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Australian Institute for  
Disaster Resilience

**Skills for  
Emergency  
Services  
Personnel**

**Manual 8**

**Four-Wheel-Drive  
Vehicle  
Operation**



**AUSTRALIAN EMERGENCY  
MANUALS SERIES**

**PART IV  
Skills for Emergency Services Personnel**

**Manual 8**  
**FOUR-WHEEL-DRIVE  
VEHICLE OPERATION**

**EMERGENCY MANAGEMENT AUSTRALIA**



## Australian Government

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### Attorney-General's Department

#### Emergency Management Australia

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**NOTE: Expansion of the Australian Emergency Manuals series**

In August 1996 the national emergency management principles and practice advisory group agreed to expand the original AEM series to cover a comprehensive range of emergency management principles and practice publications. The new series incorporates the 20 original AEMS as part IV of a five-part structure as follows:

- PART I — The Fundamentals
- PART II — Approaches to Emergency Management
- PART III — Emergency Management Practice
- PART IV — Skills for Emergency Services Personnel
- PART V — The Management of Training

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Manual 2 OPERATIONS CENTRE MANAGEMENT A

Manual 3 LEADERSHIP A

Manual 4 LAND SEARCH OPERATIONS (2nd edition) A

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Manual 6 GENERAL RESCUE (4th edition) (formerly Disaster Rescue) A

Manual 7 MAP READING AND NAVIGATION (Amendment 1 1997) A

Manual 8 FOUR-WHEEL-DRIVE VEHICLE OPERATION  
(Amendment 1 1997) A

Manual COMMUNICATIONS (2nd edition) R

## **PART V**      *The Management of Training*

Manual 1 TRAINING MANAGEMENT (2nd edition) R

Manual 2 EXERCISE MANAGEMENT D

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## **AMENDMENT LIST**

## **FOREWORD**

THE PURPOSE OF THIS MANUAL IS TO PROVIDE A BASIC REFERENCE FOR FOUR-WHEEL-DRIVE VEHICLE OPERATION. IT IS INTENDED FOR USE IN PLANNING, TRAINING AND OPERATIONS BY ALL RELEVANT EMERGENCY/DISASTER RESPONSE PERSONNEL AND ORGANISATIONS.

THIS MANUAL HAS BEEN DEVELOPED BY A NATIONAL WORKING PARTY REPRESENTATIVE OF STATE AND TERRITORY EMERGENCY SERVICES. THE WORKING PARTY WAS INITIATED AND SPONSORED BY EMERGENCY MANAGEMENT AUSTRALIA (FORMERLY THE NATURAL DISASTERS ORGANISATION).

THE WORKING PARTY THANKS THE FOLLOWING ORGANISATIONS AND ACKNOWLEDGES THEIR PUBLICATIONS AS REFERENCES IN THE PREPARATION OF THIS MANUAL: FORESTRY COMMISSION OF NSW—THE GLOVEBOX GUIDE TO 4 WHEEL DRIVING (B.R. KESTEL); TELECOM AUSTRALIA—FOUR-WHEEL-DRIVE VEHICLES, DRIVERS HANDBOOK; SOUTH AUSTRALIAN POLICE DEPARTMENT—DRIVER TRAINING COURSE NOTES AND AUSTRALIAN ARMY SCHOOL OF TRANSPORT DRIVER TRAINING—COURSE NOTES.

THIS MANUAL IS ISSUED IN LOOSE-LEAF FORM TO FACILITATE AMENDMENT AND INSERTION OF INDIVIDUAL ORGANISATIONAL SUPPLEMENTS.

AS SITUATIONS CHANGE AND IMPROVED TECHNIQUES ARE DEVELOPED, THE FOUR-WHEEL-DRIVE VEHICLE OPERATION MANUAL WILL BE REVIEWED AND UPDATED BY THE NATIONAL WORKING PARTY.

