. Bubbles indicate leaky valve core (25).

3. Attempt to reseat the valve core by depressing and releasing it quickly once or twice. Recheck for leakage. If leakage continues, discharge the accumulator as described under 'Discharging Nitrogen' in this section.

4. Replace valve core (25). Tighten locknut (26) to 11 Nm (100 lbf in) and replace valve cap (24) finger tight.

Testing Precharge Pressure

Numbers in parentheses refer to Fig. 3, unless otherwise specified.

Note: The nitrogen pressure in an accumulator is directly affected by changes in nitrogen temperature. The cylinder pressure will increase or decrease proportionally with temperature changes. An accumulator pressure reading can vary about 4.3 bar (62 lbf/in²) with 22° C (72° F) temperature change. Such temperature changes could easily occur between noon and midnight of the same day. Refer to the table at the end of this section for nitrogen pressures at ambient temperatures of other than 20° C (68° F).
To test accumulator precharge pressure or to charge the accumulator, a charging assembly kit can be used. Refer to Fig. 3.

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the treadle valve continuously to relieve pressure in the braking system. Block all road wheels and place battery master switch in the 'Off' position.

3. Check accumulator mountings to be sure the accumulator is held tightly in position.

4. Remove cap (24, Fig. 1) from accumulator charging valve (3, Fig. 1). Attach charging line (1) to charging valve by rotating 'T' handle of valve chuck (2) anticlockwise until it stops then screw the swivel nut down on the valve. Loosen locknut (26, Fig. 1) by turning anticlockwise one to two turns.

5. Turn 'T' handle clockwise until charging valve core is depressed. Be sure bleeder valve (10) is tight and does not leak, and valves (4 & 6) are closed.

6. To read accumulator precharge pressure, slowly open cylinder valve (4). Pressure gauge (5) will register precharge pressure, it should be 96 bar (1 392 lbf/in²) at 20° C (68° F) ambient temperature. Refer to the table at the end of this section for nitrogen pressures at ambient temperatures of other than 20° C (68° F).

7. Close cylinder valve (4) and open bleeder valve (10) to dissipate gauge pressure. Close bleeder valve (10) after pressure is relieved. If the accumulator needs charged, leave line (1) and valve chuck (2) attached to charging valve (3, Fig. 1). Charge the accumulator as described under 'Charging The Accumulator'.

8. If precharge pressure is correct, rotate 'T' handle anticlockwise until it stops. Tighten locknut (26, Fig. 1) on charging valve (3, Fig. 1) to 11 Nm (100 lbf in). Loosen the swivel nut and remove gauging head.

9. Install cap (24, Fig. 1) on charging valve (3, Fig. 1) and tighten finger tight.

10. Remove wheel blocks and place the battery master switch in the 'On' position.

**CHARGING THE ACCUMULATOR**

**Numbers in parentheses refer to Fig. 3, unless otherwise specified.**

**Note:** Either oil or water pumped nitrogen can be used to charge the accumulator. Both types are readily available from a local compressed gas dealer.

**WARNINGs**

Do not use Oxygen or any gas other than Nitrogen to charge an accumulator. Oxygen under pressure coming into contact with oil or grease will cause a violent explosion. Always double check to make sure you are using Nitrogen to prevent personal injury and property damage.

A high pressure nitrogen pressure regulator must be used with the charging assembly kit. Failure to use pressure regulator could cause property damage, personal injury or death.

1. Attach line (1) and the swivel nut to charging valve (3, Fig. 1) as described in steps 1 through 4 under the heading 'Testing Precharge Pressure'. Be sure valves (4 & 6) are closed.

2. Attach gauging head to nitrogen bottle by screwing down on gland nut (8).

3. Open tank valve (6) slowly; pressure shown on pressure gauge (5) is tank pressure.

4. Open cylinder valve (4) slowly and charge accumulator to 96 bar (1 392 lbf/in²) at 20° C (68° F) ambient temperature, closing valve occasionally. Refer to the table at the end of this section for nitrogen pressures at ambient temperatures of other than 20° C (68° F).

5. To check accumulator charge, close tank valve (6), relieve pressure between tank and pressure gauge (5) by opening bleeder valve (10) momentarily. This will allow gauge needle to settle, thus giving correct pressure reading of accumulator charge.

6. When the correct pressure for the ambient temperature has been reached, close valves (4 & 6) tightly. Bleed pressure off pressure gauge (5) by opening bleeder valve (10). Close bleeder valve when all pressure is bled off from the gauge and unscrew gland nut (8) from the nitrogen bottle.
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7. Rotate 'T' handle of valve chuck (2) anticlockwise until it stops, tighten locknut (26, Fig. 1) to 11 Nm (100 lbf in), loosen the swivel nut and remove gauging head.

8. Check charging valve (3, Fig. 1) for leakage using soapy water. Reinstall valve cap (24, Fig. 1) and tighten finger tight.

DISCHARGING NITROGEN
Numbers in parentheses refer to Fig. 1.

Make sure charging valve (3) is closed internally by turning locknut (26) clockwise. Remove cap (24) and core (25) from charging valve (3). Slowly turn locknut (26) anticlockwise to open charging valve (3).

Do not remove charging valve (3) until all the gas has been completely evacuated.

WARNING
Do not try to discharge the accumulator by depressing charging valve core (25).

REMOVAL

WARNING
To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Accumulators are charged with Nitrogen. The service pressure is 96 bar (1392 lbf/in²) at 20°C (68°F). To prevent personal injury and property damage do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved.

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the treadle valve continuously to relieve pressure in the braking system. Block all road wheels and place battery master switch in the 'Off' position.

3. Remove cover plate from bottom of battery box.

4. Discharge nitrogen from the accumulators as described under 'Discharging Nitrogen'.

5. Disconnect hydraulic lines from top of accumulators and plug accumulators to prevent oil spillage. Cap open lines and fittings to prevent entry of dirt.

6. Support accumulators with an adequate sling and lifting device. Remove bolts, nuts, washers and clamps. Remove accumulators and drain oil from top section into a suitable container.

7. Remove accumulators to a clean area for disassembly.

DISASSEMBLY
Numbers in parentheses refer to Fig. 1.

WARNING
Accumulators are charged with Nitrogen. The service pressure is 96 bar (1392 lbf/in²) at 20°C (68°F). To prevent personal injury and property damage do not attempt to remove any valves or fittings until all nitrogen pressure is completely relieved.

1. Make sure all nitrogen gas has been released before starting to disassemble the accumulator. Refer to section on 'Discharging Nitrogen'.

2. Remove charging valve assembly (3) from end cap (17).

3. With accumulator lying horizontal, hold accumulator cylinder (8) with a strap wrench.

4. Install pins in three equally spaced holes in end cap (17), then use a long bar working against the pins to remove end cap from cylinder (8). Remove and discard Backup ring (6) and 'O' ring (7).

5. Grip cast web of piston (9) with pliers and, while rotating, pull piston from cylinder (8). Remove and discard Seal rings (10 & 14), Washers (11 & 13) and 'O'-Ring (12).

INSPECTION
Numbers in parentheses refer to Fig. 1.

1. Wash metal components with a suitable solvent and thoroughly air dry.

2. Inspect piston (9) for cracks or burrs. Replace piston (9) if excessively scored or worn.

3. Use an inspection lamp to check the bore of accumulator cylinder (8) for scratches or scoring.
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Minor nicks, scratches or light scoring of the bore can be removed by using crocus cloth. Dress the bore until all apparent imperfections have been removed. Replace complete accumulator assembly if the inside of cylinder (8) is excessively scored or worn.

4. Inspect threads in end cap (17) and threads in cylinder (8) for damage. Replace all parts worn or damaged beyond repair.

ASSEMBLY
Numbers in parentheses refer to Fig. 1.

1. Lubricate ‘O’ rings (7, 11 & 15), Backup rings (6 & 16), Seal rings (10 & 14) and Washers (11 & 13) and inside of cylinder body (8) with hydraulic oil prior to assembly.

2. Install 'O'- ring (15) and Backup ring (16) on the End cap (17).

3. Install End cap (17) on cylinder body (8).

4. Install new Seal rings (10 & 14), Washers (11 & 13) and ‘O’-Ring (12) on grooves of Piston (9).

5. Insert Piston (9) into bore of Cylinder body (8) with the cupped end facing the open end of the cylinder body (8). Taking care not to damage any components on the threads of the Cylinder body (8) on insertion. Use a hammer and wood block to carefully tap the Piston (9) into place until the Piston (9) is 50.8mm (2.0 in) below the beginning of the honed bore. Keep pressure against the Piston (9) while tapping into place to ensure the Piston (9) does not resist movement and force its way back.

6. Install ‘O’-ring (7) and Backup ring (6) onto the Cylinder cap (5) and install the Cylinder cap into the bore of the Cylinder body (8). Tighten the Cap so that it is flush with the end of the Cylinder body (8), within 1.6-2.4mm (0.062 - 0.094in) above or below.

7. Install the Chargin valve assembly (3). Torque tighten Locnut (26) clockwise to 11Nm (100 lbf in) to close the Charging valve (3). Insert Valve core (25) and torque to 0.5 Nm ( 5 lbf in), replace Valve cap (24) and tighten hand tight.

INSTALLATION

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

WARNING
To prevent personal injury and property damage, be sure lifting equipment is properly secured and of adequate capacity to do the job safely.

1. Position accumulators in battery box with the oil inlet ports at the top.

2. Attach clamps securely with nuts, washers and bolts.

3. Remove caps installed at removal and install hydraulic lines securely to the oil inlet ports at the top of the accumulators.

4. Charge the accumulator with Nitrogen gas as described under ‘Charging the Accumulator’ in this section.

5. Install cover to bottom of battery box.

6. Check oil level in hydraulic tank and add oil as required. Refer to Section 230-0040, HYDRAULIC TANK, for correct fill level and Section 300-0020, LUBRICATION SYSTEM, for oil specification.

7. Place the battery master switch in the ‘On’ position, start the engine and check for leaks. Tighten lines and fittings as required. Remove wheel blocks.

MAINTENANCE
Inspect accumulator assembly for leaks. If leaks are found, disassemble and replace all ‘O’ rings and seals. Inspect hydraulic lines for wear and leaks. Replace/ tighten lines as required.

SPECIAL TOOLS
Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the charging assembly kit and other general service tools required. These tools are available from your dealer.
### WARNING

This vehicle is equipped with precharged nitrogen gas cylinders of more than 2.8 bar (40 lbf/in²). Special permits may be required when transporting the vehicle or cylinders by any method while cylinders are charged. For shipment, contact the appropriate agency in the country involved. Consult your dealer for further permit information.

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>Nm</th>
<th>lbf ft</th>
<th>lbf in</th>
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<tr>
<td>1</td>
<td></td>
<td>Locknut</td>
<td>11</td>
<td>-</td>
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### AMBIENT TEMPERATURE - NITROGEN PRE-CHARGE PRESSURE

<table>
<thead>
<tr>
<th>AMBIENT TEMPERATURE</th>
<th>NITROGEN PRE-CHARGE PRESSURE</th>
</tr>
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<tr>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>-20</td>
<td>-4</td>
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<tr>
<td>120</td>
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</table>

* * * *
DESCRIPTION

Numbers in parentheses refer to Fig. 1.

Note: The treadle valve can be identified as item 9 in Section 250-0000, BRAKING SYSTEM SCHEMATIC.

The tandem circuit modulating treadle valve is a closed centre controller which controls the level of hydraulic oil pressure applied to the front and rear brakes and the maximum pressure available to these circuits. It is operated by a foot pedal in the operators cab and with the engine running, is automatically applied by the parking brake solenoid valve within the main hydraulic valve. Refer to Section 215-0050, MAIN HYDRAULIC VALVE ASSEMBLY.

In the normal position, brake pedal assembly (1) is in the up position. In this condition the regulated pressure outlet ports of the valve ‘A1’ and ‘A2’ are directly linked to the hydraulic tank ports ‘T1’ and ‘T2’. While the pedal is in this position the brakes are released.

Mounted on the brake treadle valve is a potentiometer (35) which links with a brake pedal interface module.
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(36) mounted on a dashboard support, underneath the dashboard. The brake pedal interface module (36) converts voltage signals from the potentiometer (35) to activate the rear brake lights and the transmission retarder when the treadle valve is depressed. Refer to Fig. 7.

OPERATION

Numbers in parentheses refer to Fig. 1.

Normal Service Brake Application

Refer to Fig. 2. When the operator depresses pedal assembly (1), push rod (33) is moved up and pushes on pistons (24 & 27) which in turn, pushes spools (10 & 13) up. As spools (10 & 13) move up, the metering notches move out of the tank cavity and close outlet ports 'A1' and 'A2' off to tank ports 'T1' and 'T2'. Spools (10 & 13) continue to move upwards until the metering notches become exposed to the inlet pressure ports. This movement opens inlet ports 'P1' and 'P2' to outlet ports 'A1' and 'A2' respectively. As hydraulic pressure builds in the brake, oil flows through the small orifice in spools (10 & 13) and into the cavities above the spools. As pressure rises in the brake it also rises in the cavities above the spools forcing spools (10 & 13) downwards closing outlet ports 'A1' and 'A2'. Spools (10 & 13) are now balanced between the brake pressure and the pressure of springs (20 - 22) generated by the operators force on pedal (1) assembly. Spools (10 & 13) have closed off the inlet ports, outlet ports and the tank ports and will remain in this position as long as pedal (1) assembly is not moved. If the operator further depresses pedal (1) assembly, spools (10 & 13) will move up and build more pressure in the brake until it balances the pedal force.

Normal Service Brake Release

Refer to Fig. 3. When the operator releases pedal (1) assembly, spools (10 & 13) will become unbalanced and move downwards, opening outlet ports 'A1' and 'A2' to tank. At this point, oil in the 'A1' and 'A2' lines is released to tank through tank ports 'T1' and 'T2', releasing the brakes.

Emergency Stop Brake Application/Release

Refer to Fig. 4. Pushing in the park/emergency control results in the de-energization of the park brake solenoid valve within the main hydraulic valve. This allows full pressure to enter the 'PP' port in the treadle valve simulating a full and immediate depression of pedal (1) assembly, i.e. pushing spools (10 & 13) upwards and thereby applying maximum braking action.

Refer to Fig. 5. Pulling out the park/emergency control...
will energize the park brake solenoid valve within the main hydraulic valve, allowing the pressure in the 'PP' line to fall via the return to tank port opened within the park brake solenoid valve. Outlet ports 'A1' and 'A2' are opened to tank ports 'T1' and 'T2' allowing oil in the 'A1' and 'A2' lines to return to tank, releasing the brakes.

Advanced Retarder Braking

Refer to Figs. 1 & 7. The brake pedal interface module (36) converts voltage signals from the potentiometer (35) to activate transmission retarder and rear brake lamps. The brake pedal interface module (36) energises brake lamp relay K50, and transmission retarder select relay K51. Both relays are located in operator cab fuse box. Refer to Section 190-0000, CIRCUIT DIAGRAMS. When these relays are energised, electrical circuit is completed to energise appropriate lamps and solenoids.

The potentiometer (35) works on a 0 to 5 Volt scale. Initial pedal rotation starts to increase voltage from the potentiometer (35) to the brake pedal interface module (36). K50 and K51 relays are activated when the output from the potentiometer (35) is greater than 1 Volt. This allows a 24 Volt signal from the busbar to activate the rear brake lamps and the transmission retarder solenoid valve. The relays are de-activated when the output from the potentiometer is less than 1 Volt.

The first 5° movement of the pedal (1) engages the transmission retarder, providing that the transmission 'Stop' warning light is OUT, the transmission is in 'lockup' and the oil temperature is within safe operating range. Further movement of the pedal (1) applies the service brakes in addition to the transmission retarder. The transmission retarder will disengage when the pedal (1) is released, or when any of the operating conditions become out of range.

REBUILD CRITERIA

Inspect the valve regularly for any signs of leakage or damage and replace components if necessary.

The treadle valve should be rebuilt if one or more of the following conditions exist:

1. Any sign of external leakage.

Note: Check all hydraulic lines and fittings to ensure leakage is not coming from there.

2. Failure of the pedal to return to full upright position.

3. Treadle valve holds pressure when in the neutral position.

4. Varying output pressure with the pedal fully depressed.

5. Output pressure does not remain constant between circuits.
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REMOVAL

**WARNINGS**

To prevent personal injury and property damage, be sure wheel blocks are properly secured and of adequate capacity to do the job safely.

Hydraulic oil pressure will remain within the system after engine shut down. Operate the treadle pedal continuously until the pressure has dissipated before carrying out any work on the braking system or serious injury could result.

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the treadle valve continuously to relieve pressure in the braking system. Block all road wheels and place battery master switch in the 'Off' position.

3. Pull on handle to release hood catch and lift up hood.

4. Remove blanking cap from remote drain line at the bottom of the hydraulic tank. Install a length of hose on remote drain fitting, open drain cock and drain hydraulic oil into a suitable container. Close drain cock, remove hose and reinstall blanking cap.

5. If necessary remove engine air intake tube to gain access to treadle valve on front of cab. Alternatively, tilt the cab to gain access. Refer to Section 260-0010, CAB AND MOUNTING.

6. Clean treadle valve assembly and surrounding area with a suitable solvent. Ensure all hydraulic lines connected to the treadle valve are identified for ease of installation and, with suitable containers available to catch leakage, disconnect hydraulic lines. Fit blanking caps to all open lines and treadle valve ports.

7. Disconnect electrical connection from the brake pedal potentiometer (35).

8. Remove four bolts securing treadle valve and mounting plate to cab. Remove treadle valve and mounting plate as an assembly from the front of cab to a clean area for 'Disassembly'.

DISASSEMBLY

Numbers in parentheses refer to Fig. 1.

1. Remove blanking caps from treadle valve ports and drain all oil from valve body ports by rotating the valve over a suitable container.

