TRUCK UTILITY HEAVY (TUH), 4x4

REYNOLDS BOUGHTON - ALL VARIANTS

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FAILURE DIAGNOSIS

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PREFACE

1 Amendments are identified by marginal side lining.

2 Comments on this publication are to be forwarded in accordance with AESP 0100-P-011-013 to Vehicles & Weapons Branch REME, Chobham Lane, Chertsey, Surrey KT16 0EE.

ASSOCIATED PUBLICATIONS

EMER Wksp N 111	Preservation, Identification and Packaging of Assemblies (including engines)
EMER Wksp N 345	Split Shell Bearings, Assembly, Techniques using Plastigage Method
EMER T&M A 028 Chap 100	Testing Internal Combustion Engines
Equipment Table Scale No - NYK	Reynolds Boughton Special Tools
AESP 2920-C-102	Generator No 16, Mk 1, 28V, 90A (FV 1068364)
AESP 2815-F-641	Engine Diesel, PERKINS PHASER 1000 Series
AESP 2520-C-122	Gearbox, 5 Speed, T5-250 with T5-290 Supplement

Chapter 1

ENGINE

CONTENTS

GENERAL INFORMATION

1 To ensure maximum serviceability of the vehicle, major engine faults should be investigated and rectified with the engine removed from the vehicle. Where appropriate the following table refers to Chapter 11 Fuel System and Exhaust System, Chapter 12 Cooling System and Chapter 13 Electrical System.

TABLE 1 - ENGINE FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Starter motor turns engine too slowly	Battery capacity low	Charge or replace battery
2		Bad electrical connection	Turn on lights and operate starter, if lights keep their power check the switch and all connections
3		Fault in starter motor	Refer to Chap 13
4		Wrong grade of lubricating oil	Check and replace if necessary
5	Engine will not start	Low engine speed from starter motor	See Serial No 1 - 4 of this Table
6		Restriction in fuel pipe/fuel tank empty/ dirty fuel filter element/air in fuel system	Refer to Chap 11
7		Cold start equipment not correctly used	Leave starter in position III for 15 to 20 seconds
8		Faulty stop control	Check stop control linkage to fuel injection pump, for correct operation.
9	Engine difficult to start	Low engine speed from starter motor	See Serial No 1 - 4 of this Table
10		Restriction in fuel pipe/dirty fuel filter element/restriction in air supply/air in fuel system/restriction in fuel tank vent/ restriction in exhaust pipe	Refer to Chap 11
11		Cold start system not correctly used	Leave starter in position III for 15 to 20 seconds

(Contd)

TABLE 1 - ENGINE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
12		Broken valve springs	Carry out cylinder head assembly overhaul
13		Pitted valves and seats	Recondition valve seats and fit new valves Cat 5.2 Chap 1 Para 15 to 22
14	Lack of engine power	Restriction in fuel pipe/dirty fuel filter element/restriction in air supply/air in fuel system/restriction in fuel tank vent/ restriction in exhaust pipe	Refer to Chap 11
15		Sticking throttle or restricted movement	Check throttle linkage for freedom of movement, lubricate or replace as necessary.
16	Excessive fuel consumption	Restriction in air supply/restriction in exhaust pipe	Refer to Chap 11
17		Valve tip clearance not correct	Adjust valve tip clearances Cat 5.2 Chap 1 Para 11
18	Misfire and/or black exhaust	Restriction in fuel pipe/dirty fuel filter element/air in fuel system	Refer to Chap 11
19		Cylinder head gasket leaking	Check, fit new gasket, if necessary
20		Valve tip clearance not correct	Adjust valve tip clearance Cat 5.2 Chap 1 Para 11
21	Blue/white exhaust	Wrong grade of lubricating oil	Check and replace if necessary
22		Air cleaner dirty	Clean or replace

(Contd)

TABLE 1 - ENGINE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
23		Worn valve stems and guides	Renew Cat 2 Chap 1 Para 15 to 20
24	Low lubricating oil pressure	Wrong grade of lubricating oil	Check and replace if necessary
25		Insufficient lubricating oil in sump	Check level and replenish if necessary
26		Oil pump worn/pressure relief valve sticking open/damaged relief valve/blocked suction pipe	Refer to Chap 11
27		Gauge not correct	Fit new gauge
28		Dirty lubricating oil filter element	Replace element
29	Engine 'knocks'	Type or grade of fuel not correct	Check that the fuel tank has been filled with diesel and NOT petrol.
30		Valve tip clearance not correct	Adjust valve tip clearances. Cat 5.2 Chap 1 Para 11
31		Broken valve springs	Carry out cylinder head assembly overhaul
32	Engine runs erratically	Restriction in fuel pipe/dirty fuel filter element/restriction in air supply/air in fuel system/restriction in fuel tank vent	Refer to Chap 11
33		Valve tip clearance not correct	Adjust valve tip clearances Cat 5.2 Chap 1 Para 11
34	Vibration	Fan damage	Refer to Chap 12

(Contd)

TABLE 1 - ENGINE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
35		Engine mountings damaged	Replace both engine mountings
36	High lubricating oil pressure	Wrong grade of lubricating oil	Check and replace if necessary
37		Pressure relief valve sticking closed	Refer to Chap 11
38		Gauge not correct	Fit new gauge
39	Engine temperature too high	Restriction in air supply/restriction in exhaust pipe	Refer to Chap 11
40		Fan damage/restriction in coolant system/ insufficient coolant/ loose fan belt	Refer to Chap 12
41		Cylinder head gasket leaking Piston seizure	Check and fit new gasket, if necessary Overhaul engine
42	Engine starts and stops	Dirty fuel filter/air in fuel system/ restriction in air supply	Refer to Chap 11

Chapter 2

CLUTCH

CONTENTS

INTRODUCTION

1 Before attempting to check for any faults with the clutch installed in the vehicle ensure that the hydraulic fluid level in the master cylinder is correct and that the correct fluid as specified in the maintenance schedule is in the system. The wrong fluid could damage the seals in the master and slave cylinders.

TABLE 1 CLUTCH FAILURE DIAGNOSIS

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
1	Clutch pedal feels spongy	Air in the system	Check fluid level in reservoir. Check all pipe connections for tightness. Bleed the hydraulic system (See AESP 2320-E-200-522 Chapter 3).
2	Pedal can be depressed slowly without disengaging the clutch and the fluid level in the reservoir drops as the pedal is depressed	Fluid leak in system	With an assistant continually pushing and releasing the pedal, check the pipes for damage and all pipe unions for leaks. Repair or renew as necessary. Detach rubber boot from master cylinder and check for leak. Renew master cylinder if necessary. Detach rubber boot from slave cylinder and check for leak. Renew slave cylinder if necessary.
3	Clutch pedal requires heavy pressures	Sticking release bearing sleeve	Check release bearing sleeve for burrs, roughness or contamination of mating surfaces. Repair or renew.
4		Partially seized piston in hydraulic cylinder	Remove withdrawal lever clevis pin and gently depress pedal if heavy pressure is evident, slacken off the slave cylinder bleed screw and try the pedal again. If light pressure is now required the slave cylinder is defective. Renew or repair slave cylinder.

(Contd)

TABLE 1 CLUTCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
4			If the pedal is still heavy the master cylinder is defective. Renew or repair master cylinder.
5	Clutch slipping	Worn facings	Renew driven plate.
6		Oil or grease on facings	Renew driven plate and check for oil leaks.
7		Warped or scored pressure plate	Renew complete clutch unit.
8	Clutch dragging	Oil or grease on facings	Renew driven plate and check for leaks in hydraulic system.
9		Worn or broken facings	Renew driven plate.
10		Distorted driven plate	Renew driven plate after checking the cause of distortion.
11		Disc hub binding on pinion shaft	Check shaft for burrs or gummed splines. Repair or renew shaft.
12		Sticking release bearing sleeve	Remove sticking sleeve and examine mating surfaces for scoring or rough spots. Repair or renew parts as necessary.
13		Warped pressure plate	Renew complete clutch unit.
14		Defective rubber seals in master or slave cylinders	Dismantle cylinder for inspection and replacement of seals or renew cylinder.
15		Air in the hydraulic system	Bleed the system (see AESP 2320-E-200-522 Chapter 3)

(Contd)

TABLE 1 CLUTCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
16	Clutch grabbing or chattering	Oil or grease on facings	Renew driven plate. Check for oil leaks.
17		Pressure plate binding	Renew parts as required.
18		Facings glazed	Renew driven plate after checking pressure plate and flywheel for scoring. If these parts are badly scored or worn renew.
19		Driven plate distorted	Renew driven plate.
20		Pressure plate scored	Renew complete clutch unit
21		Pressure plate or flywheel worn	Renew defective parts.
22	Clutch rattling	Pressure plate damaged	Renew complete clutch unit.
23		Splines on pinion shaft worn	Renew pinion shaft.
24		Release bearing worn	Replace bearing. Examine tips of release levers for wear and replace if necessary.
25		Pilot bush or bearing dry or worn	Replace bush or bearing.
26		Driven plate distorted	Renew driven plate. Check pressure plate for excessive wear. Renew complete clutch unit if necessary.
27		Fulcrum rings or rivets loose	Renew complete clutch unit.