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# **CHAPTER ONE**

## **INTRODUCTION**

### **GENERAL**

- 1.01** Australia is a vast and rugged country providing a wide range of driving conditions. The regular requirement for use of four-wheel-drive (4WD) vehicles as ground transport necessitates that their drivers are proficient in safe 4WD operating techniques.
- 1.02** The purpose of this manual is to provide sound reference material for both operations and training.
- 1.03** The principles of 4WD operation are the same for all 4WD/6WD vehicles, regardless of what size or type. The driver is responsible for the safety of the vehicle, passengers, cargo, and for ensuring road worthiness of the vehicle and its safe operation.

### **WHAT IS FOUR-WHEEL-DRIVE?**

#### **1.04 IMPORTANT DIFFERENCES**

There are a number of important differences between a normal car and a 4WD vehicle. The 4WD is usually about the same weight as an ordinary vehicle but has a higher centre of gravity, so it is less stable. It may have a shorter wheelbase and/or larger turning circle. The tyre size and tread pattern may be more suitable for off-road conditions than for sealed roads. The two driving axles and transfer case allow the use of high or low ratio and four-wheel-drive. All these differences go to make up a vehicle that requires special handling skills. The art of successful four-wheel-driving takes practice and skill and comes with experience.

- 1.05** 4WD means that four road wheels provide traction for the vehicle. 4WD is often selectable but in some cases all wheels provide drive all the time (constant 4WD—Range Rover for example). In most cars, only two wheels provide traction and the others 'freewheel'. In the past, the driving wheels were usually the rear wheels but now front wheel drive is common. Most 4WD vehicles have stayed with traditional rear wheel drive in normal situations and front wheel drive being selectable by the driver as conditions require. To reduce wear, noise and fuel consumption 4WDs are often fitted with freewheeling hubs on the front wheels.

### **GENERAL PRINCIPLES OF FOUR-WHEEL-DRIVING**

- 1.06** The following general principles apply to Four-Wheel-Drive Operation:
- a. Think before you act.
  - b. Get out and physically check the obstacle before committing yourself to crossing it. Assess the situation and plan your action.

- c. The first attempt at crossing an obstacle is usually the best, especially in muddy or slippery conditions.
- d. Select a suitable gear **before** attempting the obstacle.
- e. Changing gear in the middle of an obstacle may cause wheel spin and thus loss of traction.
- f. In difficult conditions, allow vehicle to inch along, finding its own way purely with THROTTLE CONTROL ie engine revs at idle speed or just above idle speed, no clutch or brakes.
- g. Don't over-rev the engine. Use only the amount of engine torque needed for the job.
- h. To overcome wheel spin, decelerate.
- i. When braking don't lock up the wheels. If wheels do skid ease off the brakes until traction is regained.
- j. When two or more vehicles are travelling in convoy, cross an obstacle one at a time.

## HOW DOES IT WORK?

**1.07** Power from the engine is delivered to a gearbox assembly via a normal dry clutch system. From the gearbox output power is delivered to a 'transfer case', basically a supplementary gearbox having a neutral and two selectable gear ratios of commonly 1 is to 1 (high range) and 2 is to 1 (low range) plus a means of engaging drive to both axles. From the transfer case, drive is divided with shafts transmitting the power to the rear axle and front axle (if 4WD is engaged). By selecting low range, the gear ratio is increased providing high torque and slow speed operation. This is used for climbing and descending steep hills or when negotiating difficult terrain.