2. Remove treadle valve from mounting plate and secure the valve assembly upright in a table vice.

3. Remove circlips to allow cam assembly to be disassembled.

4. Remove boot (34) from push rod (33), then remove push rod (33) and spring (32) from pilot housing (30) bore.
5. Separate pilot housing (30) and valve housing (16) by removing screws (31). Remove 'O' ring (17) from valve housing (16).

6. Remove piston (27) from pilot housing (30). **Note:** Be careful not to scratch housing bore.

7. Remove 'O' rings (26 & 28) and back-up rings (25 & 29) from piston (27), being careful not to damage 'O' ring and piston grooves.

8. Remove piston (24), springs (20, 21 & 22) and shims (19) from valve housing bore.

9. Bearing (23) should not be removed from housing bore. **Note:** Excessive wear in both bearing (23) and piston (24) may require replacement.

10. Remove retainer assembly (18) from housing bore. **Note:** Ball is pressed into retainer.

11. Loosen nut (2) and remove end plug (5) from housing. Remove spring (7), retainer (6), nut (2), washer (3) and 'O' ring (4) from end plug (5).

12. Remove spacer (15), sleeves (9 & 12) and spools (10 & 13) assembly from housing bore. This assembly must be removed through end plug (5) end of housing (16). **Note:** Be careful not to scratch housing bore.

13. Separate spacer (15) and spools (10 & 13) from sleeves (9 & 12). **Note:** Excessive wear on either spools (10 & 13) or sleeves (9 & 12) may require replacement. Spool (10)/sleeve (9) and spool (13)/sleeve (12) are matched sets and MUST be replaced as matched sets - DO NOT intermix.

14. Remove 'O' ring (11) and cup (14) from spacer (15). Remove other 'O' rings (11) from sleeve (12) and 'O' rings from sleeve (8). **Note:** Be careful not to damage cup and 'O' ring grooves and bores.

**ASSEMBLY**

Numbers in parentheses refer to Fig. 1.

Lubricate all new rubber components with clean hydraulic oil used in the braking system. Refer to Section 300-0020, LUBRICATION SYSTEM.

1. Clean all parts thoroughly before assembly.

2. Install new cup (14) in spacer (15) and one new 'O' ring (11) on spacer (15). Note direction of cup.

3. Install other new 'O' rings (11) on sleeve (12) and
Braking System - Treadle Valve

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new 'O' rings (8) on sleeve (9).

4. Lubricate spool (13) with clean hydraulic oil and carefully insert into sleeve (12). Note direction of spool.

5. Insert spacer (15) into housing bore through end plug (5) end. Note direction of spacer.

6. Lubricate sleeve (12) and spool (13) assembly with clean hydraulic oil and carefully insert into housing bore using a wooden dowel. Note direction of assembly.

7. Carefully insert sleeve (9) into housing until it rests against sleeve (12). Lubricate spool (10) with clean hydraulic oil and carefully insert into sleeve (9). Note direction of spools and sleeves.

8. Install spring (7) and retainer (6) into housing bore.

9. Install end plug (5) and torque to 11 - 20 Nm (96 - 180 lbf in) to seat sleeves. Then turn back end plug 1/4 turn and torque to 1 - 7 Nm (10 - 60 lbf in). Install new 'O' ring (4), washer (3) and nut (2). Hold end plug and torque nut to 68 - 81 Nm (50 - 60 lbf ft).

10. Install new 'O' ring (17) on valve housing (16).

11. Install retainer assembly (18) in housing. Note: Depress retainer (18) until it bottoms on spacer (15). Spools (10 & 13) and retainer (18) should return when released. If the spools and retainer do not return when released, the bore of sleeves (9 & 12) were possibly damaged when installed.

12. Install shims (18), springs (20, 21 & 22) and piston (24) in valve housing bore. Note: For proper brake pressure setting, install the same number of shims and spacer that were removed during disassembly. If spools (10 & 13), sleeves (9 & 12), or spring (22) were replaced, shim adjustment may be required.

13. Install new 'O' rings (26 & 28) and new back-up rings (25 & 29) on piston (27). Note order of back-up rings and 'O' rings.

14. Lubricate piston (27) with clean hydraulic oil and insert into pilot housing (30) through valve housing (16) end. Be sure to install piston (27) as far as it will go into pilot housing bore.

15. Carefully attach pilot housing (30) to valve housing (16) using screws (31). Torque screws to 24 - 30 Nm (18 - 22 lbf ft).

16. Install spring (32) and push rod (33) into pilot housing (30) bore.

17. Install new boot (34) on push rod (33).

18. Assemble cam assembly and secure with circlips.

19. Install mounting plate to treadle valve.

INSTALLATION

Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Tighten all hydraulic lines fitted with ORFS connections, as described in Section 250-0000, BRAKING SYSTEM SCHEMATIC. Renew all 'O' rings where used.

1. Secure treadle valve and mounting plate assembly to front of cab using four bolts removed previously.

2. Connect electrical connection to the brake pedal potentiometer (35).

3. Remove blanking caps and connect hydraulic lines to the treadle valve assembly as noted at 'Removal'.

4. If previously removed install engine air intake tube, or if applicable, lower the cab. Refer to Section 260-0010, CAB AND MOUNTING.

5. Fill hydraulic tank with oil specified in Section 300-0020, LUBRICATION SYSTEM.

6. Place the battery master switch in the 'On' position, start the engine and bring hydraulic oil to operating temperature.

7. Apply the brakes and check for oil leaks. Tighten line connections and fittings as necessary. Note: When performing Step 8, make sure that parking brake applies and releases appropriately.

8. Check brake operations by actuating pedal and park/emergency control. Ensure that the pedal assembly is free to operate.

9. Shut off engine and check hydraulic tank oil level. Replenish as necessary.
CHECKING SYSTEM PRESSURES

⚠️ WARNINGS
To prevent personal injury and property damage, be sure wheel blocks and blocking materials are properly secured and of adequate capacity to do the job safely.

⚠️ Hydraulic fluid pressure will remain within the system after engine shut down. Operate the brake treadle pedal continuously until the pressure has dissipated before carrying out any work on the system or serious injury could result.

1. Position the vehicle in a level work area, apply the parking brake, switch off the engine and turn steering wheel in both directions several times to relieve any pressure in the steering circuit.

2. Operate the treadle valve continuously to relieve pressure in the braking system. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.

3. Connect a hydraulic gauge, capable of recording a pressure of 0 - 345 bar (0 - 5 000 lbf/in²), to front brake diagnostic pressure point (FR BRK) inside battery box.

4. Place the battery master switch in the 'On' position, start the engine and apply park/emergency brake (push button in), to apply service brakes. Monitor system pressure gauge. Brake actuating pressure for the front brake circuit is 105 +/- 5.1 bar (1500 +/- 75 lbf/in²).

**Note:** When brakes are released, a residual pressure of 0.5 bar (7 lbf/in²) should remain.

5. Repeat steps 1 through 4 at rear brake diagnostic pressure point (RR BRK) inside battery box.

**Note:** Actuating pressure for the front and rear brake circuits is 105 +/- 5.1 bar (1500 +/- 75 lbf/in²), however, system pressure is 240 bar (3 500 lbf/in²) and can be checked at the steering diagnostic pressure point (STR) inside the battery box. System pressure is checked against steering pressure as this is the highest pressure requirement in the hydraulic circuit. Refer to Section 230-0050, MAIN HYDRAULIC PUMP.

6. If the pressures to the brake circuits have been determined as high or low, refer to Troubleshooting table for treadle valve and Section 250-0000, BRAKING SYSTEM SCHEMATIC.

MAINTENANCE

General
Check all hydraulic brake lines and fittings at treadle valve for leaks and damage. Tighten/replace as required.

**Every 1 000 Hours**
Check front and rear brake pressures at remote diagnostic test points. If the pressures are outwith the specified pressure range, refer to Troubleshooting table for treadle valve and Section 250-0000, BRAKING SYSTEM SCHEMATIC.

SPECIAL TOOLS
There are no special tools required for the procedures outlined in this section. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of general service tools and adhesives required. These tools and adhesives are available from your dealer.
## TREADLE VALVE TROUBLESHOOTING

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<tr>
<th>SYMPTOM</th>
<th>POSSIBLE CAUSE</th>
<th>REMEDY</th>
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</thead>
<tbody>
<tr>
<td>Brakes slow to apply</td>
<td>No or improper accumulator pre-charge pressure</td>
<td>Check accumulator pre-charge pressure. Refer to Section 250-0060, ACCUMULATOR</td>
</tr>
<tr>
<td></td>
<td>Brakes not properly adjusted</td>
<td>Adjust brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Inoperative brakes</td>
<td>Check brakes. Refer to Section 165-0010, BRAKE PARTS</td>
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<td>Hydraulic lines/fittings leaking</td>
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<td>Damaged hydraulic brake lines</td>
<td>Check lines for restrictions</td>
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<tr>
<td></td>
<td>Air in system</td>
<td>Bleed air from system. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td>Brakes will not release</td>
<td>Pedal angle out of adjustment</td>
<td>Check for proper pedal angle</td>
</tr>
<tr>
<td></td>
<td>Inoperative brakes</td>
<td>Check brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Inoperative treadle valve. Binding spools (10 &amp; 13), damaged sleeves (9 &amp; 12), piston (24) binding</td>
<td>Replace treadle valve</td>
</tr>
<tr>
<td>Insufficient brakes</td>
<td>Low hydraulic oil level</td>
<td>Top up hydraulic oil</td>
</tr>
<tr>
<td></td>
<td>Brakes not properly adjusted</td>
<td>Adjust brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Oil or grease on brake pads</td>
<td>Clean or replace brake pads. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Hydraulic lines damaged</td>
<td>Check hydraulic lines</td>
</tr>
<tr>
<td></td>
<td>No or improper accumulator pre-charge pressure</td>
<td>Check accumulator pre-charge pressure. Refer to Section 250-0060, ACCUMULATOR</td>
</tr>
<tr>
<td></td>
<td>Inoperative brakes</td>
<td>Check brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Inoperative treadle valve. Broken spring (21). Boot (34) cut, allowing dirt under piston (24) flange.</td>
<td>Replace treadle valve</td>
</tr>
<tr>
<td>Excessive braking</td>
<td>Inoperative brakes</td>
<td>Check brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Inoperative treadle valve. Excessive shims (19) fitted</td>
<td>Replace treadle valve</td>
</tr>
</tbody>
</table>
## Braking System - Treadle Valve

### Section 250-0070

### TREADLE VALVE TROUBLESHOOTING

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>POSSIBLE CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brakes will not release completely</td>
<td>Brakes not properly adjusted</td>
<td>Adjust brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Inoperative brakes</td>
<td>Check brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Pedal angle out of adjustment</td>
<td>Check for proper pedal angle</td>
</tr>
<tr>
<td></td>
<td>Air in system</td>
<td>Bleed air from system. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>Inoperative treadle valve. Piston (24) sticking, spring (7) broken</td>
<td>Replace treadle valve</td>
</tr>
<tr>
<td></td>
<td>Back pressure on return line excessive</td>
<td>Remove restriction</td>
</tr>
<tr>
<td>No brakes</td>
<td>No oil in hydraulic system</td>
<td>Add oil to tank</td>
</tr>
<tr>
<td></td>
<td>Broken/damaged hydraulic line</td>
<td>Replace broken/damaged line</td>
</tr>
<tr>
<td></td>
<td>Brakes not properly adjusted</td>
<td>Adjust brakes. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
<tr>
<td></td>
<td>No accumulator pre-charge pressure</td>
<td>Check accumulator pre-charge pressure. Refer to Section 250-0060, ACCUMULATOR</td>
</tr>
<tr>
<td></td>
<td>No pump pressure</td>
<td>Check pump operation</td>
</tr>
<tr>
<td></td>
<td>Worn brakes</td>
<td>Replace brake pads and discs</td>
</tr>
<tr>
<td></td>
<td>Inoperative treadle valve. Piston (24) binding, broken spring (21)</td>
<td>Replace treadle valve</td>
</tr>
<tr>
<td>Pedal kickback when brakes are applied</td>
<td>Air in system</td>
<td>Bleed air from system. Refer to Section 165-0010, BRAKE PARTS</td>
</tr>
</tbody>
</table>

### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>End Plug</td>
<td>1 - 7</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Nut</td>
<td>68 - 81</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>Screw</td>
<td>24 - 30</td>
</tr>
</tbody>
</table>

* * * *
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

The cab is fully insulated and mounted on cab supports (23) to damp structure-borne noise and vibration. It conforms with ISO/SAE, ROPS (Roll Over Protective Structure) and FOPS (Falling Object Protective Structure) requirements as standard.

ROPS - ISO 3471, SAE J1040 APR 88
FOPS - ISO 3449, SAE J231

⚠️ WARNING
The protection offered by the roll over and falling object protective structure may be impaired if it has been subjected to any modification or damage.

The cab assembly can be tilted to improve accessibility to components below the cab, including transmission and main hydraulic valve. A hydraulic hand pump (1, Fig. 2), located in the battery box, and a cab raise cylinder (7, Fig. 2) are used to raise the cab.

⚠️ WARNING
Never operate the machine while the cab is tilted. Always ensure the cab is fully lowered and properly secured before operating the machine.

Cab assembly is spacious and offers outstanding visibility through large areas of tinted safety glass. Access to cab assembly is from the left hand side with open tread steps, platform and handrail.

The cab interior, trimmed with noise-absorbent
material, is extensively thermally insulated and a heater/filter/pressurizer and demisting unit keeps internal air fresh and dust free. Sliding windows provide additional ventilation. Air conditioning is fitted as standard. Refer to Section 260-0130, AIR CONDITIONING.

Note: Access from the cab, in the case of an emergency, can be gained by breaking any of the windows using the hammer provided (mounted on back pillar).

**REMOVAL**
Numbers in parentheses refer to Fig. 1.

**Note:** Identify and tag all cables, harnesses, lines and linkages disconnected from cab assembly during removal to aid in installation.

---

**WARNINGS**
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

Hydraulic fluid pressure will remain within the system after engine shutdown. Operate the brake pedal continuously until the pressure has dissipated before disconnecting any hoses.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the brake pedal continuously to relieve pressure in the system.

3. Block all road wheels, place the battery master switch in the 'Off' position and lift the hood assembly.
4. Disconnect the electrical cables in the following order to prevent damage to the electrical components:
   a. Battery earth cable.
   b. Battery supply cable.
   c. Alternator earth cables.
   d. Alternator supply cables.
   e. Electrical harnesses at cab bulkhead.

   **WARNING**
   Before disconnecting any air conditioner lines, refer to Section 260-0130, AIR CONDITIONING. Refrigerant will rapidly freeze all objects with which it comes into contact. It can cause serious and permanent damage to the eyes and skin.

5. Evacuate the refrigerant from the air conditioning system and disconnect the lines. Refer to Section 260-0130, AIR CONDITIONING. Fit blanking caps to all open lines and fittings.

6. Ensure heater lines are identified for ease of installation and with suitable containers available to catch leakage, disconnect heater lines. Fit blanking caps to open line ends and fittings.

7. Remove the front right hand tyre and rim assembly for access. Refer to Section 160-0050, WHEEL RIM AND TYRE.

   **WARNINGS**
   To prevent damage, always ensure hood is raised before tilting or lowering the cab.
   Never work near or under an unblocked or unsupported cab. Always use the cab safety prop.

8. Tilt cab to allow access to steering valve below cab, and secure with cab safety prop (7). Ensure lines are identified for ease of installation and with suitable containers available to catch leakage, disconnect and remove steering valve hoses. Fit blanking caps to open line ends and fittings.

9. Attach suitable slings to the cab lifting points and raise lifting equipment to take up the slack. Disconnect cab raise cylinder (7, Fig. 2) from cab floor by removing bolt (11, Fig. 2), washer (12, Fig. 2) and nut (13, Fig. 2).

10. Tag and disconnect any other harnesses and hoses that may be affected by cab removal.

Disconnect earth strap at rear right hand cab support (23).

11. Lower cab safety prop (7) and place in the stowed position, then using lifting equipment, slowly lower cab until horizontal.

12. Remove spring pins (6) to allow right hand pins (24) to be driven out using a suitable driver.

13. Check to make certain that all necessary disconnections have been made, before lifting cab assembly. Taking care to prevent damaging the insulating material, lift cab assembly from the frame and place on suitable stands.

**INSTALLATION**

Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

   **WARNING**
   To prevent personal injury and property damage, be sure blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Inspect cab supports (23) for damage and replace if necessary.

2. Attach suitable slings to the cab lifting points and raise and position cab on frame.

3. Secure cab assembly to right hand cab supports (23) with pins (24) and spring pins (6), as shown in Fig. 1.

4. Using lifting equipment, raise cab and secure cab raise cylinder (7, Fig. 2) to bracket on cab floor using bolt (11, Fig. 2), washer (12, Fig. 2) and nut (13, Fig. 2). Secure cab in raised position with cab safety prop (7).

5. Install and connect steering valve hoses as noted on removal. Connect earth strap at rear right hand cab support.

6. Connect and secure any other harnesses and hoses that were previously removed.

7. Place cab safety prop (7) in the stowed position.
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Using hand pump (1, Fig. 2) to control lowering of cab, gently lower cab until cab brackets align with cab supports (23). Install pins (1) and secure with spring pins (6).

8. Install front right hand tyre and rim assembly. Refer to Section 160-0050, WHEEL RIM AND TYRE.

9. Secure the heater hoses to the front of the cab as identified at removal.

10. Connect air conditioning lines and charge air conditioning system. Refer to Section 260-0130, AIR CONDITIONING.

11. Connect electrical harnesses at cab bulkhead as identified at removal.

12. Connect cables to alternator (earth cable last).

13. Connect cables to battery terminal posts (earth cable last).

14. Place the battery master switch in the 'On' position, start the engine and check for leaks. Tighten fittings if necessary. Allow engine to warm up and recheck all connections for leaks. Ensure electrical systems and gear shift are functioning properly.

15. Ensure parking brake is applied and remove wheel blocks from all road wheels.

TILTING THE CAB

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the brake pedal continuously to relieve pressure in the hydraulic system.