(Contd)

TABLE 1 CLUTCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
28	Clutch squeaking	Release sleeve dry	Lubricate release sleeve sparingly. Ensure that no grease contaminates the pressure plate.
29		Release sleeve worn	Renew release sleeve and bearing.
30		Transmission incorrectly aligned	Check clutch housing alignment.
31	Clutch not engaging correctly	Broken diaphragm spring	Renew complete clutch unit. Check release bearing.
32	Clutch not disengaging correctly	Release fingers worn	Renew complete clutch unit. Check release bearing.
33		Leak in hydraulic system	Check for leak and repair.

Chapter 3

GEARBOX

CONTENTS

INTRODUCTION

1 Gearbox faults will only arise with wear and tear after considerable use, or as a result of misuse or lack of lubrication. Most faults will affect the vehicle's performance and some will be evident from abnormal noises.

2 If the vehicle is roadworthy, road testing will reveal many symptoms provided that the tester is experienced. The tester should be able to narrow-down the diagnosis of a given symptom to a small number of possible causes. It is always advisable to check first that the gearbox is filled with the specified lubricant to the correct level.

3 Table 1 is intended as a guide to possible faults and their symptoms. As the gearbox is part of the overall transmission assembly including the clutch, some fault symptoms are likely to cover both units or the clutch only and reference must be made to Chapter 2 as well as Table 1. Some symptoms may also be due to components other than the clutch and gearbox.

4 Many times the cause of the fault is apparent when the unit is inspected prior to disassembly, but this evidence is lost when parts are separated. A careful inspection of the unit should be made as each disassembly step is performed.

5 It is bad practice to dismantle a unit as quickly as possible without bothering to inspect the parts as they are removed. It often happens that a mechanic has completely dismantled a unit and failed to find the cause of the trouble because he did not examine the parts as they are removed. Always check the lubricant for foreign particles which often reveal the cause of the trouble which has been overlooked during dismantling.

6 If the fault occurs only in one gear the cause of the trouble is generally traceable to the gears in operation.

TABLE 1 GEARBOX FAILURE DIAGNOSIS

Serial No.	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
1	Noise in neutral	Misalignment of transmission	Align transmission.
2		Worn flywheel pilot bearing	Renew pilot bearing.
3		Worn or damaged countershaft	Renew bearings as necessary.
4		Worn or rough reverse idler gear	Renew idler gear as necessary.
5		Distorted or worn countershaft	Renew countershaft.
6		Backlash in gears excessive	Re-adjust backlash if possible. If gears are badly worn renew gears.
7		Worn mainshaft spigot bearing	Renew bearing.
8		Scuffed gear tooth contact surface	Repair or renew gears as necessary.
9	Noise in gear	Worn or damaged mainshaft rear bearing	Renew bearing.
10		Rough, tapered or damaged sliding gear teeth	Renew gears affected, also mating gears if necessary.
11		Excessive end play of mainshaft gears	Re-adjust end play.
12	Jumping out of gear	Selector rod detent springs broken	Renew springs.
13		Selector rod detents worn	Renew selector rod.
14		Selector rod bent or damaged	Renew selector rod.

(Contd)

TABLE 1 GEARBOX FAILURE DIAGNOSIS

Serial No.	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
15		Selector fork pads not aligned	Align or renew pads. If selector fork is bent renew fork.
16		Selector lever bent	Repair or renew selector lever.
17		Excessive end play in drive gear, mainshaft or countershaft	Re-adjust or renew bearings if necessary.
18	Sticking in gear	Clutch not releasing correctly	Re-adjust clutch (see AESP 2320-E-200-522) Chapter 2)
19		Sliding gears tight on shaft spline	Free gears and check splines on gear and shaft. Renew if necessary.

Chapter 4

TRANSMISSION
(TRANSFER BOX PROPELLER SHAFTS)

CONTENTS

INTRODUCTION

1 Most transfer gearbox faults will only arise with wear and tear after considerable use, and will normally be evident either by noise due to worn bearings or chains, or oil leakage due to worn seals. Chain wear will give stretch, which will allow 'chain slap' to take place, where the loose side of a chain intermittently strikes against the casing. Lost motion during gear changes or drive take-up will also be felt in this condition. This can also be caused by a worn chain having jumped off the gears. Some faults may be due to associated items outside the transfer gearbox (the selector cable or the vacuum lines or control valve for the differential lock, for example).

2 Propeller-shaft faults will probably be evident by vibration when travelling, by lost motion, and by some noise, due to worn needle bearings, and possibly worn splines. However, regular inspection should detect the onset of wear before these symptoms arise.

DIAGNOSIS

3 Tables 1 and 2 are intended as a guide to possible faults and their symptoms. Since the transfer gearbox and propeller shafts are part of the overall drive train from engine to wheels, some fault symptoms may be attributable to other components.

WARNING ...

IF THERE IS NO POSITIVE DETENT 'FEEL' WHEN THE SELECTOR LEVER IS MOVED, THE VEHICLE MUST NOT BE OPERATED WITH THE TRANSFER GEARBOX IN THE NEUTRAL CONDITION (FOR WINCHING, WHERE FITTED).

TABLE 1 - TRANSFER GEARBOX FAILURE DIAGNOSIS

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
1	Vehicle will not move with any drive selection, but input propshaft rotates.	Gearbox stuck in neutral	Check selector cable, anchorages and adjustment
2	Vehicle will not move due to wheelspin on slippery terrain although diff. lock selected at control (lamp not lit)	Faulty diff. lock control valve or vacuum lines	Check lines to and from valve in cab. Check valve
3		Faulty actuator vacuum module	Check vacuum module and renew if necessary
4	No difference in vehicle performance after attempted gear change	Gearbox stuck in a gear	Check selector cable, anchorages and adjustment. Check selector mechanism in transfer box.
5	Rumbling or grinding noise	Bearing(s) worn or broken	Check all bearings and and renew if necessary
6		Bearings or chains dry due to low oil level	Check oil level; if low, refill and check seals and casing joints. Renew if necessary
7	Intermittent clatter	Chain 'slap' from worn chains	Check chains for slackness, and renew if necessary
8	Vibration	Bearings very worn or broken	Check all bearings and renew if necessary
9	No positive detent 'feel' when selector lever moved (vehicle may slip out of gear)	Detent plunger seized or spring broken	Check and service selector detent assembly

TABLE 2 - PROPELLER SHAFTS FAILURE DIAGNOSIS

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
1	Vibration which depends upon road speed	Shaft unbalanced due to attached foreign matter or to damage	Check and clean shafts, and renew the damaged ones
2		Universal joints badly worn	Check all universal joints, and renew the worn ones
3		Splines badly worn	Check all shaft splines, and renew the worn shafts

Chapter 5

FRONT AXLE

CONTENTS

GENERAL INFORMATION

1 Most axle failures are relatively easy to diagnose and correct, although proper assessment of axle noise can be a quick way to identify the problem.

2 All gear drives are noisy to some degree, particularly when not properly adjusted or lubricated. When the cause is faulty assembly, this can often be corrected by readjustment if carried out before significant wear occurs. Poor contact pattern between the crown wheel and pinion, excess of backlash or a loose pinion nut can occur in new or overhauled assemblies.

3 Slight axle noise heard at specific speeds or operating conditions is to be expected, usually peaking in a regular manner, and is not always associated with mechanical defect. Mostly, new axles which are noisy will not 'bed-in' - badly assembled gears or bearings just become increasingly worse.

4 When noise is present in a persistent form, an effort should be made to locate its source. Often this can be coupled with tyres, road surfaces, or the transmission, engine/exhaust or vehicle noise due to structural vibration. A thorough check should be made to ensure that an axle supposed to be noisy is in fact the real problem before dismantling is undertaken.

5 Axle transmission noise usually falls into a category of gears or bearings. Identifying either can sometimes require a high degree of skill and experience. Making a reasoned assessment sometimes requires a progressive road test. A smooth level road will tend to minimise tyre noise and body vibrations; raising tyre pressure can further reduce tyre noise and exaggerate body shock noise. Varying speed and load conditions will help to select the worst case noise levels. Maximum acceleration and over-running the engine, coasting, rapid right and left steering manoeuvres, all stress the transmission in a way which will isolate specific defects.

6 Tyre noise is often mistaken for axle noise even when the tyre is on another axle. Unbalance, uneven wear or non-skid tread pattern can be the source of tyre noise, although these can be emphasised as described. Most axle noise is continuous, and with normal wear and tear not very evident at speeds less than 30 mph.

7 Front wheel bearings or constant velocity joints which are worn or inadequately lubricated can cause misleading noise, although it tends to remain dependent on wheel speed. Partial application of the foot-brake at constant speed may reduce front wheel bearing/drive noise due to vibration damping, suspect bearings and swivel joints can then be isolated from the investigation.