3. Block all road wheels, place the battery master switch in the 'Off' position and lift the hood assembly.

4. Insert lever (6), located in battery box, into cab hand pump (1).

5. Using hand pump (1), charge the cab raise cylinder (7) sufficiently to allow left hand pins (1, Fig. 1) to be removed. Hold cylinder (7) in this position by locking hand valve on hand pump (1).

6. Remove spring pins (6, Fig. 1), then drive out pins (1, Fig. 1). Carefully raise or lower the cab as necessary to facilitate removal of pins (1, Fig. 1).

7. Once pins (1, Fig. 1) have been safely removed, continue to raise the cab using hand pump (1) until the cab safety prop (1, Fig. 3) can be fitted.

8. Remove pin assembly (8, Fig. 1) to allow cab safety prop (1, Fig. 3) to swing down to a vertical position on top of the front left hand cab leg.

9. Lock the cab safety prop (1, Fig. 3) in position using pin assembly (8, Fig. 1), locating through holes on bracket at front left hand cab leg.

10. Lock off hand valve on hand pump (1). Remove

4 WARNINGS

To prevent damage, always ensure hood is raised before tilting or lowering the cab.

Never work near or under an unblocked or unsupported cab. Always use the cab safety prop.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Operate the brake pedal continuously to relieve pressure in the hydraulic system.

3. Block all road wheels, place the battery master switch in the 'Off' position and lift the hood assembly.

1. Cab Safety Prop
2. Cab Support
3. Cab Raise Cylinder

Fig. 3 - Cab Secured In Raised Position
lever (6) from pump (1) and place in the stowed position.

LOWERING THE CAB
Numbers in parentheses refer to Fig. 2, unless otherwise stated.

⚠️ WARNINGS
To prevent damage, always ensure hood is raised before tilting or lowering the cab.

⚠️ Never work near or under an unblocked or unsupported cab. Always use the cab safety prop.

1. Remove pin assembly (8, Fig. 1) from bracket at front left hand cab leg. Place cab safety prop (1, Fig. 3) in stowed position by locating pin assembly (8, Fig. 1) in bracket under cab.

2. Slowly open hand valve on hand pump (1) to allow cab to gently lower. Rate of descent is controlled by the hand valve on pump (1).

3. Lower cab until holes in cab brackets line up with holes in cab supports (2, Fig. 3). Hold cylinder (7) in this position by locking hand valve on hand pump (1).

4. Install pins (1, Fig. 1) through cab brackets and cab supports (2, Fig. 3). Secure pins in position with spring pins (6, Fig. 1).

5. Lower the hood and place the battery master switch in the 'On' position before closing the battery box.

6. Ensure parking brake is applied and remove wheel blocks from all road wheels.

MIRROR ARMS

Removal
Numbers in parentheses refer to Fig. 1.

⚠️ WARNING
To prevent personal injury and property damage, be sure blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Support mirror arm bracket (11) and remove locknuts (17), hardened washers (15) and springs (16) securing mirror arm assembly to mounting brackets.

2. Remove mirror arm bracket (11) and ball bearings (14) from mounting brackets.

3. Repeat steps 1 and 2 for other mirror arm bracket (11).

Installation
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Coat ball bearings (14) with grease (18) and locate in mounting brackets.

2. Locate mirror arm bracket (11) to mounting brackets and install hardened washers (15), springs (16) and locknuts (17) as shown in Fig. 1.

3. Set mirror bracket spring (16) pressure as follows;
   a. rotate mirror arm (11) until ball bearings (14) are out of their detent.
   b. tighten locknut (17) until spring (16) is almost completely compressed (typical two places).
   c. swing arm until it seats in detent.
   d. check the other two detent positions

4. Repeat steps 1, 2 and 3 for other mirror arm bracket (11).

REPLACING GLASS

Note: When replacing broken glass, it is the user’s responsibility to ensure that the replacement glass meets the required specifications. Replacement glass can be purchased from your dealer.

The rear glass, left and right hand side glasses and front windscreen are held in place by a bonding adhesive.

To replace a glass assembly, proceed as follows:

Note: Ensure the glass is supported adequately before
Starting to cut the adhesive seal.

1. Using a pointed tool, pierce a hole in the adhesive seal, it is advisable to start at the top edge of the glass. Unscrew one handle of the special tool and feed the wire through the opening. Pierce a second hole in the adhesive on the side directly opposite the first.

2. From inside the cab pull the wire through and feed it back out through the second hole.

3. Re-fit the handle on the special tool. Pull both handles outwards until wire is taut.

4. Manoeuvre the special tool around the edge of the glass, keeping the wire taut, to cut the adhesive seal. Ensure the glass is supported adequately before completing the cut.

5. Clean the remains of the adhesive from the edge of the panel opening using a suitable solvent.

6. Coat the edge of the replacement glass with primer and apply adhesive around the lip of the window aperture, as per the manufacturers recommendations.

7. Position glass onto panel opening, pressing firmly so that adhesive bonds sufficiently to allow the glass to be moved or straightened up as required.

8. Ensuring the glass is adequately supported, allow the sealing adhesive to set properly.

9. Clean off any excess adhesive using a suitable solvent.

**Water Leaks**

Test for leaks by directing a stream of water along the adhesive seal, while an assistant marks the spot of leakage inside the cab. Care should be taken to note whether the leak is between adhesive and glass. Then apply a sealing compound from the outside. Start from a point near the leak and continue applying the sealer until well beyond the suspected point of entry.

This should stop the leak immediately, but since some sealing compounds should be allowed to set before getting wet, wait a few minutes before testing.

**MAINTENANCE**

**General**

Ensure that hand pump hydraulic tank (2, Fig. 2) is filled with clean hydraulic oil as specified in Section 300-0020, LUBRICATION SYSTEM. Capacity is 0.75 litre (0.2 US gallon).

**SERVICE TOOLS**

Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the glass removal tool, adhesive bonding kit and other general service tools required. These tools are available from your dealer.
DESCRIPTION
Numbers in parentheses refer to Fig. 1.

**WARNING**
By Law, seat belts must be provided. Always wear seat belts when travelling in the vehicle.

The seat assembly consists of a seat cushion (3) and backrest cushion (2) mounted to backrest (8) and seat pan (10). Seat pan (10) is attached to a cab seat base by means of a suspension assembly (14). The air seat only reacts when the driver sits on the seat. When unoccupied, the seat sinks to the lowest position to allow easier access.

A retractable seat belt (4) is secured to the seat assembly using nuts and spacers. A push button allows quick release of seat belt (4).
the seat position in now engaged properly.

3. Pull up horizontal adjustment handle (2) and move seat forwards or backwards, release handle when required position is achieved.

4. Pull up (or push down) height and weight adjustment (1) handle and hold until the require height position is achieved, release handle - 'bounce' lightly until a 'click' is heard, the seat position in now engaged properly.

5. Pull handle (8) to adjust seat cushion fore and aft position. Hold and pull handle (8) until desired position is achieved.

6. Pull handle (9) to adjust seat cushion rake angle, hold and pull until desired angle is achieved. Ensure cushion is locked into position. This procedure is better performed when operator is off seat.

7. Pull up handle (5) and adjust backrest to the required angle, release handle when required position is achieved.

8. Pull up (or push down) backrest (6) to the required height.

9. Turn lumber support adjustment (10) until desired pressure is felt on operators back.

10. Set damper adjustment (7) position to suit driving conditions, (4 positions; forward position - hardest setting, rearmost position - softest setting).

11. Set fore/aft isolator (3) position to suit driving conditions, (forward position - unlocked, rearmost position - locked).

12. Turning armrest adjustment (11) alters the height of armrests.


NOTE: All controls should be set to operators own personal comfort.

REMOVAL

Numbers in parentheses refer to Fig. 2.

WARNING
Do not attempt to adjust the seat or seat belt while the machine is moving. Loss of control may result. Stop the machine; apply the brakes; then adjust.

OPERATION

To achieve the most comfortable driving position, adjust the seat as follows;

1. Sit in seat.

2. Pull up and release height and weight adjustment (1) handle - this will reset the seat to the predetermined height setting - 'bounce' lightly until a 'click' is heard,
Operator's Compartment - Driver Seat and Mounting

Section 260-0090

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Block all road wheels and place the battery master switch in the 'Off' position.

3. Disconnect harness connector at the rear of the seat.

4. Push down height and weight adjustment (1) handle to release the air from the seat air suspension system.

5. Remove bolts (34), washers (35), lock washers (36) and nuts (37) securing complete seat assembly to the cab seat base. Remove seat assembly from vehicle using suitable lifting equipment.

**DISASSEMBLY**

Numbers in parentheses refer to Fig. 1.

**Note:** The disassembly and assembly procedures will cover only basic sub-assemblies due to the multitude of parts. If a sub-assembly must be disassembled, use the exploded view in Fig. 1 for reference.

1. Remove covers (6 & 7) from seat assembly. Remove nuts and spacers securing lap belt (4) to seat assembly. Remove lap belt (4).

2. Pull up and remove headrest (5) from seat frame (1).

3. Remove screws securing backrest cushion (2) to seat frame (1). Remove backrest cushion (2).

4. Remove screws securing seat cushion (3) to seat frame (1). Remove seat cushion (3).

5. Pull up horizontal adjustment (2, Fig. 2) lever and slide seat assembly rearwards. Hold captive nuts using a suitable spanner and remove front allen screws.

6. Pull up horizontal adjustment (2, Fig. 2.) lever and slide seat assembly forwards. Hold captive nuts using a suitable spanner and remove rear allen screws.

7. Remove seat assembly from suspension base.

**Horizontal Shock Absorber**

Numbers in parentheses refer to Fig. 3.

**Note:** Remove seat assembly as described in 'Disassembly'

1. Remove pop-out buttons (1) and remove access cover (2) to allow access to suspension assembly.

2. Unclip hooked end of shock absorber (4) from horizontal spring assembly.

3. Remove circlip (3) and lever out shock absorber (4) from rocker shaft and slide off of mounting pin.

4. Remove spacer (5) from mounting pin.

5. Reassembly is done in the reverse order.

**Vertical Shock Absorber**

Numbers in parentheses refer to Fig. 4.

**Note:** Remove seat assembly as described in 'Disassembly'

1. Remove pop-out buttons (1) and remove access cover (2) to allow access to suspension assembly.

2. Unhook Bowden wire (5) and damper adjuster (6) assembly from the top of shock absorber (7).

3. Remove circlips (3) and lever out shock absorber (7) from mounting pins (4).

4. Remove spacers (8) from lower mounting pin (4).

5. Reassembly is done in the reverse order.
Note: Inscription must face upwards when assembling shock absorber (7).

3. Remove pressurised airline (5) from compressor (6).

4. Identify and tag and disconnect electrical plug connections (7 & 8). Unfasten cable tie on the rocker.

5. Pull suspension assembly up to its highest position and block securely.

6. Unscrew lower nut (9) and remove micro encapsulated cylinder screw (10) and retaining clamp (11).

7. Remove compressor (6) and felt mat (12) from suspension base.

8. Reassembly is done in the reverse order.

Note: Replace micro encapsulated cylinder screw (10).

Note: Centralise compressor (6) and felt mat (12) between rocker arms.

Compressor
Numbers in parentheses refer to Fig. 5.

Note: Remove seat assembly as described in 'Disassembly'

1. Remove pop-out buttons (1) and remove access cover (2) to allow access to suspension assembly.

2. Remove pop-out buttons (3) and push down suspension skirt (4) to allow further access to suspension assembly.

Level Controller
Numbers in parentheses refer to Fig. 6.

Note: Remove seat assembly as described in 'Disassembly'

1. Remove pop-out buttons (1) and remove access cover (2) to allow access to suspension assembly.

2. Remove pop-out buttons (3) and push down suspension skirt (4) to allow further access to suspension assembly.
3. Pull suspension assembly up to its highest position and block securely.

4. Unhook bowden wires (5 & 6) from level controller (7).

5. Identify and tag and disconnect electrical plug connections (8 & 9).

6. Identify and tag and disconnect pressurised airlines (10) from air suspension unit (11). Unfasten cable tie on the rocker.

7. Remove screw (12), push out pin (13) and release roll up belt (17).

8. Remove nuts (14) and manoeuvre level controller (7) until studs are free from mounting holes.

9. Remove screws (15) and remove bowden wire (16) retainer from level controller (7).

10. Remove level controller (7) from suspension base.

11. Reassembly is done in the reverse order.

Note: Tighten nuts (14) to a torque of 25 Nm (18 lbf ft).

INSPECTION
Numbers in parentheses refer to Fig. 1.

1. Inspect air lines, shock absorbers (15 & 26), compressor (21), level controller (28) and air spring (30) for leaks and damage and replace if required.

2. Check all brackets and frame for cracks and/or damage. Repair or replace as necessary.

3. Check springs for fatigue or damage and replace as required.

ASSEMBLY
Numbers in parentheses refer to Fig. 1.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

1. Position seat assembly onto suspension base. Hold captive nuts using a suitable spanner and install front allen screws. Tighten allen screws to a torque of 25 Nm (18 lbf ft).

2. Pull up horizontal adjustment (2, Fig. 2) lever and slide seat assembly rearwards. Hold captive nuts using a suitable spanner and install front allen screws. Tighten allen screws to a torque of 25 Nm (18 lbf ft).

3. Install seat cushion (3) to seat frame (1) and secure using screws.

4. Install backrest cushion (2) to seat frame (1) and secure using screws.

5. Refit headrest (5) to seat frame (1).

6. Position lap belt (4) to seat assembly and secure using nuts and spacers as removed at ‘Disassembly’. Tighten nuts to a torque of 50 Nm (36 lbf ft). Refit covers (6 & 7).

INSTALLATION
Numbers in parentheses refer to Fig. 2.

Note: Tighten all fasteners without special torques specified to torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

WARNINGS
To prevent personal injury and property damage, be sure wheel chocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Using suitable lifting equipment, position seat assembly on the cab seat base and secure using bolts (34), washers (35), nuts (37) and lock washers (36).

2. Reconnect harness at the rear of the seat.

3. Place battery master switch in the ‘On’ position, start the engine and charge the air system. Check seat for proper operation, refer to ‘Operation’.

4. Remove wheel chocks from road wheels.
### SPECIAL TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>FIG. NO.</th>
<th>ITEM NO.</th>
<th>ITEM NAME</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>#</td>
<td>Nut</td>
<td>50</td>
</tr>
<tr>
<td>1</td>
<td>#</td>
<td>Allen Screw</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>Nut</td>
<td>25</td>
</tr>
</tbody>
</table>

### MAINTENANCE

Numbers in parentheses refer to Fig. 1.

The care of the upholstery on seat cushion (3) and backrest cushion (2) is a relatively simple, but important matter. Accumulation of dirt on the surface eventually turns into a hard gritty substance which cuts into the surface of the upholstery.

To clean seat cushion (3) and backrest cushion (2), use warm water and a mild soap, such as Castile. Work up thin soap suds on a piece of soft cloth and rub the upholstery briskly. Remove the suds with a damp cloth, using no soap, and finish by wiping the upholstery dry with a soft, dry cloth.

Lap belt (4) assembly should be inspected by the user on a regular basis. Replace lap belt (9) immediately if hardware is worn or damage, straps are nicked or frayed, buckle is not functioning correctly, loose stitching is found, or if the strap material has lost strength due to the effects of ultraviolet rays.

**Note:** Regardless of appearance, lap belt (4) must be removed and replaced at least once every three years.
DESCRIPTION

Temperature Control Switch
A thermostat switch senses the temperature of the evaporator and engages or disengages the compressor clutch. The control for this switch is located in the cab.

Compressor
The compressor is designed to compress vapour and can be damaged by non-compressibles such as dirt, moisture, liquid refrigerant (R-134a), etc. The compressor draws vaporized R-134a from the evaporator (which maintains the low pressure necessary for proper evaporation) and compresses the vapour to a high pressure, which is necessary for condensation. The high pressure vapour then moves into the condenser where heat can be radiated to change the R-134a back to liquid.

Note: R-134a designates the type of refrigerant used in heavy duty vehicle air conditioning systems.

Compressor Drive Clutch
The R-134a compressor systems use an electronically actuated clutch to engage and disengage drive to the compressor. The drive belt pulley is mounted on a bearing and is free to rotate without turning the compressor crankshaft any time electrical power is disconnected. The compressor is not operating when the pulley is freewheeling. The field coil is energized by supplying electrical current to the exposed wire. The other end of the coil winding is grounded to the compressor and equipment frame. Energizing the coil creates a magnetic force that locks the driven disk to the pulley and drives the compressor.

Condenser
The purpose of the condenser is to radiate enough heat energy from the compressed high pressure vaporized R-134a so that the R-134a changes from vapour to liquid. During normal operation all the high pressure section of the system will be warm or hot, but large quantities of heat should be radiating from the condenser. Nothing should be permitted to stop or slow
down this radiation of heat. Cooling fins are located on the condenser tubes and fans are used to circulate cool air around the condenser tubes. Keep all leaves, paper, dirt, etc. clear from the condenser and condenser filter. The cooling fins should be straight to permit free flow of air. The condenser is sometimes located ahead of the engine radiator and blockage of air flow through the radiator also affects the condenser. Bent fan blades, slipping fan drive, inoperable condenser fan motors, or any other fault that lessens the amount of cool air circulated through the condenser, should be corrected. The oil, dirt, or antifreeze will act as an insulator that will inhibit the radiation of heat.

Since the purpose of the condenser is to radiate heat energy, anything that prevents or inhibits this action may affect cooling, but the temperature and pressure of the R-134a raise and lower together. Heat energy that has not been radiated will remain in the R-134a and the result will be pressure that is too high. The condenser, hoses, connections and seals can be damaged by the high pressure. Pressure sensing safety switches may be activated by the high pressure caused by the condenser not radiating enough heat.

**Receiver Drier**
The high pressure liquid R-134a moves from the condenser to the receiver drier, where the R-134a is stored and filtered. Moisture is the major enemy of the air conditioning system and the desiccant inside the receiver drier will absorb only a small amount. The container of desiccant inside the receiver drier may break open and contaminate the system if any attempt is made to dry the desiccant, or, if more moisture is inside the system than the desiccant can absorb.

Every effort should be made to remove all moisture from the system and install a new receiver drier if its condition is questionable. Installation of a new receiver drier is recommended each time any part of the R-134a system is open to the atmosphere. Bubbles are observed in the sight glass on top of the receiver drier during the charging procedure.

A filter screen is located in the receiver drier to stop solid contaminants from leaving the unit. Blockage of the filter will result in a drop in pressure that will be indicated by a drop in temperature. Connections of the new receiver drier should be securely capped before installation to prevent the entrance of moisture (air) while in storage.

**Thermostatic Expansion Valve**
An expansion valve is installed in the system to lower the pressure before the R-134a enters the evaporator. The reduction in pressure is done by passing the R-134a through a small hole (orifice). The size of the orifice must be controlled to compensate for changes in pressure and temperature. The temperature of R-134a leaving the evaporator is sensed by a thermostatic sensor that moves the valve seat via a diaphragm and actuating pin.

**Evaporator - Heat/Cool**
The evaporator is the low pressure, low temperature component where liquid R-134a absorbs heat from surrounding air. The expansion valve bleeds high pressure R-134a into the low pressure evaporator. The R-134a expands rapidly in the evaporator and its temperature is quickly reduced. The R-134a absorbs heat from the air when the blower fan circulates air over the evaporator coil fins. The exchange of heat from the air to the R-134a depends upon the difference in temperature. During high heat load, such as usually encountered when the system is first turned on, the temperature difference is great and the R-134a will absorb heat quickly. The blower fan can be set at its highest setting to circulate large quantities of warm air around the evaporator. After the cab has cooled, the fan speed should be reduced so that the already cool air will have a longer time to yield heat to the R-134a as it passes the evaporator coils. The heater circuits utilize engine coolant at approximately 82° C (180° F).

**High Pressure and Low Pressure Switches**
The pressure switches are electric switches that monitor air conditioner operation. The high pressure and low pressure switches are activated at preset pressures and engage and disengage the compressor clutch.
REMOVAL
Numbers in parentheses refer to Fig. 2, unless otherwise stated.

**WARNINGS**
Always wear goggles or glasses to protect your eyes when working around R-134a.
R-134a boils at sea level temperatures of -29.8°C (-21.6°F), which means that direct contact with your skin will produce frostbite. Exercise extreme care when handling R-134a. If R-134a contacts your skin, wash immediately with plenty of warm water. Remove any contaminated clothing with caution as it may adhere to the skin. If blistering or continued irritation occurs obtain immediate medical attention.

If you get the slightest trace of R-134a in your eye, flood the eye immediately with cool water; then treat with mineral oil or clear petroleum jelly followed by boric acid rinse. Report to a hospital or doctor as soon as possible.

The chemicals of R-134a when burned produce gases that will damage the respiratory system if inhaled. NEVER SMOKE in an area where R-134a is used or stored. Use hot water or an approved heated charge cylinder as a heat source if required to force R-134a into the system. If using water, do not exceed 52°C (125°F). Never use direct flame or electric heaters in direct contact with the R-134a container. High temperatures may result in raising the pressure to a dangerous level.

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.
2. Block all road wheels and place the battery master switch in the 'Off' position.
3. Pull on handle (inside battery box) to release hood catch and raise the hood.
4. Discharge the air conditioning system as described under 'Discharging The System'.
5. When satisfied that the system is completely discharged, tag refrigerant hoses (8 & 9) to aid in installation and carefully disconnect hoses from cab firewall. Cap fittings at front of cab and refrigerant hoses (8 & 9) to prevent foreign matter from entering the system.
6. Remove fasteners securing front cover (36, Fig. 3) and end plate (19, Fig. 3) to main weldment (18, Fig. 3).
7. Remove heater hoses from front of cab, which connect to water inlet hose (24, Fig. 3) and water outlet hose (23, Fig. 3). Cap open ports and hoses to prevent foreign matter from entering the system.
8. Unhook control assembly cable (40, Fig. 3) at main weldment (18, Fig. 3).
9. If necessary to remove main weldment (18, Fig. 3) from cab, be sure to disconnect any remaining harnesses, hoses or ducting before withdrawing main weldment (18, Fig. 3) from cab.

**Note:** The blower assembly mounting (35, Fig. 3), thermostat (21, Fig. 3) and heat exchangers (31,32, Fig. 3) can be accessed without removing the main weldment (18, Fig. 3) from cab.
10. Tag refrigerant hoses (7 & 8) to aid in installation and carefully disconnect hoses from receiver/drier (4). Cap receiver/drier (4) fittings and refrigerant hoses (7 & 8) to prevent foreign matter from entering the system.
11. Support receiver/drier (4) and remove clamps securing receiver/drier (4) to mounting bracket (14).
12. Tag refrigerant hoses (6 & 7) to aid in installation and carefully disconnect hoses at condenser (5). Cap condenser (5) fittings and refrigerant hoses to prevent ingress of foreign matter.
13. If required, support air conditioner condenser (5) and remove bolts (15), lockwashers (16) and washers (17) securing condenser (5) to radiator assembly. Remove condenser (5) from vehicle.
14. Tag refrigerant hoses (6 & 9) to aid in installation and carefully disconnect hoses from compressor (1). Cap compressor (1) fittings and refrigerant hoses (6 & 9) to prevent foreign matter from entering the system.
15. Disconnect electrical connection from compressor (1) clutch.
16. Slacken nut (21) and bolt (20). Adjust bolt (20) to release tension on drive belt (3).

17. Drive belt (3) should now be free to slide off the groove in compressor (1).

18. Support compressor (1) and remove bolts (25), washers (26) and nuts (27) securing compressor (1) to bracket (2). Remove compressor (1) from the vehicle.

**Note:** If drive belt (3) does not require replacement do not remove from engine pulley. If drive belt (3) requires replacement, proceed with steps 19 and 20.

19. If required, remove mounting hardware securing fan guard assembly to radiator assembly. Refer to Section 210-0040, RADIATOR AND MOUNTING.

20. If required, remove bolts (28), lockwashers (18), washers (13) and bracket (2) from engine.

21. If required, remove bolts (24), lockwashers (23), washers (22) and bracket (19).

**Note:** If fitted, coolant filter will have to be removed.

22. If required, disconnect all clamps and clips securing refrigerant hoses and harnesses to the vehicle. Remove hoses and harnesses from the vehicle.
Fig. 3 - Air Conditioner Lines and Mounting
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LEGEND FOR FIG. 3

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
| 1 | - Heater/Air-Con Assy | 13 | - Nut Insert | 25 | - Water Valve Assy | 37 | - Recirculation Filter |
| 2 | - Grommet | 14 | - Allen Screw | 26 | - Jubilee Clip | 38 | - Coil Seal |
| 3 | - Seal | 15 | - Allen Screw | 27 | - Demist Flap Assy | 39 | - Coil Seal |
| 4 | - Grommet | 16 | - Clamp Plate | 28 | - Cable Bracket | 40 | - Control Assy Cable |
| 5 | - Screw | 17 | - Clamp Plate | 29 | - Pivot Bracket | 41 | - Louver |
| 6 | - Grommet | 18 | - Main Weldment | 30 | - Fresh Air Flap Assy | 42 | - Drain Tube Assy |
| 7 | - 'O' Ring | 19 | - End Plate | 31 | - Evaporator | 43 | - Control Knob |
| 8 | - 'O' Ring | 20 | - Valve | 32 | - Heater Coil | 44 | - Potentiometer Assy |
| 9 | - Control Arm | 21 | - Thermostat | 33 | - Manifold | 45 | - Air Con Switch |
| 10 | - Control Arm | 22 | - Water Outlet Pipe | 34 | - Manifold | 46 | - Fan Speed Switch |
| 11 | - Nut Insert | 23 | - Water Outlet Hose | 35 | - Blower Assy Mounting |
| 12 | - Binary Switch | 24 | - Water Inlet Hose | 36 | - Front Panel Assy |

INSTALLATION

Numbers in parentheses refer to Fig. 2, unless otherwise stated.

Note: Tighten all fasteners to standard torques specified in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

Note: Renew all 'O' rings where necessary (10, 11 & 12).

⚠️ WARNING

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

1. If main weldment (18, Fig. 3) was removed, install in cab and reconnect harnesses, hoses and air ducting as noted during removal.

2. Attach control assembly cable (40, Fig. 3) as noted during removal.

3. Reconnect heater hoses to front of cab and connect to water inlet hose (24, Fig. 3) and water outlet hose (23, Fig. 3), as identified at removal.

4. Once all necessary connections have been made, secure front cover (36, Fig. 3) and end plate (19, Fig. 3) to main weldment (18, Fig. 3) using fasteners previously removed.

5. Remove caps from end of refrigerant hoses (8 & 9) and ports at front of cab and connect hoses to ports as tagged at removal.

6. Route refrigerant hoses (8 & 9) along the LH side of the engine securing with clamps removed during removal.

7. If removed, install receiver/drier (4) to mounting bracket (14) and secure with clamps.

8. Remove caps from end of refrigerant hoses (7 & 8) and ports on receiver/drier (4) and connect hoses to ports as tagged at removal.

9. If removed, install condenser (5) to radiator assembly and secure with bolts (15), lockwashers (16) and washers (17).

10. Remove caps and connect refrigerant hoses (6 & 7) to condenser (5) ports as tagged at removal.

11. If removed, install bracket (19) to engine and secure with bolts (24), lockwashers (23) and washers (22). If applicable, install coolant filter to bracket (19).

12. If removed, install compressor bracket (2) to engine and secure using bolts (28), lockwashers (18) and washers (13) as shown in Fig. 2.

13. Fit compressor (1) to compressor bracket (2) and secure with bolts (25), washers (26) and locknuts (27). Do not fully tighten at this stage.

Note: If fan guard and compressor drive belt (3) were removed, proceed with steps 14 & 15.

14. Install new drive belt (3) onto engine pulley and fit to groove on compressor (1).

15. Adjust tension of compressor drive belt with nut (21) on adjuster bolt (20) until there is approximately an inward deflection of 10 mm (0.4 in) at the centre of drive belt (3). Fully tighten all mounting hardware.

16. Remove caps from end of refrigerant hoses (6 & 9) and ports on compressor (1) and connect hoses to ports as tagged at removal.

17. Connect electrical connection to compressor (1) clutch.
18. Secure all lines with clips and clamps as removed during removal. Ensure no lines are chaffing on sharp edges or resting against areas where heat will be evident.

19. Charge the air conditioning system as described under 'Charging Procedure'.

20. Switch the battery master switch to the 'On' position, start up the engine and check for correct operation of the air conditioning system.

21. Lower hood and remove wheel blocks from all road wheels.

MAINTENANCE

⚠️ WARNINGS

Always wear goggles or glasses to protect your eyes when working around R-134a. R-134a boils at sea level temperatures of -29.8°C (-21.6°F), which means that direct contact with your skin will produce frostbite. Exercise extreme care when handling R-134a. If R-134a contacts your skin, wash immediately with plenty of warm water. Remove any contaminated clothing with caution as it may adhere to the skin. If blistering or continued irritation occurs obtain immediate medical attention.

If you get the slightest trace of R-134a in your eye, flood the eye immediately with cool water; then treat with mineral oil or clear petroleum jelly followed by boric acid rinse. Report to a hospital or doctor as soon as possible.

The chemicals of R-134a when burned produce gases that will damage the respiratory system if inhaled. NEVER SMOKE in an area where R-134a is used or stored. Use hot water or an approved heated charge cylinder as a heat source if required to force R-134a into the system. If using water, do not exceed 52°C (125°F). Never use direct flame or electric heaters in direct contact with the R-134a container. High temperatures may result in raising the pressure to a dangerous level.

1. Periodically clean the condenser coil of debris and dirt using water or air pressure. A partially blocked condenser coil can reduce the life of the compressor belt and/or clutch.

2. If the system has a heater in the same location as the air conditioning evaporator core, heater valves should be closed.

3. To check the refrigerant level, run the engine at 1 200 rev/min with fans on high speed and thermostat fully open for a minimum of five minutes. If the clutch is engaged in this situation, there should be very few bubbles visible in the receiver-drier sight glass.

Note: Unit can operate with some bubbles visible, but not milky looking.

4. Ensure all hoses and hose clamps are free from contact with sharp metal, moving parts or near to manifolds.

5. Inspect condensation drain lines for debris, sharp bends or breaks.

6. Inspect the clutch wire from the thermostat for bare spots.

7. Inspect bolts and nuts on the compressor and mounting bracket for proper tightness.

8. Check for any air blockages within the system. Clean recirculation filter periodically, by shaking off dust or by washing in soapy water.

9. If the refrigerant system is broken into following gas loss due to mechanical damage or there is any other reason to suspect foreign material ingress, then the receiver/drier should be replaced.

10. Every 4,000 hours, drain, flush and refill the compressor with refrigerant oil specified in Section 300-0020, LUBRICATION SYSTEM. Also see 'Refrigerant Oil'.

Maintenance of drive belts

1. Listen for 'ticking' sound - they mean interference with the belts. Visually inspect for bent or damaged belt guards.

2. Replace all belts in a mismatched set at one time to ensure even load distribution.

3. Periodically check tension and keep belts tight.

- The ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
- Check belt tension frequently during the first 24 - 48 hours of run-in operation.
- Initial belt tension should be 533 N (120 lbf)

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- drooping to 422 N (95 lbf) after the first 48 hours.
- There should be a freeplay of 10 mm in the belt.
- Do not over tension belts.
- Keep belts free from foreign material that may cause slippage.
- Inspect the drive periodically. Re-tension belts if they are slipping.
- Maintain sheave alignment with a strong straight edge tool while tensioning belts.

4. Never attempt to correct belt slippage by using a belt dressing. The dressing may cause softening and deterioration.

5. If belt slips, even when properly tensioned, check for overload, worn sheave grooves or oil or grease on the belts.

6. Never pry a drive belt or force it into the sheave groove. Loosen the drive belt tightener prior to installation.

7. A belt that has operated while rolled over in the sheave groove may be damaged - replace it.

8. Store belts in a cool, dry place. If stored on a machine, relieve all belt tension by loosening the drive belt tightener.

9. Never attempt to check or adjust belts while they are running.

Refrigerant Oil

**WARNINGS**

To prevent personal injury always wear rubber gloves when handling refrigerant oils.

Too much refrigerant oil will dampen the cooling effect and too little refrigerant oil may lead to compressor failure. If in doubt flush the system.

Oil is required to lubricate the compressor. The oil mixes with the refrigerant and is carried around the system. The compressor is supplied with an oil charge. However, additional oil is required, the amount depending on the length of refrigerant hose being used. The quantity added should be calculated using the following equation:

\[
\text{Amount of oil to add in fl oz} = (0.47 \times \text{total length of hoses in m}) - 2.15
\]

If any component is replaced the following amount of oil should be added to the system:

- Condenser add 1 fl oz (28.4 ml)
- Drier add 1 fl oz (28.4 ml)
- Evaporator add 3 fl oz (85.2 ml)
- Compressor add 4.4 fl oz (125 ml)

The oil should be added to the oil filling port of the compressor before the evacuation procedure is started or by using an oil injector when the system is being charged, observing the following good practises:

a. Only pour the amount required from the container straight into a CLEAN measuring jug and immediately pour the oil into the compressor.

b. Re-cap container tightly as soon as the required amount has been taken (never leave an oil container open).

c. Do not mix different oils.

Only new oil should be used, because oil that has been exposed to the air will have absorbed water (hygroscopic).

Use only refrigerant oil as specified in Section 300-0020, LUBRICATION SYSTEM.

System Leak Testing

**Recommended Equipment Required:**

Electronic Leak Detector

Switch off the engine and check all connections throughout the system for leaks. A large leak point will have an oily or greasy appearance. The refrigerant carries compressor oil with it and deposits it around the leak area. Check all such points for loose connections and tighten.

Using a suitable leak detector, search for leaks around all joints, connections, seals and control devices. If a leak is located, purge the system of refrigerant and repair. Fully evacuate and charge the system to make it operational.

**DISCHARGING THE SYSTEM**

**Note:** Refer to all WARNINGS listed under 'Maintenance' prior to discharging the system.

**Recommended Equipment Required:**

Portable High Vacuum Charging Station

Suitable Canister

or Standard Service Manifold (Refer to Fig. 4)
To eliminate system contaminants from an air conditioning system requires discharging the entire system. This means removing all of the refrigerant and cleansing all contamination (air and moisture) from the system components. If any of the major system components are to be repaired or replaced, the system must also be completely discharged.

**WARNING**
The vehicle must not be running during this procedure. Be sure to have adequate ventilation during this operation. Do not discharge refrigerant near an open flame.

Numbers and letters in parentheses refer to Fig. 4.

1. Position the vehicle in a level work area, apply the parking brake and switch off the engine.

2. Block all road wheels and place the battery master switch in the 'Off' position.

3. Pull on handle to release hood catch and raise the hood.

4. Connect the service hose (yellow) to the centre access port on the manifold gauge and to the vacuum connection (6) on vacuum pump. Ensure that the system is empty before connecting the vacuum so that refrigerant does not enter the pump.

5. Tighten down (turn clockwise) both high and low side valves on the gauge manifold to the closed position. Remove protective caps from the service ports on the compressor.

6. Connect both service hoses from the two fittings (2 & 3) in the bottom of the manifold to the two service ports on the compressor. High side (red) to compressor discharge valve, low side (blue) to compressor suction valve.

7. Switch vacuum pump on, open vacuum pressure valve (1) until less than 6 mb is reached on vacuum gauge (A). The vacuum gauge (A) should remain at this value when vacuum pressure valve (1) is closed to indicate that there are no leaks.

8. Open the low side hand valve on the manifold and vacuum pressure valve (1) and watch that the gauges start to register that a vacuum is being drawn. If the gauges do not register the vacuum then a blockage is present. Open the high side and pump down until a vacuum of 10 mb is achieved.