8 The front suspension incorporates vibration isolators (rubber bushes) which sometimes, due to wear, become ineffective. Metal to metal contact across one of these isolators (eg. a spring shackle rubbing on both a spring eye and the chassis) will transmit any normal vibration from the axle into the bodywork. Metal panels then amplify the vibration like a sounding board, and greatly exaggerate the actual sound of an otherwise normal noise.

9 Gear noise from the axle usually has a cyclic characteristic corresponding to the wear involved, and will probably be concentrated within a restricted speed range. Crown wheel and pinion wear will cause a continuous noise corresponding to the road speed. If the gears seem otherwise in good condition, carry out a tooth to tooth contact pattern check and reset the engagement. Backlash and preload adjustment are frequent sources of noise; early diagnosis may only require shim adjustment.

10 A metallic knock which occurs at the start of acceleration and deceleration can be a loose coupling in the prop shaft joint or companion flange. Wear associated with the differential system, eg. case bearings, side gear hub pivots, pinion thrust washers, are other sources of backlash causing a more muffled clunk when the applied drive reverses during acceleration and deceleration.

11 Worn CV joints exhibit a more continuous rumble, which is exaggerated during steering manoeuvres.

12 Noise from worn bearings is continuous and varies with road speed. Pinion bearings, which rotate faster than differential case bearings, cause the higher frequency noise of the combination. Differential bearings rotating at wheel speed will have a more muffled noise than wheel bearings, which are affected by axle loading. Bearings of both the pinion and differential case may also give rise to backlash knock during acceleration and deceleration.

CAUTION...
During rolling motion, extra friction caused by worn components, and assemblies which are badly lubricated or adjusted, can give rise to rapid local heating sufficient to cause skin burns. Overheating can also cause lubrication failure, giving rapid wear and total breakdown.

TABLE 1 - FRONT AXLE FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Front wheel noise	Lubrication	Check oil level in CV joint. Check grease packing of hub.
2		Wheel insecure	Tighten nuts to required torque. (Note: left side - left hand thread).
3		Wheel bearing	Adjust to required pre-load Replace worn/corroded bearings.
4	Front axle drive shaft noise	CV joint	Check the half shaft spline/ flange assembly. Replace worn wheel spindle bush. Replace worn CV joint.
5		Sheared half-shaft	Replace and avoid excessive load.
6	Drive noise	Loose drive pinion flange	Tighten flange nut to prescribed torque.
7		Drive pinion bearings	Check for bearing condition and end play. Adjust pre-load.
8		Crown wheel/pinion backlash	Check differential/pinion bearings. Re-assemble to proper clearance and preload settings.
9	Differential case damage	Incorrect assembly	Check for component failure. Replace defective components and rebuild.
10		Excessive backlash	Check for distorted housing or component wear. Replace defective components and rebuild.

(Contd)

TABLE 1 - FRONT AXLE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
11		Excessive load	Replace damaged components and reassemble. Avoid abusive service.
12	Lubricant leakage	Level too high	Drain to correct level
13		Worn oil seal	Verify this is not induced by other defects and replace.
14		Mechanical defects	Check for wear on pinion flange, badly fitting cover plate, cracked differential housing and recitfy.
15		Breather blocked	Clean breather.
16	Front Axle noise	Insufficient lubricant	Check for leakage. Correct and refill.
17		Maladjusted crown wheel and pinion	Check tooth contact pattern and correct as necessary.
18		Unmatched crown wheel and pinion	Replace with correctly matching pair.
19		Worn crown wheel and pinion	Determine cause of excessive wear and replace worn components.
20		Improperly adjusted bearings	Examine for wear and reassemble with recommended preload.
21		Misaligned crown wheel	Determine cause of run-out and rectify.
22	Scored gears	Insufficient lubricant	Check for oil leaks. Replace worn components and reassemble.

(Contd)

TABLE 1 - FRONT AXLE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
23		Lubricant improper grade or contaminated	Replace worn components. Clean and reassemble.
24		Excessive wheel spin on soft terrain.	Check for component wear. Replace defective components and re-assemble.
25	Damaged gear teeth	Overloading	Replace defective components and and rebuild. Restrict vehicle to correct loading.
26		Maladjusted assembly	Replace damaged components and reassemble to specification.

Chapter 6

REAR AXLE

CONTENTS

GENERAL INFORMATION

1 Most axle failures are relatively easy to diagnose and correct, although proper assessment of axle noise can be the most essential aspect of servicing.

2 All rear axles are noisy to some degree, particularly when improperly adjusted or lacking adequate lubrication. When the cause is maladjustment, this can be corrected if readjustment is carried out before significant wear occurs. Poor contact pattern between crown wheel and pinion, excessive backlash, or a loose pinion nut often occur in new or overhauled assemblies. Slight axle noise heard at specific speeds or operating conditions is to be expected, usually peaking in a consistent manner, and is not always indicative of a mechanical defect. Mostly it is not a case of 'bedding-in', noisy gears or bearings will become increasingly worse.

3 When noise is present in a persistent form, an effort should be made to locate its source. Often this can be coupled with tyres, road surfaces, or the transmission, engine/exhaust or vehicle noises due to structural vibration. A thorough check should be made to ensure that a supposedly noisy axle is in fact the real cause, before dismantling is undertaken.

4 Axle transmission noise usually falls into a category of gears or bearings. Identifying either can sometimes require a high degree of skill and experience. To make a reasoned assessment, a progressive road test is sometimes necessary. A smooth level road will tend to minimise tyre noise and vehicle body vibrations. Raising tyre pressure can further reduce tyre noise and increase body shocks. Varying speed and load condition assists selection of the worst-case noise levels. Maximum acceleration and over-running the engine, coasting, rapid right and left steering manoeuvres, all stress the transmission in a way which will isolate specific defects.

5 Tyre noise is often mistaken for rear axle noise even though the offending tyre is on a front wheel. Unbalance, uneven wear or non-skid tread pattern can be the source of tyre noise, although these will change with pressure or differing road surface while rear axle noise is mostly constant. Tyre over-pressure of 20 psi can be used (during controlled test runs only, in safe

conditions). Remaining tyre noise will still correspond with road speed and surface, but axle noise will probably cease at less than 30 mph. Smooth concrete, asphalt, soft earth and similar variations will assist tyre noise analysis.

6 Wheel bearings which are worn or inadequately lubricated can cause misleading noise, though it tends to remain related to wheel speed. Partial application of the foot-brake at constant speed may reduce wheel bearing noise due to vibration damping, and suspect bearings can be isolated from the investigation.

7 Rear suspensions incorporate rubber bushes and spring insulators, which isolate normal axle vibrations from the sounding-board effect of the vehicle structure. Metal to metal contact due to hanger/shackle wear etc. may provide a 'stethoscope' effect and amplify the axle noise as body vibration.

8 Gear noise from the axle usually has a cyclic characteristic corresponding to the wear involved and will probably be concentrated within a restricted speed range. Crown wheel and pinion wear will cause a continuous noise at the corresponding speed. A contact pattern check will show the degree of maladjustment if the gears are otherwise in satisfactory condition.

9 When dismantling takes place, careful observation related to the road test may point quickly to the nature of the defect. Improper backlash, pinion or differential housing preload are frequent sources of axle noise. Early diagnosis and repair may only require shim adjustment. Analysis and records of axle defects will quickly accumulate into an expert success rate.

10 A metallic knock which occurs with the start of acceleration or deceleration can be a loose coupling in the prop shaft joint or companion flange. Wear associated with the differential system, eg. differential case bearings, side gear hub pivots, pinion thrust washers are other sources of backlash causing a more muffled clunk when the applied drive changes direction during acceleration/deceleration.

11 Noise from worn bearings is continuous and varies with road speed. Pinion bearings, rotating faster than differential/road wheel hub bearings, generate a higher frequency. Differential bearings will probably be more muffled than wheel hub bearings, and both the pinion and differential bearings may also cause backlash knock.

LOCKING DIFFERENTIAL

12 Malfunction of the locking differential will usually be accompanied by tyre scuffing or a loud metallic clicking sound. Road test each driving wheel by making a slow turn on full lock, both forward/reverse and left/right.

13 Badly worn or incorrectly assembled mechnanisms exhibit 3 principal defects:

(1) excessive tyre wear or half shaft failure
(2) pronounced understeer
(3) exaggerated noise.

14 Understeer can also be induced by an under inflated tyre or a heavy load positioned to one side of the vehicle. Exaggerated noise is usually caused by accelerated wear prior to breakdown induced by incorrect or contaminated lubrication.

CAUTION ...
During rolling motion extra friction caused by worn components, and assemblies which are badly lubricated or adjusted, can give rise to rapid local heating sufficient to cause skin burns. Overheating can also cause lubrication failure, resulting in rapid wearout and total breakdown.

TABLE 1 - REAR AXLE FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Rear wheel noise	Wheel loose Worn wheel bearing	Tighten loose nuts. Replace worn or corroded bearings.
2	Rear axle drive shaft noise	Axle housing	Inspect mounting and alignment
3		Distorted axle shaft	Replace shaft.
4		Drive pinion bearing	Check bearings condition, adjust pre-load.
5		Crown wheel/pinion back-lash	Check crown wheel/pinion gear setting. Check differential bearings and pre-load.
6		Loose drive pinion flange	Tighten flange nut to prescribed torque.
7		Wheel bearing adjustment	Check bearings and re-set.
8		Scuffed drive-gear teeth	Replace crown wheel and pinion pair.
9	Rear axle drive shaft breakage	Misaligned housing Faulty "No spin" differential lock assembly	Replace shaft and "No spin" differential lock assembly.
10		Vehicle overload	Replace shaft avoid excessive load.

(Contd)

TABLE 1 - REAR AXLE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
11	Differential case damage	Incorrect bearing adjustment	Inspect for all damage and rebuild
12		Excessive crown wheel clearance	Check for cracked case or component wear and rebuild.
13		Excessive loading	Rebuild and avoid abusive service.
14	Lubricant leakage	Oil level too high	Drain to lower edge of filler plug
15		Worn oil seal	Verify this is not due to other defects and replace.
16		Mechanical defects	Check for wear on pinion flange, badly fitting cover plate cracked differential housing.
17	Rear axle noise	Insufficient lubricant	Check for leakage. Correct and refill.
18		Malajusted crown wheel and pinion	Check tooth contact pattern and correct as necessary.
19		Unmatched crown wheel and pinion	Replace with correctly matched pair.
20		Worn crown wheel and pinion	Investigate for excessive wear and replace defective components.
21		Improperly adjusted bearings	Examine for wear and reassemble with recommended preload.
22		Misaligned crown wheel	Determine cause of runout and rectify.
23		Locking differential	Check for normal operation.

(Contd)

TABLE 1 - REAR AXLE FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
24	Scored gears	Insufficient lubricant	Check for oil leaks. Replace worn components and rebuild.
25		Improper grade/ contamination of lubricant	Replace worn components, clean and rebuild.
26	Damaged gear teeth	Overloading	Replace defective components and rebuild. Restrict vehicle loading.
27		Maladjusted assembly	Replace damaged components and rebuild to specification.

Chapter 7

STEERING SYSTEM

CONTENTS

INTRODUCTION

1 The steering hydraulic system is fail safe, a failure will not interfere with the steering of the vehicle except that a greater degree of physical effort will be required for any given manoeuvre.

2 Should mechanical failure occur that prevents power assistance eg. pump seizure or hose failure, the hydraulic pump drive belt must be removed to avoid damage to the drive pulleys and a potential fire hazard from an overheated belt.

Fig 1 STEERING SYSTEM FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Heavy steering over entire travel	Nil or insufficient oil pressure	Check hydraulic pump drive belt tension
2			Check hydraulic system oil level
3			Check/clean oil filter, check pressure hoses are not kinked or collapsed
4			Check for air ingress at pump or reservoir, bleed system if necessary
5			Check/replace hydraulic pump
6		Steering box damaged	Check/replace steering box
7		Steering damper U/S	Check/replace steering damper
8		Tyre pressure(s) low	Inflate as necessary
9	Steering wanders or pulls to one side	Misaligned steering box control valve	Disconnect drag link from drop arm and run engine at medium speed. If steering wheel moves without assistance replace steering box
10		Wheels out of balance	Refer to Chapter 9
11		Damaged/worn shock absorbers	Refer to Chapter 8
12	Steering feels vague	Worn steering box	Replace steering box

(Contd)

Fig 1 STEERING SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
13		Worn steering linkage ball joints	Renew worn ball joints
14	Steering chatter or excessive free play	Worn steering linkage	Renew worn ball joints
15		Track rod or drag link clamps loose	Tighten clamp bolts
16		Universal joint pinch bolts loose	Tighten pinch bolts
17	Tight spot(s)	Bent steering column inner shaft	Renew steering column
18		Damaged universal joint	Renew universal joint assembly

Chapter 8

SUSPENSION

CONTENTS

INTRODUCTION

1 One suspension spring is fitted for each wheel, when unladen any failure or deterioration will be obvious by the lay of the vehicle.

2 The shock absorbers are sealed units which cannot be dismantled or adjusted. In the event of a shock absorber being faulty a replacement unit must be fitted.

TABLE 1 FAILURE DIAGNOSIS - SUSPENSION

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Excessive pitching or rolling on corners or during braking	Poor distribution of load. Load insecure.	Ensure large loads are secured on the vehicle centre line above the rear axle.
2		Weak or broken spring	Replace suspect spring as detailed in Cat.5.2 Chap. 8.
3		Faulty shock absorber	Replace suspect shock absorber as detailed in Cat. 5.2 Chap.8.
4	Wheel wobble and excessive vibration	Wheels out of balance, buckled or incorrectly aligned.	Refer to Chap. 9.
5		Weak or broken spring	Replace suspect spring as detailed in Cat.5.2 Chap. 8.
6		Faulty shock absorber	Replace suspect shock absorber as detailed in Cat. 5.2 Chap.8.

Chapter 9

WHEELS AND TYRES

CONTENTS

TABLE 1 - SPECIAL TEST EQUIPMENT AND TOOLS

Tool No	NSN/Part No	Designation
(1)	(2)	(3)
30711 (valve key)	TBA	Wheel valve

TABLE 2 - WHEELS AND TYRES FAILURE DIAGNOSIS

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
1	Tyre flat or under inflated	Occasional air loss through usage	Re-inflate tyre to correct pressure.
2		Tyre punctured	If puncture is obvious fit spare wheel and repair punctured tyre. If puncture is not immediately obvious moisten tyre surface re-inflate and check for bubbling or air escaping.
3		Valve core faulty	Inflate tyre, moisten valve opening and check for bubbling. If air bubbles are evident replace valve core.
4		Valve base faulty	Inflate tyre, moisten valve base and check for bubbling. If air bubbles are evident replace valve to wheel 'o' ring.
5		Valve body damaged	Replace complete valve assembly.
6		Rim flange damaged	Lay the wheel assembly on the ground and pour water in the channel formed between the rim flange and tyre wall, repeat on the other side. If a steady stream of bubbles appears replace the wheel.
7		Rim damaged (very rare)	Replace wheel.

(Contd)

TABLE 2 - WHEELS AND TYRES FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible causes	Action
(1)	(2)	(3)	(4)
8		Wheel weld integrity suspect	Lay the wheel assembly on the ground, pour water on the welds and check for air bubbles. If a steady stream appears from welds replace wheel.
9	Excessive wheel vibration or wobble	Wheel nuts fitted incorrectly or incorrectly torqued	Check wheel nuts and re-torque.
10		Wheels require balancing	Check wheel balancing.
11		Road wheel buckled or damaged	Check wheels and renew if necessary.
12		Incorrect wheel alignment	Check wheel alignment.
13		Suspension or steering faulty	See relevant Chapters for suspension and steering.

Chapter 10

BRAKING SYSTEM

CONTENTS

INTRODUCTION

1 Self adjusting brakes retain fluid in slave cylinder to compensate for brake wear. After fitting new brake shoes the reservoir may overflow, due to fluid returned to the master cylinder by re-adjustment of the slave cylinders.

TABLE 1 BRAKING SYSTEM FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Low efficiency	Incorrect adjustment	Check setting of shoes.
2		Air in fluid	Bleed hydraulic system.
3		Badly fitting shoes	Replace using correct type.
4		Contaminated shoes	Check source and correct, clean or replace shoes.
5		Load sensing valve	Check operation and setting.
6		Servo operation	Check non-return valve and hose joints. Replace servo unit.
7		Glazed/corroded friction surface	Slight defects may be rectified by abrading and cleaning. (Do not distribute asbestos dust into atmosphere by airlines or dry abrading tools). Replace badly affected units.
8		Defective master or slave cylinders	Clean and replace seals and dust caps, replace corroded units.
9	Unbalanced braking	Suspension	Check shock absorbers, tyre pressures, correct tyre pairings, road springs.
10		Contaminated linings	Rectify cause and fit new shoes.
11		Incorrect shoe fitting	Refit correctly - renew if wear is significant.

(Contd)

TABLE 1 BRAKING SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
12		Faulty hydraulics (pulling = 'good'side	Check hydraulic pressure, slave cylinders and shoes at non-pulling side. Bleed lines, replace defective units.
13		Loose backplate	Tighten fixings to prescribed torques.
14	Front wheel lock-up	Shock absorber faulty	Check shock absorber of locking side.
15		Slave cylinder faulty	Check for sticking slave cylinder at other side.
16	Rear wheel lock-up	Load sensing valve faulty	Check load sensing valve setting/adjustment.
17	Brakes fade	Overheating	Check for wheel bearings overheating.
18			Check for sustained brake application due to fluid restriction or slave cylinder operation.
19		Contaminated fluid vapourisation.	Replace fluid.
20	Noisy operation	Metallic knocks	Check mounting of back plates, slave cylinders and shoes. Tighten to correct torques.
21		Vibration, squeal	Localised high spots or corrosion on drum - clean up using hand tools.
22		Leading shoe action	File a 45^{0} chamfer on leading edges of shoes.