9. After 10 - 15 minutes close vacuum pressure valve (1) and allow the system to settle, vacuum gauge (A) should not alter. If the vacuum is held, no leaks or refrigerant contaminated oil is present. If not, open the vacuum pressure valve (1) and continue pumping, checking at regular intervals. If there is a leak, check all fittings and tighten if necessary.

10. Tighten down (turn clockwise) both high and low side valves on the gauge manifold to the closed position, remove the service hose (yellow) from the vacuum connection (6) on vacuum pump and switch the pump 'Off'.

11. Connect the service hose (yellow) to the R-134a cylinder. Open the cylinder valve and then purge air from the hose at the manifold connection.

12. Open the low side hand valve on the manifold slowly, until low pressure gauge (B) is at bottle pressure. Watch the high side manifold gauge (C) rise to ensure that no blockage is present. Close the manifold valve and cylinder, then disconnect the hose from the cylinder.

13. Connect the service hose (yellow) to the Nitrogen cylinder. Open the neck valve on the cylinder and set the regulator pressure such that it is higher than the system pressure then purge the hose. Open the low side hand valve on the manifold, as the pressure rises open the high side hand valve on the manifold and allow a system pressure of 10 bar (150 psig) to be reached. Close all the valves. Using a suitable electronic leak detector, check all joints in the air conditioning system for leaks. Tighten any loose joints and re-test if necessary.

14. Vent the refrigerant mix to atmosphere by removing the service hose (yellow) from the Nitrogen cylinder and opening the low side hand valve on the manifold. Re-evacuate the system to below 6 mb (steps 7 to 10).

15. Lower hood assembly and remove wheel blocks.

**CHARGING THE SYSTEM**

**Note:** Refer to all WARNINGS listed under 'Maintenance' prior to charging the system.

**Recommended Equipment Required:**
Portable High Vacuum Charging Station
Electronic Leak Detector
or Standard Service Manifold (Refer to Fig. 4)
For New Or Completely Empty System

Note: The charging procedure must be done in ambient temperatures above 15.5° C (60° F) with the R-134a canister temperature equal to the outside ambient temperature.

1. Shut off engine and block all road wheels.
2. Pull on handle to release hood catch and raise the hood.
3. Remove protective caps from 'quick coupler' valves on rear of compressor.
4. Connect low pressure gauge hose (blue hose and gauge) to suction side or low side fitting on compressor. The suction side can be identified by the size of the hose connected to the fitting. This will be the largest diameter hose of the system.
5. Connect the high pressure gauge hose (red hose and gauge) to discharge or high side fitting on compressor.
6. Connect yellow supply hose to suction port on vacuum pump.
7. Open both sides of gauges, low and high, completely.
8. Start vacuum pump to evacuate the complete air conditioning system.
9. Run vacuum pump for approximately 30 minutes. Ideal gauge readings should be 29.92 inches of mercury. The pressure will vary with altitude; it will be approximately 0.03 bar (0.5 lbf/in²) less for each 305 m (1 000 ft) of elevation.
10. Before disconnecting power supply from vacuum pump, close both high and low side gauges. Remove yellow hose from vacuum pump and connect to R-134a source.
11. Open R-134a source. Loosen, but do not remove, yellow supply hose at manifold on gauges to remove all air in the yellow supply hose, replacing the air with R-134a. This is done in a few seconds. Tighten yellow supply hose.
12. Open low side of R-134a gauges slowly. When gauge reads zero open both sides completely. Vacuum in the system will draw R-134a gas into the system. Hold until both gauge readings equalize.

Note: Never charge with liquid R-134a. Charge on the low pressure side only.

Final Charging Of The System

1. Start the engine and run at engine idle speed.
2. Turn the air conditioning system on with the thermostat set on maximum cooling and fan on high speed.
3. At this point a visual inspection must be made of the sight glass on top of the receiver-drier. Allow charging to continue until 1.1 kg (2.43 lbs) of refrigerant has been added. The charging process can be speeded up by running the engine at a fast idle.
4. The sight glass on top of the receiver/drier will be substantially free of bubbles.

Note: It is normal for bubbles to increase during clutch cycling or system start-up.
5. With the system completely charged, shut off the engine. Close the valve on the R-134a canister and remove the yellow supply hose. Remove both the low pressure (blue) hose and high pressure (red) hose from the filling ports on the compressor.

Note: Some R-134a will escape as the hoses are being removed.
The system is completely charged when;

a. the suction pressure on the gauge is approx. 20 - 30 psig at 25° C ambient.
b. the correct weight of refrigerant has been added i.e. 1.1 kg (2.43 lbs).
c. the correct sub-cooling can be measured at the condenser, approx. 5 - 7° C.

6. Replace protective caps on hoses and valve fittings.
7. Lower hood assembly and remove wheel blocks.

TROUBLESHOOTING

Preliminary Checks
Before any checks are carried out on the refrigerant circuit the following checks should be made:

1. Check the compressor drive belt is serviceable and correctly tensioned.

2. Check the condenser and engine radiator are not blocked by debris. Clean with compressed air or water if necessary.

3. Check that the condenser fins are not flattened or damaged, the fins must allow air to pass freely.

4. Check the cab fresh air inlet filter for blockage.

5. Check that, with the ignition switch on (engine not running), the blower operates over whole speed range

6. Check that, with the ignition switch on (engine not running), the blower and air conditioning switched on, the compressor clutch engages.

Charge level:
Note: It is not possible to check refrigerant charge level with R134a systems. Any bubbles seen at the sight glass on the receiver drier may be bubbles of oil and are perfectly normal.

Fault finding:
Refer to Troubleshooting table
Important: Refer to appropriate removal and installation procedures before working on any system component.

SPECIAL TOOLS
Refer to Section 300-0070, SERVICE TOOLS, for part numbers of special tools referenced in this section and general service tools and sealants required. These tools and sealants are available from your dealer.
## AIR CONDITIONING TROUBLESHOOTING

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<tr>
<td></td>
<td>Air in system</td>
<td>Evacuate system and re-charge</td>
</tr>
<tr>
<td></td>
<td>Compressor mounting or belts loose</td>
<td>Tighten</td>
</tr>
<tr>
<td></td>
<td>Drive pulley loose</td>
<td>Tighten</td>
</tr>
<tr>
<td></td>
<td>Belt tension incorrect</td>
<td>Correct tension</td>
</tr>
<tr>
<td></td>
<td>Faulty compressor</td>
<td>Replace compressor</td>
</tr>
<tr>
<td>Noise with clutch engaged</td>
<td>Faulty clutch bearing</td>
<td>Replace bearing</td>
</tr>
<tr>
<td>Noise with clutch engaged or disengaged</td>
<td>Clutch loose</td>
<td>Tighten</td>
</tr>
<tr>
<td>Noise</td>
<td>Clutch rubbing field coil</td>
<td>Align clutch</td>
</tr>
<tr>
<td></td>
<td>Faulty belt</td>
<td>Replace belt</td>
</tr>
<tr>
<td></td>
<td>Compressor oil level low</td>
<td>Add oil</td>
</tr>
<tr>
<td>Chatter/Knock</td>
<td>Valve plate broken</td>
<td>Repair or replace</td>
</tr>
<tr>
<td><strong>3. Noise - Evaporator</strong></td>
<td>Fan blade or blower</td>
<td>Repair or replace</td>
</tr>
<tr>
<td>Rubbing/scraping</td>
<td>Low charge/leak</td>
<td>Correct charge/repair leak</td>
</tr>
<tr>
<td>Hissing</td>
<td>Expansion valve</td>
<td>Replace</td>
</tr>
<tr>
<td>Chatter/Knocking</td>
<td>Loose brackets/screws</td>
<td>Tighten</td>
</tr>
<tr>
<td>Noisy case</td>
<td>Dry bearings</td>
<td>Replace</td>
</tr>
<tr>
<td>Motor squeal</td>
<td>Fan blade or blower</td>
<td>Repair or replace</td>
</tr>
<tr>
<td></td>
<td>Low charge/leak</td>
<td>Correct charge/repair leak</td>
</tr>
<tr>
<td></td>
<td>Expansion valve</td>
<td>Replace</td>
</tr>
<tr>
<td></td>
<td>Loose brackets/screws</td>
<td>Tighten</td>
</tr>
<tr>
<td></td>
<td>Dry bearings</td>
<td>Replace</td>
</tr>
</tbody>
</table>
### AIR CONDITIONING TROUBLESHOOTING (CONTINUED)

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>PROBLEM</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. Air Conditioning Inadequate After Short Period Of Operation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling quits</td>
<td>Loss of refrigerant</td>
<td>Charge system/check for leaks</td>
</tr>
<tr>
<td></td>
<td>Moisture in system</td>
<td>Replace drier</td>
</tr>
<tr>
<td></td>
<td>Thermostat</td>
<td>Replace thermostat</td>
</tr>
<tr>
<td></td>
<td>Clutch</td>
<td>Check pull-in of clutch or replace</td>
</tr>
<tr>
<td>Cooling intermittent</td>
<td>Moisture in system</td>
<td>Replace drier</td>
</tr>
<tr>
<td><strong>5. Electrical Trouble</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blower motor or condenser fan motor inoperable</td>
<td>Defective circuit breaker or bad wiring connections</td>
<td>Replace. Clean and tighten connections</td>
</tr>
<tr>
<td></td>
<td>Tight motor bearing</td>
<td>Repair or replace motor</td>
</tr>
<tr>
<td></td>
<td>Switch open or shorted</td>
<td>Repair or replace switch</td>
</tr>
<tr>
<td></td>
<td>Blown fuse</td>
<td>Check fuse, replace if necessary</td>
</tr>
<tr>
<td></td>
<td>Motor seized</td>
<td>Check rotors are free to turn</td>
</tr>
<tr>
<td></td>
<td>Loose wire/connection</td>
<td>Check connectors at blower. Check there is power across terminals</td>
</tr>
<tr>
<td></td>
<td>Motor failure</td>
<td>Replace and replace blower</td>
</tr>
<tr>
<td></td>
<td>Faulty control</td>
<td>Check system with replacement</td>
</tr>
<tr>
<td></td>
<td>Module damaged</td>
<td>Check system with replacement module inside main weldment</td>
</tr>
<tr>
<td>Slow running blower</td>
<td>Shaft binding</td>
<td>Replace motor - worn bearings</td>
</tr>
<tr>
<td></td>
<td>Wheel misaligned</td>
<td>Replace</td>
</tr>
<tr>
<td></td>
<td>Bad blower switch</td>
<td>Replace blower</td>
</tr>
<tr>
<td></td>
<td>Insufficient current</td>
<td>Install larger alternator</td>
</tr>
<tr>
<td>Clutch inoperable</td>
<td>Defective relay</td>
<td>Replace</td>
</tr>
<tr>
<td></td>
<td>Loose connection</td>
<td>Clean and tighten connection</td>
</tr>
<tr>
<td></td>
<td>Broken wire - ground</td>
<td>Repair wire</td>
</tr>
<tr>
<td></td>
<td>Shorted or open field</td>
<td>Replace field</td>
</tr>
<tr>
<td></td>
<td>Blown fuse</td>
<td>Check fuse, replace if necessary</td>
</tr>
<tr>
<td></td>
<td>Faulty freeze protection thermostat</td>
<td>When temperature is above cut-off temp, thermostat should be closed. If faulty, replace thermostat</td>
</tr>
</tbody>
</table>
### AIR CONDITIONING TROUBLESHOOTING (CONTINUED)

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>PROBLEM</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutch inoperable (continued)</td>
<td>Faulty compressor</td>
<td>If compressor clutch is being fed power then it should be engaged. If not, check wiring. Replace compressor if faulty</td>
</tr>
<tr>
<td></td>
<td>Faulty pressure switch</td>
<td>If the binary pressure switch detects pressure within range, circuit should be closed. If switch is not closed circuit, indicates incorrect pressure or faulty switch.</td>
</tr>
</tbody>
</table>

### 6. Air Conditioning System Trouble - Gauges must be connected

<table>
<thead>
<tr>
<th>Condition</th>
<th>Problem</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>High head pressure</td>
<td>Overcharge of refrigerant</td>
<td>Purge system as necessary</td>
</tr>
<tr>
<td></td>
<td>Air in system</td>
<td>Evacuate and re-charge</td>
</tr>
<tr>
<td></td>
<td>Condenser clogged</td>
<td>Clean condenser</td>
</tr>
<tr>
<td>Low head pressure</td>
<td>Undercharge of refrigerant</td>
<td>Complete charge</td>
</tr>
<tr>
<td></td>
<td>Bad compressor valve plate or gasket</td>
<td>Repair or replace</td>
</tr>
<tr>
<td>Low suction pressure</td>
<td>Restriction in drier</td>
<td>Replace drier</td>
</tr>
<tr>
<td></td>
<td>Restriction in lines</td>
<td>Clean lines</td>
</tr>
<tr>
<td></td>
<td>Restriction in expansion valve</td>
<td>Replace expansion valve and drier</td>
</tr>
<tr>
<td></td>
<td>Improper expansion valve in charge</td>
<td>Replace expansion valve</td>
</tr>
<tr>
<td></td>
<td>Refrigerant leak</td>
<td>Inspect lines and fittings. Tighten, repair or replace</td>
</tr>
</tbody>
</table>

* * * * *
DESCRIPTION
The standard body is an all welded construction with all wear plates fabricated from high hardness (min. 360 BHN) 1 000 MPa (145 000 lbf/in²) yield strength steel. Angled lower body sides reduce body impacts when loading and a tailshute angle of 25° provides good retention when travelling without a tailgate. Refer to Section 000-0000, GENERAL INFORMATION for body capacities.

The body is pivoted at the rear of the trailer frame and is operated by two single stage, double acting hoist cylinders which are cushioned at both ends of the stroke to reduce impact shocks. The hoist cylinders raise the body to a tipping angle of 65° in 12 seconds and powerdown the body in 7.5 seconds.

OPERATION
The body control lever, mounted on the right hand dash panel, controls the main hydraulic valve assembly.

When the body control lever is operated, a voltage is sent to the hydraulic ECU, which converts voltage to current. This current controls the body raise and lower proportional pressure control valves, producing a pilot pressure to shift the control spool in the main hydraulic valve. This allows the flow of oil to reach the body cylinders, to either raise or lower the body. Refer to Section 230-0000, BODY SYSTEM SCHEMATIC and Section 215-0050, MAIN HYDRAULIC VALVE.

The three operating positions of the joystick from front to rear are as follows:

Power Down - Pushing the lever forward provides hydraulic force to power-down the body.
lever fully forward will engage the electric detent. When the body reaches the body proximity switch, the lever springs back to 'NEUTRAL' and power down is ramped back to allow the body to float down onto the chassis.

**Neutral** - If the body is above the body proximity switch, the lever in this position will stop and hold the body at any desired height. If the body is below the proximity switch, the hydraulic ECU defaults the control spool in the main hydraulic valve to the neutral position and energises the float solenoid, allowing the body to float down onto the chassis. The body should be fully lowered and in the 'NEUTRAL' position while the machine is in motion. The lever will remain in the 'NEUTRAL' position when released.

**Raise** - Pulling the lever back and holding it in this position directs oil to extend the body hoists and raise the body. When released, the lever will spring back to the 'NEUTRAL' position.

Means of electrical signals to the pressure reducing valves, which in turn operates the body hoist cylinders. The four operating positions of the joystick from front to rear are as follows:

A body lower emergency switch in the cab is connected directly to the float solenoid, within the main hydraulic valve, to enable the lowering of the body in the event of an engine, hydraulic or hydraulic ECU failure. The cause of the failure must be investigated and corrected.

**Note:** The body must remain lowered with lever in the 'NEUTRAL' position until it is necessary to operate the body again. Failure to comply to this could result in overheating the hydraulic oil and failure of the hydraulic system components.

**Note:** A proximity sensor prevents the body being fully powered down onto the chassis. At a predetermined height, the sensor automatically energises the float solenoid on the main hydraulic valve assembly.

**Note:** If an electrical failure occurs, the main hydraulic valve assembly will automatically default to the 'HOLD' condition. The cause of the electrical fault must be investigated and corrected.

**WARNING**

Never work under or near an unblocked or unsupported raised body. Always use the body safety prop. The body safety prop must only be used when the body is empty.

### REMOVAL

Numbers in parentheses refer to Fig. 1.

**WARNINGS**

- To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.
- Hydraulic fluid pressure will remain within the body hoist system after engine shutdown. To prevent personal injury and property damage, press and release the brake treadle valve continuously to relieve pressure in the system.

**WARNING**

Exercise extreme caution when lowering the cylinders from the body. The cylinders will swing out sharply as they leave their mountings.

1. Position the vehicle in a level work area, ensure the body is fully lowered, apply the parking brake and switch off the engine.
2. Relieve stored hydraulic pressure in accumulators (x3), by pressing and releasing brake treadle valve continuously, until all accumulator pressure is relieved.
3. Block all road wheels, place the steering lock bar in the 'Locked' position and the battery master switch in the 'Off' position.
4. Remove upper pins securing the body cylinders to body (1) assembly and secure body cylinders clear of the body. Refer to Section 230-0130, BODY CYLINDER.
5. Secure lifting lugs to body (1) using suitable bolts. Using appropriate lifting equipment, sling body (1) assembly at the four lifting points and take an initial strain.
6. Remove bolts (15) and washers (13) securing hinge pins (3) in place. Remove hinge pins (3) and shims (9) from body (1).
7. Remove body (1) assembly from the vehicle.
8. Remove bushing (2) from body hinge bores.

**INSTALLATION**

Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

---

**WARNING**

To prevent personal injury and property damage, be sure wheel blocks, blocking materials and lifting equipment are properly secured and of adequate capacity to do the job safely.

---

1. Inspect bushing (2) for damage and replace if necessary. Install bushing (2) in body hinge bores.

**Note:** Body lifting lugs can be fabricated as shown in Fig. 2.

2. Secure lifting lugs to body (1) using suitable bolts. Using appropriate lifting equipment, sling body (1) assembly and position over the trailer frame.