(Contd)

TABLE 1 BRAKING SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
23		Metal to metal friction	Excessive wear. Replace normally worn shoes investigate cause of abnormal wear.
24	Excessive foot brake motion	Only one circuit operating	Front or rear circuit not functioning. Check fluid levels, master cylinder oil seals, slave cylinder operation.
25		Excessive brake-shoe wear	Self adjustment of rear brake shoes reaching limits of useful compensation due to wear. Replace shoes.
26	Restricted foot brake motion	Mechanical obstruction	Clean obstruction to give free movement.
27		Return springs	Replace stretched or broken springs.
28		Defective hydraulic cylinders	Check operation of master slave hydraulic cylinders. Replace defective seals.
29	Excessive handbrake motion	Linkage out of adjustment	Check corrosion and wear of cable and linkage. Clean, re-adjust and lubricate.
30		Compensation mechanism	Check for proper adjustment of wear compensation mechanism. Replace excessively worn shoes.

(Contd)

TABLE 1 BRAKING SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
31	Rear brakes not releasing	Equalising linkage movement restricted	Remove accumulated road dirt and corrosion. Clean, re-adjust and lubricate linkage.
32	Sluggish or no operation of footbrake	Constriction in hydraulic circuit	Replace damaged hydraulic fluid pipes/ hoses.
33	Heavy footbrake	Exhauster not operating correctly	Repair/replace exhauster
34		Vacuum servo not operating correctly	Check loss of vacuum from pipes or reservoir and renew as necessary Repair/replace vacuum servo

Chapter 11

FUEL AND EXHAUST SYSTEMS

CONTENTS

GENERAL INFORMATION

1 If air enters the fuel system it must be eliminated from the system, in accordance with the procedure in Category 5.2 Chapter 11 paragraph 2, before the engine can be started. Air can enter the system if :

1.1 the fuel tank is drained in normal operation
1.2 the low-pressure fuel pipes are disconnected
1.3 a part of the low-pressure fuel system leaks during operation

2 The fuel injection pump is built to extremely fine limits and ingress of the smallest particle of dirt will diminish its accuracy of operation. The pump is intended to be maintenance free with repair by replacement in the field. Only suitably qualified personnel should attempt to adjust the fuel injection pump and governor settings.

CAUTION ...

Before any part of the fuel system is dismantled the surrounding area must be thoroughly cleaned.

TABLE 1 FUEL SYSTEM AND EXHAUST SYSTEM FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Engine fails to start or is difficult to start	Insufficient fuel in tank	Refill fuel tank and eliminate all air from fuel system
2		Incorrect grade or type	Check that tank is filled with diesel and NOT petrol
3		Restriction in fuel supply	Change the fuel filter and drain the sedimenter bowl. Check that the fuel system does not contain water In sub-zero temperatures check for ice blockages, at very low temperatures it is possible for wax crystals to separate from the fuel and cause a blockage
4		Incorrect cold start procedure	Check cold start procedure (Cat 2 Chap 3)
5		Cold start aid inoperative	Check fluid level in cold start reservoir. If start pilot pump is faulty renew pump.
6		Defective fuel lift pump	Check output of lift pump, if necessary, replace pump Cat 5.2 Chap 11 Para 4 to 6
7		Defective fuel injection pump or incorrect pump timing	Note... Only qualified personnel should carry out work on the fuel injection pump. Check fuel injection pump timing. Cat 5.2 Chap 11 Para 13. If the engine runs, check idle adjustment Cat 5.2 Chap 11 Para 12

(Contd)

TABLE 1 FUEL SYSTEM AND EXHAUST SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
7			Replace fuel injection pump Cat 5.2 Chap 11 Para 10 and 11.
8		Defective fuel injector	Renew injectors Cat 5.2 Chap 11 Para 18 to 20
9	Engine starts then stops	Insufficient fuel or restriction in fuel supply	See Serial No 1 of this Table
10		Engine air intake restricted	Check air cleaner element, clean/renew as necessary.
11		Air in fuel system	Eliminate all air from the system and check for leaks
12		Insufficient engine idling rpm	Adjust engine idling speed Cat 5.2 Chap 11 Para 12
13	Incorrect engine speed	Engine speed control stops incorrectly adjusted	Adjust the engine idling and maximum no-load rev/min Cat 5.2 Chap 11 Para 12
14		Engine air intake restricted	See Serial No (10) of this Table
15		Restriction in fuel supply	See Serial No (1) of this Table
16		Accelerator linkage and cable seized	Check for full accelerator action. Lubricate or renew cable and joints as necessary
17		Fuel lift pump delivering incorrect amount of fuel	Repair or renew fuel lift pump Cat 5.2 Chap 11 Para 4 to 6

(Contd)

TABLE 1 FUEL SYSTEM AND EXHAUST SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
18		Defective fuel injectors	Overhaul or renew injectors Cat 5.2 Chap 11 Para 18 to 20
19	Engine misfiring and running unevenly	Defective fuel lift pump	Repair or renew fuel lift pump Cat 5.2 Chap 11 Para 4 to 6
20		Defective fuel injectors	Overhaul or renew fuel injectors Cat 5.2 Chap 11 Para 18 to 20
21		Air in fuel system	Eliminate all air from the system, check for leaks
22	Lack of engine power and excessive fuel consumption	Excessive load being carried or towed	The load carried should not exceed that stated on the vehicle specification plate
23		Incorrect tyre pressure	Check tyre pressures
24		Brakes binding	Refer to Chap 10
25		Engine air intake restricted	See Serial No 10 of this Table
26		Restriction in fuel system	See Serial No 1 of this Table
27		Accelerator linkage and cable seized	See Serial No 16 of this Table
28		Restriction in exhaust system	Check exhaust system for damage
29		Defective fuel injection pump	See Serial No 1 of this Table

(Contd)

TABLE 1 FUEL SYSTEM AND EXHAUST SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
30	Engine overheating	Restriction in air cleaner	Service or replace air cleaner
		Faulty fuel injection pump	See Serial No 1 of this Table
		Faulty injector(s)	Check injector for correct type, renew Cat 5.2 Chap 11 Para 18 to 20
		Defective cold start equipment	Renew starting aid Cat 5.2 Chap 11 Para 21 and 22
		Restriction in exhaust pipe	Remove restriction
31	Slow acceleration	Fault in manifold pressure boost control mechanism	Check air leaks in the pipework between the induction manifold and the manifold pressure compensator
			Renew the fuel injection pump Cat 5.2 Chap 11 Para 10 and 11
32	Engine surges	Accelerator cable or linkage seized or worn	Check cable and linkage for wear, lubricate or renew as necessary
33		Air leaking into the fuel system	Check for leaks and air vent the system
34		Speed control mechanism or pump seized or worn	Replace the fuel injection pump Cat 5.2 Chap 11 Para 10 and 11
35		Defective fuel injectors	Fit new injectors Cat 5.2 Chap 11 Para 18 to 20

(Contd)

TABLE 1 FUEL SYSTEM AND EXHAUST SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
36	Slow deceleration	Accelerator cable or linkage seized or worn	Check cable and linkage for wear. Lubricate or renew as necessary
37		Speed control mechanism or pump seized or worn	Replace the fuel injection pump Cat 5.2 Chap 11 Para 10 and 11

Chapter 12

COOLING SYSTEM

CONTENTS

GENERAL

1 When investigating an engine coolant or temperature fault refer also to Chapter 1 Engine and Chapter 11 Fuel and Exhaust system.

TABLE 1 - COOLING SYSTEM FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Engine coolant temperature too high	Insufficient coolant in system	Top up coolant system and check for leaks
2		Loose fan belt	Adjust fan belt to correct tension. Replace all belts if one appears worn
3		Radiator blocked or radiator grille restricted	Back flush radiator to remove sediment or scale. Clear grille of obstructions
4		Faulty water pump	Check/replace water pump Cat 5.2 Chap 12 Paras 5 and 6
5		Thermostat not working correctly	Test/replace thermostat Cat 5.2 Chap 12 Para 2 to 4
6		Exhaust pipe restriction	Check and remove any restrictions
7		Oil level in sump too low	Top up sump to "H" mark on the dipstick
8		Cylinder head gasket leaking	Fit new gasket
9		Restriction in water jacket	Check coolant for excessive sediment or scale and if necessary flush with a descaling solution
10	Engine coolant temperature too low	Thermostat jammed open	Renew thermostat Cat 5.2 Chap 12 Para 2 and 3
11		Fan drive will not disengage	Renew fan drive unit Cat 5.2 Chap 12 Para 10 and 11

(Contd)

TABLE 1 - COOLING SYSTEM FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
12		Temperature gauge showing incorrect reading	Renew temperature gauge
13	Excessive vibration	Damaged fan	Fit new fan Cat 5.2 Chap 12 Para 9

Chapter 13

ELECTRICAL SYSTEM (12V)

CONTENTS

STARTING CIRCUIT FAILURE DIAGNOSIS

CAUTION :
Before carrying out any tests on the starting circuit, check that the vehicle gearbox is in park with the handbrake applied..

STARTER MOTOR DOES NOT TURN ENGINE

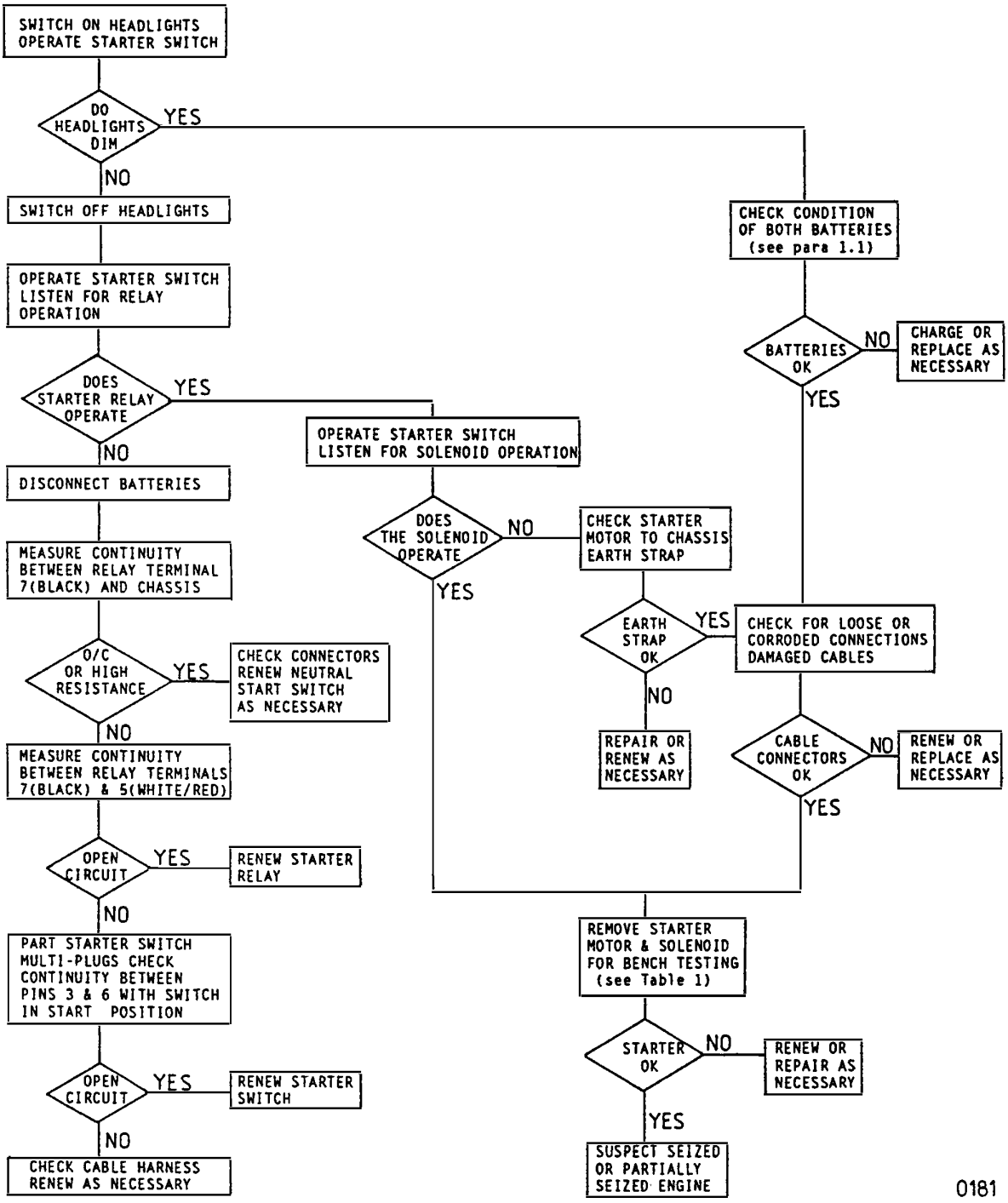

Fig 1 Starting circuit failure diagnosis algorithm

1 Use the algorithm, Figure 1, and the diagrammatic representation of the circuit, Figure 2, to isolate the fault. Starter motor and solenoid faults can be investigated by removing the starter from the vehicle and carrying out the bench tests described in Table 1.

1.1 Using a hydrometer check the batteries are at least 70% charged (specific gravity reading greater than 1.230 in climates normally below 25°C, greater than 1.170 in climates normally above 25°C).

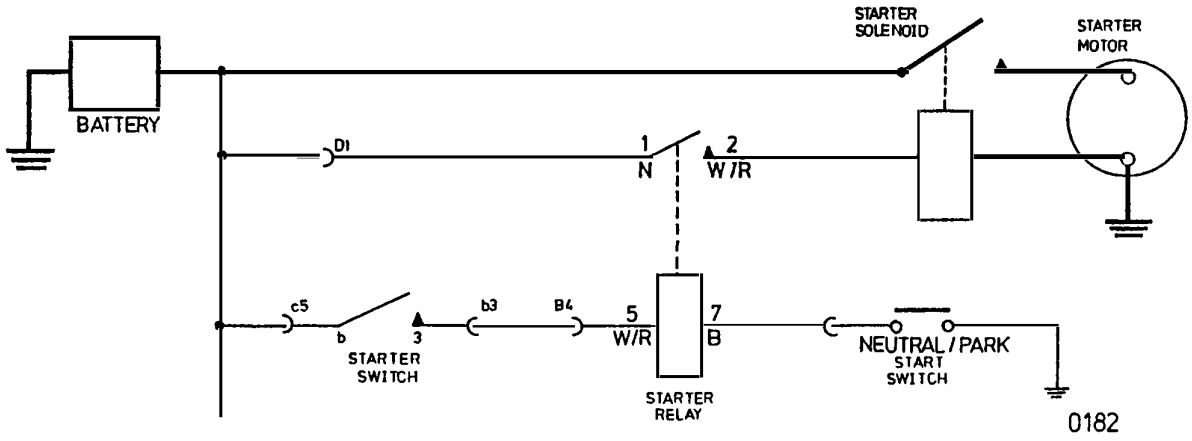

Fig 2 Starting circuit - schematic

STARTER MOTOR BENCH TESTING

2 Remove the starter to a test bench having a 12 volt supply, and voltmeter.

TABLE 1 STARTER MOTOR BENCH TESTING

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Starter fails to operate, no audible operation of solenoid	Solenoid faulty	Connect 12 volt supply from battery to STA terminal, if motor runs renew solenoid.
2		Starter faulty	Connect 12 volt supply from battery to STA terminal, if motor does not run renew starter.
3	Starter fails to operate, audible operation of solenoid	Solenoid contacts open circuit	Connect 12 volt supply from battery to solenoid input terminal, check for voltage at STA terminal. The voltage drop across the solenoid must be zero, any other result renew solenoid.
4		Starter faulty	Replace starter.

CHARGING CIRCUIT FAILURE DIAGNOSIS

CAUTION:
The alternator contains polarity sensitive components that could be permanently damaged if subjected to incorrect polarity. Do not connect or disconnect any part of the charging circuit, including the battery leads, while the engine is running.

3 Faults within the charging circuit will usually show up in one of the following ways:

3.1 Abnormal operation of the alternator warning lamp

3.2 Low specific gravity measured at the battery, slow engine cranking speed when starter switch is closed

3.3 An overcharged battery using excessive water

3.4 A noisy alternator

TABLE 2 CHARGING CIRCUIT FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Warning lamp ON, or intermittent	Alternator drive belt worn, slack or broken	Check belt tension, all belts should be replaced at the same time.
2		Open circuit between alternator +Ve terminal and battery	Connect voltmeter between alternator +Ve terminal and earth. If meter reads zero check for open circuit, if meter reading low check for poor/dirty connections.
3	Warning lamp ON goes off at high revs	Faulty rectifier or rotor windings	Replace alternator
4	Warning lamp glows	High resistance across alternator connections	Clean/tighten connections, the voltage measured at the +VE and W2 Terminals should be identical (approx. 14.4V)

(Contd)

TABLE 2 CHARGING CIRCUIT FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
5	Warning lamp flashes	Worn or dirty alternator brushes	Replace regulator and brush box
6		Bad connection in warning light wiring	Check and tighten connections
7	Warning lamp ON Engine stopped, starter switch open	Alternator rectifier short circuit	Disconnect alternator +Ve and WL leads, if the lamp stays ON there is a wiring fault. If the lamp is extinguished replace the alternator
8		Faulty starter switch	Investigate starter switch, replace if continuity between terminals 1 and 2 in the OFF position.
9	Warning lamp OFF, Engine stopped, starter switch in pos II	Lamp, lampholder or wiring open circuit.	Disconnect WL lead and earth it, if warning lamp remains OFF replace lamp/investigate wiring for open circuit. If warning lamp lights replace alternator.
10	Overcharged battery	Faulty regulator	Replace regulator assembly.
11	Noisy alternator (Squeal)	Worn alternator drive belt.	Replace all belts
12	Noisy alternator (whine)	Faulty bearings faulty rectifier, short circuit stator.	Replace alternator