**Note:** Approximate weight of body (1) assembly is 4 400 kg (9 700 lb).

3. Align hinge pin bores in body (1) assembly with bores in the trailer frame. Install hinge pins (3) and shims (9) and secure with bolts (15) and washers (17).

4. Secure body cylinders to body (1) assembly with pins and mounting hardware removed during removal. Refer to Section 230-0130, BODY CYLINDER for instructions.

5. Lubricate hinge pins (3) through lube fitting (14) with lubricant specified in Section 300-0020, LUBRICATION SYSTEM. Lubricate slowly until excess lube is seen.

6. Install body pads (4) and body guide plates (12) on body (1) assembly as described under 'Body Shimming Procedure'.

7. Remove lifting equipment from body (1) assembly and blocks from all road wheels.

8. Place the battery master switch in the 'On' position, start the engine and check for correct operation of body (1) assembly.

---

**BODY SHIMMING PROCEDURE**

Numbers in parentheses refer to Fig. 1.

**Note:** Tighten all fasteners to standard torques listed in Section 300-0080, STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

**Note:** When it becomes necessary, body pads (4) should be replaced as a set to maintain load distribution along the frame. Existing body pads will have taken a compression 'set' and a new pad, shimmed to match existing pads, will not carry its share of the load, resulting in uneven load distribution along the frame.

1. Raise body (1) clear of the trailer frame and lay body pads (4) (metal face down) roughly in position on the frame.

2. Lower body (1) assembly onto body pads (4).

3. Centralise body (1) assembly to the frame and place shims (5 & 6) under the front two body pads (4) until all other pads are clear of body (1) assembly.

4. Slide shims (5 & 6) under remaining body pads (4) until they just make contact with body (1) assembly.

5. Raise body (1) assembly and install body pads (4) and shim packs (5 & 6) to their relative brackets on body (1) assembly securing with bolts (8), washers (7) and locknuts (10).

6. Lower body (1) assembly to the frame and check the shimming.

7. Install body guide plates (12) with spacers (11) to mounting brackets on body (1) assembly. Set gap between plates (12) and the frame at 5 - 10 mm (0.2 - 0.4 in). Secure plates (12) and spacers (11) to mounting brackets with bolts (8).
MAINTENANCE
Lubricate the body hinge pins and body cylinder pins at the intervals stated and with lubricant specified in Section 300-0020, LUBRICATION SYSTEM. Lubricate slowly until excess lube is seen.

SPECIAL TOOLS
Special tools can be fabricated as shown in Fig. 2. Refer to Section 300-0070, SERVICE TOOLS, for part numbers of the general service tools required. These tools are available from your dealer.
SAFETY PRECAUTIONS

Do not allow unauthorized personnel to service or maintain this vehicle. Study the Operators Handbook and Maintenance Manual before starting, operating or servicing this vehicle. Always follow procedures and safety precautions detailed throughout this manual.

Always attach a DO NOT OPERATE or similar warning sign to the ignition switch or a prominent control before cleaning, lubricating or servicing the vehicle.

Never allow anyone to work on the vehicle while it is moving. Make sure there is no one on the vehicle before working on it.

Do not work under or near an unblocked or unsupported body. Always use the body prop. The body prop must only be used when the body is empty.

Always install the steering lock bar before making adjustments or servicing the vehicle with the engine running.

Do not work under or near any unblocked or unsupported linkage, part or vehicle.

Always relieve pressure before servicing any pressurized system. Follow the procedures and safety precautions detailed in the relevant Maintenance Manual section.

When changing oil in the engine, transmission and hydraulic system, or removing hydraulic lines, remember that the oil may be hot and can cause burns to unprotected skin.

When working on or around exhaust components, remember that the components may be hot and can cause burns to unprotected skin.

Always deflate the tyre before trying to remove any embedded objects or removing the tyre and rim assembly from the vehicle.

Always use a self-attaching chuck with a long airline, and stand to one side while inflating the tyre. Refer to Section 160-0050, WHEEL RIM AND TYRE.

LUBRICATION AND SERVICE

WARNING

These vehicles are equipped with engine and transmission oil pans which permit operation at maximum gradeability as designated in the 'Performance Data' section of the relevant Sales Specification Sheet.

Lubrication is an essential part of preventive maintenance. It is important that the instructions regarding lubricant specifications, and the frequency of their application, be followed to prolong the useful life of the vehicle. Periodic lubrication of moving parts reduces to a minimum the possibility of mechanical failures.

All change periods are recommendations based on average operating conditions. Lubricants showing evidence of excessive heat, oxidation or dirt should be changed more frequently to prevent these conditions.

Lubricant change and service periods must be established on the basis of individual job conditions utilizing oil sampling and recommendations from lubricant suppliers.

Thoroughly clean all fittings, caps, plugs etc., to prevent dirt from entering any system while carrying out servicing procedures. Lubricants must be at normal operating temperature when draining.

Note: Do not operate any system unless oil level is within the recommended operating levels as indicated on oil level dipstick, sight gauge or level plug.

Small circles on the following illustration represent points at which lubrication and/or servicing must take place, at the intervals indicated on the left hand side of the lubrication and service chart.

The numbered circles on the illustration contain reference numbers which correspond to the reference numbers in the 'Ref. Points' column of the lubrication and service chart.
<table>
<thead>
<tr>
<th>Interval</th>
<th>Ref. Points</th>
<th>Identification</th>
<th>Service Instructions</th>
<th>No. of Points</th>
<th>Lubricant</th>
<th>Service/Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
<td>Engine</td>
<td>Check oil level. Add if low.</td>
<td>1</td>
<td>EO</td>
<td>As Required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transmission</td>
<td>Check oil level. Add if low.</td>
<td>1</td>
<td>EO</td>
<td>As Required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radiator Header Tank</td>
<td>Check coolant level. Add if low.</td>
<td>1</td>
<td>HO</td>
<td>As Required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel Filter/ Water Separator</td>
<td>Drain.</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air Filter Restriction Gauge</td>
<td>Check. Replace element if required.</td>
<td>1</td>
<td>-</td>
<td>See Note 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drive Belts</td>
<td>Check for damage.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engine Crankcase Breather</td>
<td>Inspect and clean if required.</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic Filter Restriction Indicator</td>
<td>Check. Replace element if required.</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tyres</td>
<td>Check condition and pressure.</td>
<td>6</td>
<td>-</td>
<td>See 160-0050</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hood</td>
<td>Check air intake/vents for blockage.</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>Check for debris, leaks and damage.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>Battery Electrolyte</td>
<td>Check level. Add if low.</td>
<td>2</td>
<td>-</td>
<td>As Required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wheel Rim Nuts</td>
<td>Check torque. (Torque Seal)</td>
<td>72</td>
<td>-</td>
<td>590 Nm (435 lbf ft)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cab Ventilation Filter</td>
<td>Inspect and clean if required.</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steering Cylinder Pins</td>
<td>Lube.</td>
<td>4</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body Cylinder Pins</td>
<td>Lube.</td>
<td>4</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body Hinge Pins</td>
<td>Lube.</td>
<td>2</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spherical Bearings</td>
<td>Lube.</td>
<td>4</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oscillation Bushes</td>
<td>Lube.</td>
<td>2</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suspension Beam Bushings</td>
<td>Lube.</td>
<td>2</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drive Belts</td>
<td>Check tension, tighten if required.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Differential Breathers</td>
<td>Clean if required.</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oscillation Pivot</td>
<td>Check end float. Adjust if required.</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Articulation Bearings</td>
<td>Lube.</td>
<td>2</td>
<td>EP, NLGI</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parking Brake Pads</td>
<td>Check wear. Replace if required.</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service Brake Pads</td>
<td>Check wear. Replace if required.</td>
<td>24</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### LUBRICATION AND SERVICE CHART (CONTINUED)

<table>
<thead>
<tr>
<th>Interval Hours</th>
<th>Ref. Points</th>
<th>Identification</th>
<th>Service Instructions</th>
<th>No. of Points</th>
<th>Lubricant</th>
<th>Service/Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 (Monthly)</td>
<td>5</td>
<td>Radiator and Charge Air Cooler</td>
<td>Clean and inspect fins.</td>
<td>1</td>
<td>-</td>
<td>See Note 3</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Wheel Planets</td>
<td>Check oil level. Add if low.</td>
<td>6</td>
<td>EPL</td>
<td>As Required</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Differentials</td>
<td>Check oil level. Add if low.</td>
<td>3</td>
<td>EPL</td>
<td>As Required</td>
</tr>
<tr>
<td>500 (3 Monthly)</td>
<td>1</td>
<td>Engine</td>
<td>Drain oil and refill.</td>
<td>1</td>
<td>EO</td>
<td>See Page 13</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Engine Oil Filter</td>
<td>Replace.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>Fuel Tank</td>
<td>Clean filler neck, screen &amp; cap.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Engine Air Cleaner</td>
<td>Clean inlet screen.</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1,000 (6 Monthly)</td>
<td>2</td>
<td>Transmission</td>
<td>Drain oil and refill.</td>
<td>1</td>
<td>EO</td>
<td>See Page 13</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Fuel Filter/Water Separator</td>
<td>Replace.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>DCA4 Coolant Filter</td>
<td>Replace.</td>
<td>1</td>
<td>-</td>
<td>See engine manual</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>DCA4 Coolant Additive</td>
<td>Check DCA4 Concentration</td>
<td>-</td>
<td>-</td>
<td>See engine manual</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Transmission Breather</td>
<td>Clean if required.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Wheel Planets</td>
<td>Drain oil and refill.</td>
<td>6</td>
<td>EPL</td>
<td>See Page 13</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Driveshaft Bearings</td>
<td>Check oil level. Add if low.</td>
<td>3</td>
<td>EPL</td>
<td>See Note 2</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>Transmission Oil Filters</td>
<td>Replace.</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>Transmission Internal Oil Filter</td>
<td>Clean.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>Cab Ventilation Filter</td>
<td>Replace.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Hinges</td>
<td>Lube.</td>
<td>2</td>
<td>-</td>
<td>See Note 1</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>Fuel Tank</td>
<td>Replace cap filter/cartridge.</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2,000 (Annually)</td>
<td>1</td>
<td>Engine</td>
<td>Steam clean.</td>
<td>1</td>
<td>HO</td>
<td>See Page 13</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Hydraulic Tank</td>
<td>Drain oil and refill.</td>
<td>1</td>
<td>-</td>
<td>(1 425 Nm) (1 050 lbf ft)</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>Articulation Pivot Nut</td>
<td>Check torque.</td>
<td>1</td>
<td>-</td>
<td>See Page 11</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>Hydraulic Oil Filter</td>
<td>Replace.</td>
<td>1</td>
<td>-</td>
<td>See Page 11</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>Drivelines (Low Maintenance)</td>
<td>Check for leaks and damage.</td>
<td>-</td>
<td>-</td>
<td>See Page 11</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Engine Mounting Bolts</td>
<td>Check torque. (Torque Seal)</td>
<td>4</td>
<td>-</td>
<td>298 Nm (220 lbf ft)</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>Transmission Mounting Bolts</td>
<td>Check torque. (Torque Seal)</td>
<td>3</td>
<td>-</td>
<td>Sec. 120-0010</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>TurboCharger Mounting Bolts</td>
<td>Check torque.</td>
<td>4</td>
<td>-</td>
<td>65 Nm (50 lbf ft)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Engine Water Pump</td>
<td>Inspect drain hole. Clean if required.</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Strainer</td>
<td>Clean</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4,000</td>
<td>5</td>
<td>Cooling System</td>
<td>Check DCA4 concentration level</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>Air Conditioning Compressor</td>
<td>Drain, flush and refill</td>
<td>1</td>
<td>PAG Oil</td>
<td>See Page 13</td>
</tr>
</tbody>
</table>

**Note:** Use 'Lubrication and Service Chart' in conjunction with 'Notes on Lubrication and Service Chart' and 'Miscellaneous Servicing' contained on the following pages.

### Notes on Lubrication and Service Chart

**Note**
- Capacities given are approximate - work to dipstick, sight gauges or level plugs.

**Note 1**
- Lubricate slowly until excess lube is seen.

**Note 2**
- Capacity of front and rear differentials is 17 litres (4.5 US gal). Capacity of centre differential is 18.5 litres (4.9 US gal). This includes 1.5 litre (3.2 pints) for priming the 3rd differential unit.

**Note 3**
- Clean radiator and cooler fins more often when operating under extremely dusty conditions.

**Note 4**
- Remove plug from port on underside of oscillation hub. Plug is removed to drain the cavity of any oil that enters the cavity when filling. Remove grommet and level plug on side of oscillation hub. Add oil if required. Refit all plugs.

**Note 5**
- Change safety element after every third primary element service.

EO
- Engine Oil. Refer to 'Recommended Lubricants' and 'Engine Oil Drain Intervals'.

HO
- Hydraulic Transmission Oil. Refer to 'Recommended Lubricants'.

EPL
- Extreme Pressure Gear Lubricant spec. MIL-L-2105D.

EP, NLGI
- Extreme Pressure Lithium No. 2 Grease (without 'Molybdenum').

PAG Oil
- Polyalkylene Glycol (PAG) Compressor Lubricating Oil - Low Viscosity (ISO46).
MISCELLANEOUS SERVICING

WHEN REQUIRED

Seat Belts - Inspect for damage. Replace if required.

Windscreen Wipers And Washers - Replace wiper blades and top up reservoirs.

Wheel Rim Nuts - After first 10 hours of operation retorque nuts to 590 Nm (435 lbf ft). Check torque every 50 hours (weekly) thereafter.

EVERY 10 HOURS OF OPERATION (DAILY)

Walk Around Inspection - Inspect the vehicle as described in Section 4 of the Operators Handbook.

Engine - Visually check engine for damage, loose or frayed belts and listen for any unusual noises.

Engine Air Cleaner - Change air cleaner element only when air restriction gauge locks up in the red. Service vacuum valves daily. Inspect and remove any obstructions from the vacuum valve lips which should be open and pliable with the engine stopped.

Note: Service air cleaners more often when operating under extremely dusty conditions.

Engine Crankcase - Check oil level and add oil if low. With the engine off, the oil should be between the lower and upper marks on the dipstick, up to the upper mark is preferable.

Transmission - Check oil level and add oil if low. Refer to Section 120-0010, TRANSMISSION AND MOUNTING, for correct oil level check procedure.

Hydraulic Tank - Check oil level and add oil if low. With the engine off and the body down the oil should be visible in the sight gauge.

Radiator Header Tank - Check coolant level when cold and add if low. Fill the radiator header tank with coolant until coolant reaches the bottom of the filler neck and holds that level.

Note: Any time a significant amount of coolant is added, the coolant concentration MUST be checked. Failure to use recommended coolant and to maintain mixture at sufficient concentration levels can result in damage to the cooling system and its related components. Always maintain concentrations at recommended levels. Refer to 'Recommended Coolants'. Section 210-0000, COOLING SYSTEM.

AFTER FIRST 500 HOURS OF OPERATING NEW OR REBUILT COMPONENTS

Transmission - Drain oil, replace filter, clean internal filter and finger magnet. Refill transmission.

Note: When refilling transmission ensure that transmission cooler is primed to prevent damage.

Differentials - Drain oil and refill to level plug.

Note: When refilling centre axle ensure that 3rd. differential unit is primed with 1.5 litre (3.2 pints) of oil before filling drivehead.

Planetaries - Drain oil and refill to level plug.

EVERY 250 HOURS OF OPERATION (MONTHLY)

Oil Can Points - Oil working parts with engine oil.

General Inspection - Check entire dumptruck for leaks, loose bolts and nuts or damaged parts. Examine the dumptruck, particularly the chassis, for cracks or broken welds. Repair where necessary.

Engine Air Intake - Check air intake system for wear points or damage to piping, loose clamps and leaks.

Service Brakes - Check pads and discs for wear and adjust or replace where necessary. Test for proper function.

Note: This service interval applies to normal driving. Check the pads more frequently under more severe conditions. Thickness of pad friction material should never be allowed to wear below 3 mm (0.12 in).

Parking Brake - Check pads and disc for wear. Adjust or replace if required. Test for proper function. Friction material thickness should never be allowed to wear below 0.79 mm (0.03 in).

Parking Brake (A8681066 onwards) - Check pads and disc for wear. Adjust or replace if required. Test for proper function. Friction material thickness should never be allowed to wear below 0.79 mm (0.03 in).

EVERY 1 000 HOURS OF OPERATION (6 MONTHS)

Differential - Drain oil and refill to level plug.

Note: When refilling centre axle ensure that 3rd. differential unit is primed with 1.5 litres (3.2 pints) of oil before filling drivehead.
Planetaries - Drain oil and refill to level plug.

**EVERY 2 000 HOURS OF OPERATION (ANNUALLY)**

Hydraulic Oil Tank - Drain oil, remove and clean filter screen assemblies. Reinstall filter screens and refill tank.

Hydraulic Oil Filter - Clean filter housing and install new element when filter restriction gauge reads in red zone, or after 2 000 hours of operation, whichever comes first.

Drivelines - Visually check Low Maintenance drivelines for leaking or damaged seals.