Head and side light faults

4 The following table assumes the correct positions have been selected at the lighting and starter switches.

TABLE 3 HEAD AND SIDE LIGHT FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Failure of both side lights and dim dip	Fuse C3 open circuit	Replace fuse C3
2		Lighting switch open circuit	Gain access to the rear of the lighting switch, check for 12V at terminals 1 (N) and 4 (RB). Replace switch if open circuit.
3	Failure of main beam flash	Fuse B2 open circuit	Test horn, if horn is faulty replace fuse B2
4		Combination switch faulty	Part connector X, check for 12V at x8. If present, short x8 to x5, if main beam flash OK replace combination switch.
5	Dipped headlights remain at 10% full intensity when HST is selected	Dim dip relay stuck in the dim dip position	Replace dim dip relay
6		12 volts one side of dim dip relay only	Select main beam, if unavailable check for open circuit at lighting switch. If available: check for open circuit between headlamp resistor (behind fuse panel) and dim dip relay.
7	Dim/Dip fails to operate	Dim/Dip resister faulty	Replace Dim/Dip resistor

Turn signal and hazard warning light

5 The following table assumes the correct position are selected at the lighting and starter switches.

TABLE 4 TURN SIGNAL AND HAZARD WARNING LIGHT FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Turn signal and hazard warning functions fail on all lamps.	Fuse B4 open circuit	Check and replace Fuse B4
2		Flasher unit open circuit	Replace flasher unit
3		Sequential relay faulty	Replace sequential relay
4	No hazard warning function, turn signal OK.	Hazard warning switch faulty	Check/replace hazard warning switch
5	No turn signal function, hazard warning OK	Flash inhibit relay lighting switch relay faulty	Check supplies to flash inhibit relay, replace relay if supplies OK.

Windscreen wiper circuit failure diagnosis

6 The following table assumes the correct positions have been selected at the combination switch and starter switch.

TABLE 5 WINDSCREEN WIPER FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Wipers fail to switch OFF	Wiper control switch faulty	Switch to fast speed wipe, if wipers increase speed go to Serial No.3, if not investigate short circuit across switch.
2		Intermittent wipe relay faulty	Remove relay and insert shorting strap between sockets 31b and 53e. If wipers restart with switch in OFF position go to Serial No.3. If wipers remain stopped fit new intermittent wipe relay.
3		Parking switch faulty	Remove FSA3, remove wiper motor assembly, dismantle, clean/replace parking switch.
4	Wipers operate in fast speed only, do not park when switched OFF	Intermittent relay missing or faulty	Fit new intermittent relay
5	Wipers do not park when switch to OFF	Parking switch faulty	Remove wiper motor assembly, dismantle clean/replace, parking switch.
6	Wipers operate slowly or not at all	Brushes badly worn commutator dirty, greasy or burnt, gearbox parts, badly worn, linkages damaged.	Remove wiper motor assembly overhaul as detailed in Cat. 5.2 Chap. 13

Chapter 13-1

ELECTRICAL SYSTEM (24V)

CONTENTS

INTRODUCTION

1 Failure diagnosis information for the No 16 Mk1 28 volt 90 amp fused alternator FV1068364 is available in AESP 2920-C-102

TABLE 1 24 VOLT SYSTEM FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Warning lamp ON Ammeter indicates a discharge	Excessive current drawn by radio	Disconnect at socket 2 and observe ammeter
2		Alternator drive belts slack	Adjust belt tension as detailed in Category 2 Chapter 4-2. Renew both belts where necessary
3	Warning lamp ON Ammeter indicates zero	Alternator fuse open circuit	Check and renew if necessary
4		Alternator fault	Refer AESP 2920-C-102
5	Warning lamp glows	Alternator fault	Refer AESP 2920-C-102
6	Warning lamp OFF Ammeter indicates a discharge	Starter switch to OFF or in position I	Start engine
7		Warning lamp open circuit	Check and replace as necessary
8		RL1 faulty	Check 12 volt supply to RL1, if supply present and contact open renew relay See AESP 2320-E-200-302 Fig 1
9		Alternator chassis return open circuit	Check continuity of alternator earth strap, clean/tighten terminals See AESP 2320-E-200-302 Fig 1

Chapter 16

BODY CAB AND FITTINGS

CONTENTS

TABLE 1 CAB FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Cab moves on chassis	Cab mounting bolts loose	Refer 5.2 Chapter 16
2		Cab mountings worn	Refer 5.2 Chapter 16
3	Door fails to close fully	Door striker out of adjustment	Refer 5.2 Chapter 16
4	Window winder fails to operate window	Window regulator worn/damaged	Refer 5.2 Chapter 16

TABLE 2 CAB FITTINGS FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Drivers seat does not move freely when adjustment handle is operated	Seat rail requires cleaning and lubricating	Clean seat rail and apply XG279 Grease to moving parts
2	Inertial reel seat belts do not store when released	Internal damage to store assembly	Replace seat belt assembly
3	Inertial reel seat belts do not lock	Internal damage	Replace seat belt assembly

TABLE 3 HEATER FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	No warm air being delivered	Air temperature regulator is set to blue (cold)	Move regulator away from blue (cold)
2		Engine thermostat failed to open	Replace thermostat refer Section 5.2 Chapter 12
3		Heater water valve failed closed	Replace heater unit
4		Air temperature regulator cable requires adjustment or is broken	Adjust/replace regulator cable
5	Unable to regulate air flow to screen or cab	Air flow regulator cable's to screen/cab require adjustment or are broken	Adjust/replace cables as necessary
6	Blower motor fails to run	Fuse FSA2 ruptured	Replace fuse FSA2 refer 5.2 Chapter 13
7		Blower switch damaged	Replace switch refer 5.2 Chapter 13
8		Fault in blower motor	Replace blower motor refer 5.2 Chapter 16
9	Blower motor runs in slow only	Blower switch damaged	Replace switch refer 5.2 Chapter 13
10	Blower motor runs in fast only	Blower switch damaged	Replace switch refer 5.2 Chapter 13
11	Blower motor noisey when running	Bearings worn	Replace blower motor refer 5.2 Chapter 16

Chapter 17

WINCH (INCLUDING PTO)

CONTENTS

WARNINGS ...

(1) DO NOT ATTEMPT TO WORK ON AN INSTALLED PTO WITH THE ENGINE RUNNING.

(2) DO NOT OPERATE THE PTO CONTROL FROM UNDERNEATH THE VEHICLE WITH THE ENGINE RUNNING.

(3) WHEN HANDLING CABLE, WEAR PROTECTIVE GLOVES AND ENSURE THAT DURING OPERATIONS, HANDS ARE KEPT CLEAR OF THE ROPE DRUM AND FAIRLEAD ROLLERS.

(4) THE WINCH OPERATOR MUST ENSURE THAT ALL PERSONNEL ARE CLEAR OF THE WINCH AREA WHILST THE CABLE IS UNDER TENSION.

CAUTIONS ...

(1) To minimise the risk of damage to the hydraulic system, change or clean the suction filter as recommended and check the oil level in the tank regularly. If the level falls, find and cure the leak immediately.

(2) Do not dismantle the hydraulic pump unnecessarily. If a loss of performance occurs, the system as a whole must be investigated before assuming that the pump is at fault.

TEST EQUIPMENT

1 The items of special test equipment listed in Table 1 may be required for failure diagnosis on the winch system.

TABLE 1 SPECIAL TEST EQUIPMENT

Serial No	NSN/ Part No	Designation
(1)	(2)	(3)
1	BW 85494	Dial pressure gauge (range 0-100 bar)

PERFORMANCE DATA

2 With second gear selected at the vehicle gearbox, the winch hydraulic system produces a maximum oil flow rate of 32 1/min at an engine speed of 1500 r/min. The pressure relief valve is set to operate at 54 bar. The maximum pull of the winch is 3.71 tonnes with the rope on the 1st layer or 2.2 tonnes with rope on the 5th layer.

DIAGNOSTIC PROCEDURES

3 The hydraulic winch is only used occasionally in service and, provided regular user maintenance is carried out in accordance with Cat 2, should remain trouble free.

4 The most common causes of premature wear and malfunctioning of hydraulic system components are the ingress of contaminants and the loss of fluid. To minimise the risk, the following precautions should be taken :

4.1 Change or clean the suction filter as instructed in Category 601.

4.2 Check the oil level in the tank regularly and if it falls, find and cure the leak immediately.

4.3 Use a clean container and the correct grade of oil as specified in Category 601 when topping up or changing the oil.

4.4 Observe a high standard of cleanliness when servicing parts.

4.5 Blank off all exposed parts and loose ends immediately after disconnection.

5 Failures arising from contamination or loss of hydraulic fluid may only become evident over a period of time. Most faults of this nature will give rise to an abnormal noise in the system, allowing the suspect item to be identified very quickly.