**Note:** Low Maintenance drivelines can be identified by having plugs fitted to the spiders, not grease nipples.

---

### RECOMMENDED LUBRICANTS

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>LUBRICANT</th>
<th><strong>CAPACITY</strong></th>
<th>SPECIFICATIONS</th>
<th>API CODE</th>
<th>SAE GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Crankcase (Including Filters)</td>
<td>Engine Oil with 1.00% sulphated ash limit is recommended. Sulphated ash must not exceed 1.85% limit</td>
<td>21.9 litre (5.8 US gal)</td>
<td>CH-4</td>
<td>15W-40 (See Note 1)</td>
<td></td>
</tr>
<tr>
<td>Transmission (Including cooler)</td>
<td>Engine Oil with 1.85% max. sulphated ash limit</td>
<td>63 litre (16.6 US gal)</td>
<td>CH-4</td>
<td>15W-40 See Trans. Oil Table.</td>
<td></td>
</tr>
<tr>
<td>Hydraulic System (Including Lines)</td>
<td>Hydraulic Transmission Oil</td>
<td>202 litre (53.4 US gal)</td>
<td>See Hydraulic Oil Table (See Note 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling System</td>
<td>Anti-freeze, Ethylene Glycol</td>
<td>55 litre (14.5 US gal)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differential (Front &amp; Rear)</td>
<td>Extreme Pressure Gear Lubricant</td>
<td>17 litre each (4.5 US gal)</td>
<td>MIL-L-2105 D (See Note 4)</td>
<td>GL-5</td>
<td>80W-90 LS</td>
</tr>
<tr>
<td>Differential (Centre)</td>
<td>Extreme Pressure Gear Lubricant</td>
<td>18.5 litre (4.9 US gal)</td>
<td>MIL-L-2105 D (See Note 4)</td>
<td>GL-5</td>
<td>80W-90 LS</td>
</tr>
<tr>
<td>Planetaries</td>
<td>Extreme Pressure Gear Lubricant</td>
<td>3 litre each (0.8 US gal)</td>
<td>MIL-L-2105 D (See Note 4)</td>
<td>GL-5</td>
<td>80W-90 LS</td>
</tr>
<tr>
<td>Fuel Tank</td>
<td>Diesel Fuel Oil with max. sulphur 0.5%</td>
<td>390 litre (103 US gal)</td>
<td>DIN EN590</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grease Nipples</td>
<td>Extreme Pressure Lithium Grease</td>
<td></td>
<td>No.2 Consistency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driveshaft through Bearings</td>
<td>Extreme Pressure Gear Lubricant</td>
<td>(See Note 4 - Page 3)</td>
<td>MIL-L-2105 D</td>
<td>GL-5</td>
<td>80W-90</td>
</tr>
<tr>
<td>Articulation Bearings</td>
<td>Extreme Pressure Lithium Grease</td>
<td></td>
<td>No.2 Consistency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Conditioning Compressor</td>
<td>Polyalkylene Glycol (PAG) Compressor Lubricating Oil - Low Viscosity</td>
<td>0.125 litre (0.033 US gal)</td>
<td>ISO46 SP 10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LUBRICANT GRADE SELECTION GUIDE AT AMBIENT (START-UP) TEMPERATURE

HYDRAULIC OIL

<table>
<thead>
<tr>
<th>SAE</th>
<th>API CODE</th>
<th>MIL-SPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>MIL-H-5606A</td>
</tr>
<tr>
<td>2</td>
<td>DEXRON Auto Trans. Fluid</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10W CC/CD</td>
<td>MIL-L-2104 B/C</td>
</tr>
<tr>
<td>4</td>
<td>20W/20 CC/CD</td>
<td>MIL-L-2104 B/C</td>
</tr>
<tr>
<td>5</td>
<td>30 CC/CD</td>
<td>MIL-L-2104 B/C</td>
</tr>
</tbody>
</table>

TRANSMISSION OIL

Note 3 - Hydraulic Transmission Oil meeting Specification EMS19058 is suitable for use in the hydraulic system.

Note 4 - Axles have limited slip differentials. If use of standard SAE 90 oil results in very loud noise and jerking of the wheels when driving slowly round sharp corners, an EP oil with limited slip additives should be used.

Note 5 - Automatic Transmission Fluids (ATF) may only be used when the ambient temperature is less than -10° C (14° F). Should the temperature increase, it is necessary to switch to engine oil.

Note - Consult your lubricant supplier for correct viscosity of lubricant when ambient temperatures are consistently above or below those listed.
**ENGINE OIL DRAIN INTERVALS**

Engine oil drain intervals are dependant on working environment and oil type used. Refer to table below for engine manufacturer’s recommended oil drain intervals.

<table>
<thead>
<tr>
<th>Fuel Consumption</th>
<th>Severe</th>
<th>Heavy</th>
<th>Medium</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>API CF-4</td>
<td>&gt; 13 gal/hr</td>
<td>10 to 13 gal/hr</td>
<td>8.5 to 10 gal/hr</td>
<td>&lt; 8.5 gal/hr</td>
</tr>
<tr>
<td>API CG-4</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>API CH-4 or ACEA E5</td>
<td>250</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>CES20076 or CES20077</td>
<td>300</td>
<td>350</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>400</td>
<td>550</td>
<td>700</td>
</tr>
</tbody>
</table>

* * * *
INTRODUCTION

Contained in this section are recommended service tools and equipment required for maintenance, overhaul and troubleshooting. In certain instances, both Metric and Imperial equivalents of the same tools are listed.

Note: A tool may be of one piece construction or consist of a number of parts.

General

*15269784 - Multi-Gauge - Pressure range of 30 in of vacuum to 5 000 lbf/in²
15269785 - Non-contact Infrared Thermometer
15271082 - ORFS ‘O’ Ring Kit
15268968 - Strap Type Filter Wrench
15268969 - Socket Type Filter Wrench
15268970 - Universal Belt Tension Gauge
15269858 - Digital Tachometer
15269859 - Multimeter
15269813 - Water Manometer
15269802 - Dial Indicator Gauge - Metric
15269803 - Dial Indicator Gauge - Imperial
15269804 - Magnetic Base for Dial Indicator Gauge
15269805 - Micrometer - 0 to 25 mm
15269806 - Micrometer - 0 to 1 in
15269860 - 92 Piece Heavy Equipment Tool Kit
15269861 - Torque Wrench - 3/8 in drive, 20 - 100 Nm (15 - 80 lbf ft) range
15269862 - Torque Wrench - 1/2 in drive, 60 - 330 Nm (45 - 250 lbf ft) range
15269863 - Torque Wrench - 3/8 in drive, 4 - 20 Nm (40 - 180 lbf in) range
15269864 - Torque Wrench - 3/4 in drive, 300 - 1 000 Nm (200 - 750 lbf ft) range
15269865 - Torque Wrench - 3/4 in drive, 700 - 1 500 Nm (500 - 1 000 lbf ft) range
15269866 - Torque Multiplier - 1/2 in to 1 in drive, 25:1 Ratio, 3 000 Nm (2 000 lbf ft) range

* - The following items should be added to the multi-gauge to enable the gauge to be used on diagnostic test points:
15018226 - Diagnostic Coupling
00118748 - Connector (2 off)
15004085 - Hose Assembly (-4 HP, 84 in long)

Engine

QSM - Electronic Diagnostic Tooling

15500623 - Insite (Lite) Kit (Engine diagnostic software kit & cables PC)
15274134 - Insite Inline Adaptor + Connection Kit (Interface box for inSite. Connect between PC and engine ECM + associated cables)

Transmission

ZF- Electronic Diagnostic Tooling

15501299 - ZF Testman Hardware kit (Testman software, cables, interface box, adaptor cable)
15501300 - Testman Software (Diagnostic software for transmission range-6WG210/260/310)
15273803 - Harness breakout box (interface box breaks into ZF ECU harness to allow circuit check)
The following tools are recommended for Transmission Maintenance Procedures. These tools should be used in conjunction with procedures outlined in the transmission manufacturers service manual.

15273664 - AEB Starter
15270087 - Straight Pin
15270195 - Ring
15270196 - Threaded Insert
15270092 - Puller
15270093 - Puller
15270098 - Driver
15270197 - Driver
15270198 - Driver
15270199 - Driver
15270200 - Driver
15270201 - Driver
15270202 - Driver
15270203 - Driver
15270204 - Driver
15270112 - Measuring Pin
15270115 - Set of Eye Bolts
15270205 - Back-off Screws - M10
15270119 - Adjusting Screws - M10
15270206 - Back-off Screws - M8
15270116 - Adjusting Screws - M8
15270207 - Back-off Screws - M12
15270208 - Adjusting Screws - M5
15270209 - Adjusting Screws - M12
15270210 - Adjusting Screws - M12 x 1.5
15269899 - Hot Air Blower 220 V
15269900 - Hot Air Blower 110 V
15269893 - Pin Spanner - M95 x 1.5
15269894 - Wheel Bolt Puller - Basic Set
15269895 - Insert - M22 x 1.5
15269896 - Driver
15275086 - Driver
15269898 - Driver Handle
15269899 - Hot Air Blower - 220 V, 50 Hz
15269900 - Hot Air Blower - 127 V, 60 Hz
15269928 - Back-off Screw - M14
15269929 - Lifting Pliers
15269930 - Grab Sleeve
15269931 - Sleeve
15269932 - Basic Set Rollex 1
15269933 - Grab Sleeve 'Super'
15269934 - Measuring Shaft
15269935 - Thrust Washer
15269936 - Measuring Piston
15269937 - Shims - 120 mm Diameter
15270204 - Driver
15269939 - Measuring Ring
15269940 - Driver
15269941 - Driver
15269942 - Driver Handle
15269943 - Socket
15269944 - Hook Spanner
15269945 - Insert
15269946 - Puller Set
15269947 - Shims
15269948 - Straightedge - 600 mm
15269949 - Pry Bars - Set of 2
15269950 - Driver
15275085 - Driver

Axles and Differentials

15269893 - Pin Spanner - M95 x 1.5
15269894 - Wheel Bolt Puller - Basic Set
15269895 - Insert - M22 x 1.5
15269896 - Driver
15275086 - Driver
15269898 - Driver Handle
15269899 - Hot Air Blower - 220 V, 50 Hz
15269900 - Hot Air Blower - 127 V, 60 Hz
15269928 - Back-off Screw - M14
15269929 - Lifting Pliers
15269930 - Grab Sleeve
15269931 - Sleeve
15269932 - Basic Set Rollex 1
15269933 - Grab Sleeve 'Super'
15269934 - Measuring Shaft
15269935 - Thrust Washer
15269936 - Measuring Piston
15269937 - Shims - 120 mm Diameter
15270204 - Driver
15269939 - Measuring Ring
15269940 - Driver
15269941 - Driver
15269942 - Driver Handle
15269943 - Socket
15269944 - Hook Spanner
15269945 - Insert
15269946 - Puller Set
15269947 - Shims
15269948 - Straightedge - 600 mm
15269949 - Pry Bars - Set of 2
15269950 - Driver
15275085 - Driver
Hydraulic Control System
15500834 - IQAN Develop Change Interface
Contact Local Dealer - Hydraulic ECU Electronic Diagnostic Software.

Nitrogen Charging/Inflation
15269121 - Nitrogen Tyre Inflation Kit
09359489 - Charging Assembly

Cooling and Air Conditioning
15269814 - DCA4 Test Kit - Metric Version
15269815 - DCA4 Test Kit - US Gallon Version
15269816 - Refractometer - °C Scale
15269817 - Refractometer - °F Scale
15269844 - Portable High Vacuum Charging Station - R-134a Gas
15269845 - Halogen Leak Tester

Cab
15271016 - Glass Removal Tool
15271017 - Bonding Kit (Quick Dry)

Adhesives and Sealants
15500552 - Torque Seal
15269103 - Loctite 221
09362529 - Loctite 225
09029849 - Loctite 243
15500690 - Loctite 262
09244598 - Loctite 270
09985300 - Loctite 271
15269104 - Loctite 275
15269245 - Loctite 277
15233715 - Loctite Prism 406
15269111 - Loctite Prism 410
15269105 - Loctite 515
09007209 - Loctite 574 (50 ml)
09379518 - Loctite 574 (160 ml)
15269106 - Loctite 577 (Superflex)
15270244 - Loctite 592 - Pipe Sealer with Teflon
15023696 - Loctite 635
09371048 - Loctite 638

Fabricated Tools
The service tools shown in Figs. 1 through 6 can be fabricated as shown.
15269107 - Loctite 641
15269108 - Loctite Superclean Safety Solvent 706
15229541 - Loctite Activator 'N'
09243825 - Loctite Activator 'T'
09175039 - General Adhesive
15269114 - Tectyl 280 Wax Based Rust Preventive
09380475 - Hylosil RTV Silicone Compound

Fig. 2 - End Cap Torque Tool (Section 220-0120, STEERING CYLINDER)
Section 300-0070

Miscellaneous - Service Tools

Fig. 3 - Piston Torque Tool (Section 220-0120, STEERING CYLINDER)

OUTER SHIELD TO BE SECURED TO INNER BODY WITH 2BA CAPSCREWS

Dimensions in mm (inches)

Fig. 4 - End Cap Torque Tool (Section 230-0130, BODY CYLINDER)

SECURE ALUMINIUM COLLAR WITH (3) M8 CAP SCREWS

FIT 2 OFF B&T BUSH 12 (0.472) ID 18 (0.708) OD AND 2 OFF 12 DIA DOWEL DRIVE FIT IN BUSH

Dimensions in mm (in)
Fig. 5 - Piston Torque Tool (Section 230-0130, BODY CYLINDER)

Fig. 1 - Centring Spring Installation Tool (Section 220-0090, STEERING VALVE)

Fig. 6 - Body Lifting Lug Dimensions (Section 270-0010, BODY AND MOUNTING)
TORQUE LIMITS IN Nm (lbf ft)

Friction coefficient total 0.125 for screws and nuts without after treatment as well as for phosphated nuts.

Tighten by hand!

If nothing special is indicated, select correct Torque Limits from the following tabulations -

### Metric ISO Thread DIN 13

<table>
<thead>
<tr>
<th>Size</th>
<th>6.9 Nm (lbf ft)</th>
<th>8.8 Nm (lbf ft)</th>
<th>10.9 Nm (lbf ft)</th>
<th>12.9 Nm (lbf ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 6</td>
<td>8 (5.9)</td>
<td>9.5 (7)</td>
<td>13 (9.6)</td>
<td>16 (11.8)</td>
</tr>
<tr>
<td>M 8</td>
<td>19 (14)</td>
<td>23 (16.9)</td>
<td>32 (23.6)</td>
<td>39 (28.8)</td>
</tr>
<tr>
<td>M 10</td>
<td>39 (28.8)</td>
<td>46 (33.9)</td>
<td>64 (47.2)</td>
<td>77 (56.8)</td>
</tr>
<tr>
<td>M 12</td>
<td>67 (49.4)</td>
<td>80 (59)</td>
<td>110 (81.1)</td>
<td>135 (99.6)</td>
</tr>
<tr>
<td>M 14</td>
<td>105 (77)</td>
<td>125 (92)</td>
<td>180 (133)</td>
<td>215 (159)</td>
</tr>
<tr>
<td>M 16</td>
<td>165 (122)</td>
<td>195 (144)</td>
<td>275 (203)</td>
<td>330 (243)</td>
</tr>
<tr>
<td>M 18</td>
<td>225 (166)</td>
<td>270 (199)</td>
<td>390 (288)</td>
<td>455 (336)</td>
</tr>
<tr>
<td>M 20</td>
<td>325 (240)</td>
<td>385 (284)</td>
<td>540 (398)</td>
<td>650 (479)</td>
</tr>
<tr>
<td>M 22</td>
<td>435 (321)</td>
<td>510 (376)</td>
<td>720 (531)</td>
<td>870 (642)</td>
</tr>
<tr>
<td>M 24</td>
<td>560 (413)</td>
<td>660 (487)</td>
<td>930 (686)</td>
<td>1,100 (812)</td>
</tr>
<tr>
<td>M 27</td>
<td>830 (612)</td>
<td>980 (723)</td>
<td>1,400 (1,033)</td>
<td>1,650 (1,217)</td>
</tr>
<tr>
<td>M 30</td>
<td>1,100 (811)</td>
<td>1,350 (996)</td>
<td>1,850 (1,365)</td>
<td>2,250 (1,660)</td>
</tr>
</tbody>
</table>

### Metric ISO Fine Thread DIN 13

<table>
<thead>
<tr>
<th>Size</th>
<th>6.9 Nm (lbf ft)</th>
<th>8.8 Nm (lbf ft)</th>
<th>10.9 Nm (lbf ft)</th>
<th>12.9 Nm (lbf ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 8 x 2</td>
<td>21 (15.5)</td>
<td>25 (18.4)</td>
<td>35 (25.8)</td>
<td>42 (31)</td>
</tr>
<tr>
<td>M 10 x 1.25</td>
<td>41 (30.3)</td>
<td>49 (36.1)</td>
<td>68 (50.2)</td>
<td>82 (60.5)</td>
</tr>
<tr>
<td>M 12 x 1.25</td>
<td>74 (54.6)</td>
<td>88 (64.9)</td>
<td>125 (92.2)</td>
<td>150 (110.6)</td>
</tr>
<tr>
<td>M 12 x 1.5</td>
<td>70 (51.6)</td>
<td>83 (61.2)</td>
<td>115 (84.8)</td>
<td>140 (103.3)</td>
</tr>
<tr>
<td>M 14 x 1.5</td>
<td>115 (85)</td>
<td>140 (103)</td>
<td>195 (144)</td>
<td>235 (173)</td>
</tr>
<tr>
<td>M 16 x 1.5</td>
<td>175 (129)</td>
<td>210 (155)</td>
<td>295 (218)</td>
<td>340 (251)</td>
</tr>
<tr>
<td>M 18 x 1.5</td>
<td>255 (188)</td>
<td>305 (225)</td>
<td>425 (314)</td>
<td>510 (376)</td>
</tr>
<tr>
<td>M 20 x 1.5</td>
<td>360 (266)</td>
<td>425 (314)</td>
<td>600 (443)</td>
<td>720 (531)</td>
</tr>
<tr>
<td>M 22 x 1.5</td>
<td>480 (354)</td>
<td>570 (420)</td>
<td>800 (590)</td>
<td>960 (708)</td>
</tr>
<tr>
<td>M 24 x 2</td>
<td>610 (450)</td>
<td>720 (531)</td>
<td>1,000 (738)</td>
<td>1,200 (885)</td>
</tr>
<tr>
<td>M 27 x 2</td>
<td>890 (656)</td>
<td>1,050 (774)</td>
<td>1,500 (1,106)</td>
<td>1,800 (1,328)</td>
</tr>
<tr>
<td>M 30 x 2</td>
<td>1,250 (922)</td>
<td>1,450 (1,070)</td>
<td>2,050 (1,512)</td>
<td>2,500 (1,844)</td>
</tr>
</tbody>
</table>
**Miscellaneous - Axle Bolt and Nut Torque Specifications**

Section 300-0080

Friction coefficient total 0.14 for screws and nuts without after treatment as well as for phosphated nuts.