6 Noise, however, may also result from driving the system at above 1500 r.p.m., and operator error or misuse of the system could also be a contributing factor in other areas of malfunction. For example, if the drum stops suddenly with the rope still under tension, it is likely that the pressure relief valve has blown, indicating that the system is being overloaded. Likewise, engaging the dog clutch whilst the motor is running can damage the mechanism to a point where it will no longer engage at all.

Failure diagnosis table

7 Failure diagnosis is carried out using Table 2, which is provided as a guide to the symptoms and possible causes of faults that may develop in service. The recommended remedial action is also indicated. This may refer to Cat 5.2 for repair or replacement instructions, or to tests detailed in this chapter for special procedures required to isolate some faults.

8 The Table should be considered only as a guide to failure location. It has not been compiled with the intention of locating the source of every failure. Obvious physical damage, for example, has been excluded. Note also that successful operation of the winch is dependent on the engine, gearbox and transfer box, and the failure diagnosis table assumes that these are functioning normally. If not, reference should be made first to Chapter 1, 3 and 4 respectively.

Tests

9 Additional diagnostic testing may be necessary to confirm or isolate a failure to a particular component. These tests, called for by an action in Table 2, are detailed below.

Test 1 - PTO indicator switch.

10 To check the serviceability of the PTO indicator switch, proceed as follows:

10.1 Reset the winch controls and stop the engine.

10.2 Disconnect the wire for the PTO warning light at the PTO indicator switch.

10.3 Using a continuity meter, attach one probe to the screw on the indicator switch.

10.4 Attach the other probe to the PTO shifter cover or housing.

10.5 Engage the PTO to activate the shifting device and check the meter or light for an indication. If there is no indication, the switch is faulty.

10.6 Disengage the PTO and remove the continuity meter. Replace the warning light wire or, if necessary, replace the switch.

Test 2 - hydraulic pump

11 To check for excessive wear of internal components of the hydraulic pump, proceed as follows:

11.1 Reset the winch controls and stop the engine.

11.2 Place a container under the control valve to collect any oil spillage.

11.3 Remove the most accessible of the two pressure plugs from the extended adaptor at the input port of the control valve and fit a pressure gauge (Table 1, item 1).

11.4 Disconnect the motor hoses from the service ports of the control valve. Plug the hoses to prevent entry of dirt and identify them to assist in reassembly.

11.5 Plug the control valve service ports and, if necessary, top up the hydraulic oil at the tank.

11.6 Start the engine and operate the winch controls as normal, with the control lever set for either direction of winding.

11.7 Increase the engine speed to 1500 r.p.m. and observe the hydraulic pressure developed by the pump, as indicated on the gauge. If it is less than 54 bar then the pump is faulty. If the pressure reaches 54 bar, the relief valve will blow, indicating that the pump is serviceable.

11.8 Reset the controls and stop the engine. Remove the pressure gauge and blanking plugs and reconnect the motor hoses to the control valve. If necessary, replace the pump in accordance with Cat 5.2.

Test 3 - hydraulic motor

12 To check for excessive wear of internal components of the hydraulic motor, proceed as follows:

12.1 Reset the winch controls and stop the engine.

12.2 Place a container under the control valve to collect any oil spillage.

12.3 Fit a pressure gauge (Table 1, item 2) to the test point on the control valve.

12.4 Identify the hose which connects the motor port nearest the winch unit gearcase to the control valve (ie the return line from the motor when the winch is winching in).

12.5 Disconnect the hose at the service port of the control valve and direct the hose into a suitable container. Blank off the service port at the control valve.

12.6 If necessary, top up the hydraulic oil at the tank.

12.7 With the winch on the fourth of fifth lay, and the winch rope attached to a known load of 3 tonnes or more, start the engine, engage winch in, raise r/min to 1500 and allow the winch to winch in and stall (54 bar on the pressure gauge).

12.8 After 15 seconds at winch stall, reset the winch controls and stop the engine. The amount of oil in the container is an indication of the leakage rate and should be negligible (less than 0.1 l) If the amount is greater than 0.1 l the motor is faulty.

12.9 Reconnect the return hose remove the gauge and refit the plug.

TABLE 2 - WINCH FAILURE DIAGNOSIS

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
1	Winch operating normally - PTO warning light off	Warning lamp faulty	Check and replace lamp if necessary
2		Wire from warning light to PTO indicator switch disconnected or broken	Reconnect or replace wire as necessary
3		PTO indicator switch faulty	Carry out the procedures of Test 1, Para 10. If necessary, remove and replace PTO indicator switch.
4	No drive in either direction - PTO warning light off, engine running	PTO disengaged	Reset controls and repeat operating procedure(Cat 2)
5		Control cable to PTO shifter lever linkage disconnected or broken	Reconnect or replace cable as necessary (Cat 5.2)
6		Control cable linkage adjustment incorrect	Check and adjust linkage (Cat 5.2)
7	No drive in either direction - PTO warning light on, engine running	Dog clutch disengaged	Engage dog clutch
8		Vehicle gearbox in neutral	Engage second gear
9		Oil level too low	Check level indicator at tank and, if necessary, add oil to correct level
			Check all hoses and seals etc. for leaks and replace as necessary (Cat 5.2)

(Contd)

TABLE 2 - WINCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
10		Cable to control valve spool disconnected or broken	Reconnect or replace cable as necessary (Cat 5.2)
11		Cable to valve spool adjustment incorrect	Check and adjust (Cat 5.2)
12		Pressure relief valve stuck open (no oil flow in motor hoses)	Remove and clean the valve. Refit or replace as necessary (Cat 5.2)
13		Motor drive shaft fracture or seized motor gearwheel set	Remove and replace the motor (Cat 5.2)
14		Pump damaged	Remove and replace the pump (Cat 5.2)
15	Dog clutch noisy	Dog clutch not fully engaged	Engage dog clutch
16	Dog clutch will not engage	Worn clutch ring and/ or sliding member	Renew winch (Cat 522)
17	Gearcase noisy	Gearcase oil level too low	Check level and, if necessary, add oil to correct level Check cover gasket and drain plug for leaks and replace as necessary (Cat 5.2)
18		Gear or bearing damage	Renew winch (Cat 522).
19	Noisy motor and pump	Cavitation in the pump (reflected at the motor) from restriction in the suction hose.	Clean the suction filter and replace the element. Clean dirt etc out of the suction hose.

(Contd)

TABLE 2 - WINCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
20	Noisy motor only	Cavitation in the motor as a result of negative pressure. Caused, for example, by a runaway load on the rope turning the drum faster than the motor is driving it.	Release the winch control lever and apply external braking to the load in order to introduce slack in the rope
21		Oil flow rate too high causing motor shaft to run too fast Mechanical wear in motor	Reduce engine speed to 1500 r.p.m. Remove and replace the motor (Cat 5.2).
22	Noisy pump only	Cavitation in the pump from restriction in the suction hose	Clean the suction filter and replace the element. Clean dirt etc out of the suction hose
23		Pump shaft running too fast	Reduce engine speed to 1500 r.p.m.
24		Pump sucking in air at the pump shaft	Renew pump
25		Pump sucking in air through loose fittings	Tighten fittings as necessary
26		Pump sucking in air because oil level is too low	Check level indicator at tank and, if necessary, add oil to correct level Check all hoses and seals etc for leaks and replace as necessary (Cat 5.2)
27		Mechanical wear in pump	Remove and replace the pump (Cat 5.2)

(Contd)

TABLE 2 - WINCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
28	Motor noisy and jerky with foam in the oil tank	Air in the system caused by suction hose restriction or leakage	Clean out or replace suction hose (Cat 5.2)
29	Reduced pulling power at winch	Insufficient oil flow to motor	Increase engine speed to 1500 r.p.m.
30		Oil level too low	Check level indicator at tank and, if necessary, add oil to correct level Check all hoses and seals etc for leaks and replace as necessary (Cat 5.2)
31		Suction filter clogged	Clean the suction filter and replace the element
32		Cable to valve spool adjustment incorrect	Check and adjust (Cat 5.2)
33		Pressure relief valve operating at less than 54 bar as a result of spring settlement over a period of time	Reset valve to operate at 54 bar (Cat 5.2)
34		Mechanical wear in motor or pump	Carry out procedures of Test 2, Para 11 and/or Test 3, Para 12 to isolate failure to motor or pump. Remove and replace motor or pump as necessary (Cat 5.2)
35		Control valve spool worn	Remove and replace the control valve (Cat 5.2)
36	Overrun of rope when pulling from drum by hand (dog clutch disengaged)	Pad brake failure	Adjust or replace pad brake (Cat 5.2)

(Contd)

TABLE 2 - WINCH FAILURE DIAGNOSIS (Contd)

Serial No	Symptom	Possible cause	Action
(1)	(2)	(3)	(4)
37	Rope not spooling smoothly	Fairlead rollers seized	Apply grease and free rollers
38		Fairlead rollers distorted and jamming	Replace rollers (Cat 5.2)
39		Rope in radial twist	Lay out complete length of rope in straight line and apply a light load