Tighten by hand!

If nothing special is indicated, select correct Torque Limits from the following tabulations -

<table>
<thead>
<tr>
<th>Size</th>
<th>6.9 (lbf ft)</th>
<th>8.8 (lbf ft)</th>
<th>10.9 (lbf ft)</th>
<th>12.9 (lbf ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 6</td>
<td>8.5 (6.3)</td>
<td>10 (7.4)</td>
<td>14 (10.3)</td>
<td>17 (12.5)</td>
</tr>
<tr>
<td>M 8</td>
<td>21 (15.5)</td>
<td>25 (18.4)</td>
<td>35 (25.8)</td>
<td>41 (30.2)</td>
</tr>
<tr>
<td>M 10</td>
<td>41 (30.2)</td>
<td>49 (36.1)</td>
<td>69 (50.9)</td>
<td>83 (61.2)</td>
</tr>
<tr>
<td>M 12</td>
<td>72 (53.1)</td>
<td>86 (63.4)</td>
<td>120 (88.5)</td>
<td>145 (106.9)</td>
</tr>
<tr>
<td>M 14</td>
<td>115 (85)</td>
<td>135 (100)</td>
<td>190 (140)</td>
<td>230 (170)</td>
</tr>
<tr>
<td>M 16</td>
<td>180 (133)</td>
<td>210 (155)</td>
<td>295 (218)</td>
<td>355 (262)</td>
</tr>
<tr>
<td>M 18</td>
<td>245 (181)</td>
<td>290 (214)</td>
<td>400 (295)</td>
<td>485 (358)</td>
</tr>
<tr>
<td>M 20</td>
<td>345 (255)</td>
<td>410 (302)</td>
<td>580 (428)</td>
<td>690 (509)</td>
</tr>
<tr>
<td>M 22</td>
<td>465 (343)</td>
<td>550 (406)</td>
<td>780 (575)</td>
<td>930 (686)</td>
</tr>
<tr>
<td>M 24</td>
<td>600 (443)</td>
<td>710 (524)</td>
<td>1 000 (738)</td>
<td>1 200 (885)</td>
</tr>
<tr>
<td>M 27</td>
<td>890 (656)</td>
<td>1 050 (774)</td>
<td>1 500 (1 106)</td>
<td>1 800 (1 328)</td>
</tr>
<tr>
<td>M 30</td>
<td>1 200 (885)</td>
<td>1 450 (1 070)</td>
<td>2 000 (1 475)</td>
<td>2 400 (1 770)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>6.9 (lbf ft)</th>
<th>8.8 (lbf ft)</th>
<th>10.9 (lbf ft)</th>
<th>12.9 (lbf ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 8 x 1</td>
<td>23 (17)</td>
<td>27 (19.9)</td>
<td>38 (28)</td>
<td>45 (33.2)</td>
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<tr>
<td>M 10 x 1.25</td>
<td>44 (32.5)</td>
<td>52 (38.4)</td>
<td>73 (53.8)</td>
<td>88 (65)</td>
</tr>
<tr>
<td>M 12 x 1.25</td>
<td>80 (59)</td>
<td>95 (70)</td>
<td>135 (99)</td>
<td>160 (118)</td>
</tr>
<tr>
<td>M 12 x 1.5</td>
<td>76 (56.1)</td>
<td>90 (66.4)</td>
<td>125 (92)</td>
<td>150 (111)</td>
</tr>
<tr>
<td>M 14 x 1.5</td>
<td>125 (92)</td>
<td>150 (111)</td>
<td>210 (155)</td>
<td>250 (184)</td>
</tr>
<tr>
<td>M 16 x 1.5</td>
<td>190 (140)</td>
<td>225 (166)</td>
<td>315 (232)</td>
<td>380 (280)</td>
</tr>
<tr>
<td>M 18 x 1.5</td>
<td>275 (203)</td>
<td>325 (240)</td>
<td>460 (339)</td>
<td>550 (406)</td>
</tr>
<tr>
<td>M 20 x 1.5</td>
<td>385 (284)</td>
<td>460 (339)</td>
<td>640 (472)</td>
<td>770 (568)</td>
</tr>
<tr>
<td>M 22 x 1.5</td>
<td>520 (384)</td>
<td>610 (450)</td>
<td>860 (634)</td>
<td>1 050 (774)</td>
</tr>
<tr>
<td>M 24 x 2</td>
<td>650 (479)</td>
<td>780 (575)</td>
<td>1 100 (811)</td>
<td>1 300 (959)</td>
</tr>
<tr>
<td>M 27 x 2</td>
<td>970 (715)</td>
<td>1 150 (848)</td>
<td>1 600 (1 180)</td>
<td>1 950 (1 438)</td>
</tr>
<tr>
<td>M 30 x 2</td>
<td>1 350 (997)</td>
<td>1 600 (1 180)</td>
<td>2 250 (1 660)</td>
<td>2 700 (1 991)</td>
</tr>
</tbody>
</table>
The following torque specification tables are based on GM Standard Materials for bolts, nuts, studs and self-locking fasteners based on SAE bolt steel classifications, or, prevailing torque specifications for self-locking fasteners.

To prevent the threaded bolts and nuts used on this equipment from being overstressed during assembly, and to establish a uniform value to which these fasteners can be safely tightened, the following torque tables have been compiled.

The torque values listed in the tables have been established over a period of years and cover all conditions of assembly. The maximum torque values for standard bolts and nuts are based on 75% of the specified minimum proof strength of the bolt steel in order to provide a safety factor to compensate for the variation in the accuracy of torque wrenches, skill of the assembler, and variance in fractional conditions.

All torque values are for lubricated threads. The term "lubricated" includes the application of thread lubricants, cadmium plating or the use of hardened washers.

To provide a quick method for determining the GM material classification of a particular standard bolt or nut, compare the bolt head markings to those in the appropriate tables, then locate the maximum torque value for that bolt size in the column under that marking.
### RECOMMENDED MAXIMUM TORQUES (IMPERIAL) ± 10%

<table>
<thead>
<tr>
<th>Size</th>
<th>SAE Symbol GM 260-M Steel (SAE GR 2)</th>
<th>SAE Symbol GM 280-M Steel (SAE GR 5)</th>
<th>SAE Symbol GM 290-M Steel (SAE GR 7)</th>
<th>SAE Symbol GM 300-M Steel (SAE GR 8)</th>
<th>12 Point Cap Screws</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nm</td>
<td>lbf ft</td>
<td>Nm</td>
<td>lbf ft</td>
<td>Nm</td>
</tr>
<tr>
<td>1.12 - 7</td>
<td>366</td>
<td>270</td>
<td>800</td>
<td>590</td>
<td>1.132</td>
</tr>
<tr>
<td>1.12 - 12</td>
<td>407</td>
<td>300</td>
<td>902</td>
<td>665</td>
<td>1.274</td>
</tr>
<tr>
<td>1.25 - 7</td>
<td>515</td>
<td>380</td>
<td>1.132</td>
<td>835</td>
<td>1.600</td>
</tr>
<tr>
<td>1.25 - 12</td>
<td>569</td>
<td>420</td>
<td>1.254</td>
<td>925</td>
<td>1.776</td>
</tr>
<tr>
<td>1.38 - 6</td>
<td>664</td>
<td>490</td>
<td>1.478</td>
<td>1.090</td>
<td>2.095</td>
</tr>
<tr>
<td>1.38 - 12</td>
<td>759</td>
<td>560</td>
<td>1.688</td>
<td>1.245</td>
<td>2.393</td>
</tr>
<tr>
<td>1.50 - 6</td>
<td>881</td>
<td>650</td>
<td>1.966</td>
<td>1.450</td>
<td>2.786</td>
</tr>
<tr>
<td>1.50 - 8</td>
<td>936</td>
<td>690</td>
<td>2.088</td>
<td>1.540</td>
<td>2.962</td>
</tr>
<tr>
<td>1.50 - 12</td>
<td>990</td>
<td>730</td>
<td>2.217</td>
<td>1.635</td>
<td>3.145</td>
</tr>
<tr>
<td>1.75 - 5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.393</td>
</tr>
<tr>
<td>1.75 - 12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5.091</td>
</tr>
<tr>
<td>1.88 - 8</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>6.006</td>
</tr>
<tr>
<td>1.88 - 12</td>
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<td>-</td>
<td>-</td>
<td>6.304</td>
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<td>-</td>
<td>-</td>
<td>6.623</td>
</tr>
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<td>2.00 - 8</td>
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<td>7.342</td>
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<td>7.687</td>
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<td>9.701</td>
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<td>-</td>
<td>-</td>
<td>10.629</td>
</tr>
<tr>
<td>2.25 - 12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.050</td>
</tr>
<tr>
<td>2.50 - 12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.280</td>
</tr>
</tbody>
</table>

### Note:
Where materials other than GM Standards are used, refer to the conversion table below.

<table>
<thead>
<tr>
<th>Types of Steel</th>
<th>Rockwell Hardness Range</th>
<th>Applicable Torque Values</th>
<th>SAE Bolt Head Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain Low Carbon (eg. SAE 1018 or 1020)</td>
<td>Rockwell &quot;B&quot; 85-100</td>
<td>GM 260-M</td>
<td>[Symbol]</td>
</tr>
<tr>
<td>Plain Medium Carbon (eg. SAE 1035, 1038 &amp; 1045)</td>
<td>Rockwell &quot;C&quot; 19-30</td>
<td>GM 280-M</td>
<td>[Symbol]</td>
</tr>
<tr>
<td>Medium Carbon Alloy (eg. SAE 4140, 8642 &amp; 5157)</td>
<td>Rockwell &quot;C&quot; 28-34</td>
<td>GM 290-M</td>
<td>[Symbol]</td>
</tr>
<tr>
<td>Medium Carbon Alloy (eg. SAE 4140, 8642 &amp; 5147)</td>
<td>Rockwell &quot;C&quot; 32-38</td>
<td>GM 300-M</td>
<td>[Symbol]</td>
</tr>
</tbody>
</table>
**Miscellaneous - Standard Bolt and Nut Torque Specifications**

**TABLE 146**

<table>
<thead>
<tr>
<th>Size</th>
<th>Class 8.8</th>
<th>Class 9.8</th>
<th>Class 10.9</th>
<th>Class 12.9</th>
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<td>Nm</td>
<td>lbf ft</td>
<td>Nm</td>
<td>lbf ft</td>
</tr>
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<td>M 1.6 - 0.35</td>
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<td>-</td>
<td>0.20</td>
<td>0.15</td>
</tr>
<tr>
<td>M 1.6 - 0.20</td>
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<td>-</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>M 2.0 - 0.40</td>
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<td>-</td>
<td>0.25</td>
<td>0.20</td>
</tr>
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<td>-</td>
<td>0.45</td>
<td>0.30</td>
</tr>
<tr>
<td>M 2.0 - 0.45</td>
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<td>-</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>M 2.5 - 0.35</td>
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<td>-</td>
<td>1.0</td>
<td>0.75</td>
</tr>
<tr>
<td>M 3.0 - 0.50</td>
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<td>-</td>
<td>1.0</td>
<td>0.75</td>
</tr>
<tr>
<td>M 3.0 - 0.35</td>
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<td>-</td>
<td>1.0</td>
<td>0.75</td>
</tr>
<tr>
<td>M 3.5 - 0.60</td>
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<td>-</td>
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<td>1.5</td>
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<tr>
<td>M 4.0 - 0.70</td>
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<td>2</td>
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<td>M 4.0 - 0.35</td>
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<td>2</td>
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<td>M 5.0 - 0.80</td>
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<td>M 6.0 - 1.00</td>
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<td>-</td>
<td>9</td>
<td>6</td>
</tr>
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<td>8</td>
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<td>M 6.0 - 0.75</td>
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<td>7</td>
</tr>
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<td>M 8.0 - 1.25</td>
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<td>21</td>
<td>15</td>
</tr>
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<td>M 8.0 - 1.00</td>
<td>-</td>
<td>-</td>
<td>23</td>
<td>17</td>
</tr>
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<td>M 10.0 - 1.50</td>
<td>-</td>
<td>-</td>
<td>42</td>
<td>31</td>
</tr>
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<td>M 10.0 - 1.25</td>
<td>-</td>
<td>-</td>
<td>45</td>
<td>32</td>
</tr>
<tr>
<td>M 12.0 - 1.75</td>
<td>-</td>
<td>-</td>
<td>74</td>
<td>53</td>
</tr>
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<td>M 12.0 - 1.25</td>
<td>-</td>
<td>-</td>
<td>81</td>
<td>58</td>
</tr>
<tr>
<td>M 14.0 - 2.00</td>
<td>-</td>
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SELF-LOCKING FASTENERS

Self-locking fasteners develop a measured gripping action or torque and provide a renewed locking action after being removed and reinstalled to their original mating part. The self-locking fasteners used on this equipment meet specifications necessary to allow the fasteners to be reused up to five times. Whenever a self-locking fastener is removed, the head of the fastener should be deeply scribed or otherwise marked to record the number of times the fastener has been used. Do not use a self-locking fastener more than five times.

The following table shows the minimum torque specifications allowed to remove self-locking fasteners after the initial break-away torque has been achieved. Any self locking fastener that can be removed with less than the prevailing torque value shown in the table should be discarded, even if the fastener has not yet been reused five times.

<table>
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* * * *
GENERAL
The storage of machines for short periods of time or during the off-season is an important item if major damage to components is to be avoided. Failure to take the necessary steps to protect the various assemblies while the machine is being stored can result in an expensive overhaul job and delay in returning the machine to work.

TEMPORARY STORAGE
When storing a machine for a period of 30 days or less, the following precautions must be taken:

1. INSPECTION AND REPAIR - Thoroughly inspect and test the machine and make any necessary repairs or adjustments which may be necessary to prepare the machine for service. This will enable you to put the machine back into use immediately at the end of the storage period.

2. LUBRICATION - Lubricate the machine completely according to the instructions given in Section 300-0020, LUBRICATION SYSTEM of this manual.

3. PARKING - After thoroughly cleaning the entire machine, park it on a hard, dry, level surface that is free from grease and oil. The oil and grease would cause tyre deterioration. Apply the parking brake.

4. BATTERIES - Where moderate temperatures are expected, the batteries may be left in the machine. Up to 30 days, the batteries may require a boost at the end of the storage period. Preferably place the batteries in the shop where they can be inspected, brought up to full charge and placed on a trickle charge to keep them at full charge. In very cold or hot climates, store the batteries where they will be protected from temperature extremes.

5. RUST PREVENTION - Remove all evidence of rust from the machine and repaint. In addition, cover all exposed machine surfaces with a good rust preventive.

6. SUPPLY TANKS - Fill fuel and hydraulic tanks to prevent moisture condensation within the tanks.

7. TYRES - Inflate all tyres to correct pressure. During storage, check inflation pressure approximately once every two weeks.

8. ENGINE - Consult the relevant Engine Maintenance Manual for complete information on storing the engine for periods shorter than 30 days.

9. TRANSMISSION - Fill transmission sumps to the proper level.

EXTENDED STORAGE - Under Six Months
When storing a machine for periods of longer than 30 days, but under six months, the following procedure must be followed:

1. INSPECTION AND REPAIR - Same as Step 1 given under 'Temporary Storage'.

2. LUBRICATION - Same as Step 2 given under 'Temporary Storage'.

3. PARKING - Same as Step 3 given under 'Temporary Storage'. Machines should be blocked up so the tyres are off the ground or floor.

4. BATTERIES - Remove batteries from the machine and store them in a suitable place where they can be inspected and charged at least every 30 days or placed on a trickle charger.

5. RUST PREVENTION - Same as Step 5 given under 'Temporary Storage'.

6. SUPPLY TANKS - Same as Step 6 given under 'Temporary Storage'.

7. TYRES - With the machine on blocks, as called for in Step 3, deflate the tyres to 0.7 bar (10 lbf/in²) pressure. Remove all traces of grease and oil and protect the tyres from direct sunlight and water with a suitable cover.

8. TRANSMISSION - Consult the relevant Transmission Maintenance Manual for storage data involving periods longer than 30 days.

9. ENGINE - Consult the relevant Engine Maintenance Manual for storage data involving periods longer than 30 days.

10. VENTS AND BREATHERS - Remove all vents and breathers and plug openings with pipe plugs. If it is not possible to do this, seal vents and breathers with waterproof tape.
EXTENDED STORAGE - Over Six Months

When a machine is to be stored for a period over SIX MONTHS, the following procedure must be followed:

Note: These steps are in addition to those given previously under 'Extended Storage - Under Six Months'.

1. LUBRICATION - Completely lubricate the machine according to the instructions contained in Section 300-0020, LUBRICATION SYSTEM of this manual.

2. WHEEL BEARING - Remove, clean, inspect and repack all wheel bearings.

Note: The above steps must be repeated for every Six Month period the machine is in storage.

REMOVAL FROM EXTENDED STORAGE

General

1. LUBRICATION - Completely lubricate the machine according to the instructions in Section 300-0020, LUBRICATION SYSTEM of this manual.

2. BATTERIES - Install batteries and check for a full charge. Charge batteries as required.

3. TYRES - Inflate tyres to the proper pressures. Refer to Section 140-0040, WHEEL RIM AND TYRE, of this manual.

4. FUEL AND HYDRAULIC TANKS - Drain off condensation and fill tanks to proper level, remove breather covers and install air breathers. Be sure breathers are clean before installation.

5. VENTS AND BREATHERS - Remove seals and plugs from all breather openings, then install all breathers and vents.

6. ENGINES - Consult the relevant Engine Maintenance Manual for instructions on removing an engine from storage.

7. PAINT - Check machine for rust. Remove all rust spots and repaint rusted areas.

8. TRANSMISSION - Consult the relevant Transmission Maintenance Manual for instructions on removing from storage.

* * * *