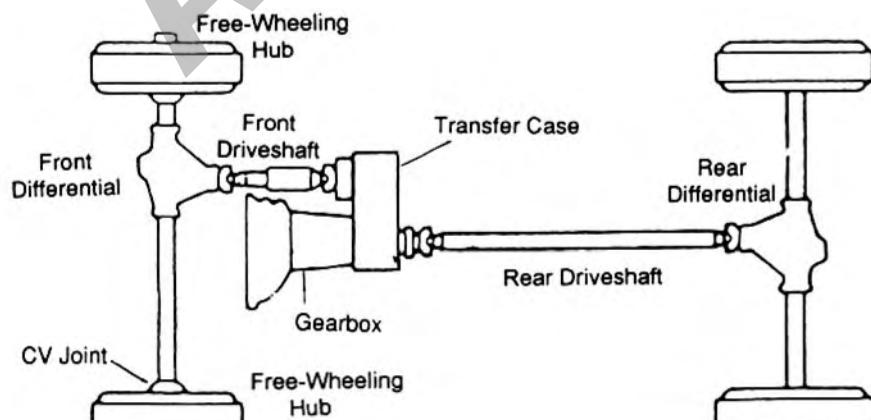


Figure 1:1 4  
WD Drive Train

## WHEN IS IT USED ?

- 1.08**
- a. Cross-country driving where maximum traction is required.
  - b. Negotiating very steep hills, (up or down).

- c. Negotiating short vertical rises (either up or down).
- d. Crossing soft terrain, mud or sand.
- e. Water crossings.
- f. Towing in slippery conditions.
- g. Launching and retrieving boats on steep boat ramps or improvised sites.
- h. Extreme winter conditions—ice and snow.

## **1.09 HIGH AND LOW RANGE FOUR-WHEEL-DRIVE USE**

4WD high range (H4) should only be used when additional traction is needed to negotiate adverse surfaces. Low Range (L4) should be used when the terrain is steep, low speed operation is essential for safety and/or maximum traction is needed. The best way to negotiate most adverse terrain is slowly.

## **WHEN NOT TO USE FOUR-WHEEL-DRIVE**

- 1.10** 4WD should not be selected (unless the vehicle is fitted with constant four-wheel-drive) in any situation where a normal car can travel with ease , for example, sealed roads or roads with a hard-packed surface.

## **IMPORTANT COMPONENTS**

### **1.11 CLUTCH**

Whenever possible do not ride the clutch; take your foot off the clutch and use minimum accelerator, or none at all.

### **1.12 GEARBOX**

Modern 4WD vehicles are fitted with either a four or five speed manual gearbox which is generally synchromesh on all forward gears and operate in the same manner as that of a normal car. They have a direct action floor mounted shift lever to ensure positive engagement of gears. The reverse gear is open mesh and the vehicle must be stationary before selecting this gear. Automatic Transmissions are also available but are not in common use by emergency services and are generally not recommended for emergency service work.

### **1.13 TRANSFER CASE**

The transfer case with its neutral, high and low ratio selection and choice of two or four-wheel-drive is generally operated by a floor mounted lever. This lever is normally located near the gear lever. It has four positions:

- H2 — High ratio, two wheel drive
- H4 — High ratio, four-wheel-drive
- N — Neutral [for power take off use]

#### L4 — Low ratio, four-wheel-drive

- 1.14 A shift between H2 AND H4 can be made at any speed below 50 km per hour, in any gear. Ensure the freewheeling hubs are at LOCK when 4WD is engaged. To shift between H4 and L4 or L4 and H4 the vehicle should be stationary.

#### 1.15 TYRES

4WD vehicles may be fitted with off-road tyres. These tyres are self cleaning, the tread pattern is designed to throw off mud when the tyre is rotating. The tyres are also designed for maximum traction. The condition and type of the tyres greatly affects the vehicles ability to climb hills, its traction, and the amount of wind-up that occurs. Special purpose off-road tyres are designed to meet specific terrain conditions, however, there are also some good all purpose off-road tyres on the market. It is most important that all four tyres on a 4WD vehicle be the same make and tread pattern, at the same stage of wear and inflated to the same pressure.

#### FREE-WHEELING HUBS

- 1.16 Vehicles can be fitted with free-wheeling hubs to reduce noise and wear, and improve fuel consumption. However, you must ensure that both hubs are locked in position before selecting 4WD. Free-wheeling hub selectors are located at the centre of the front wheels and have two distinct positions (Commonly marked LOCK and FREE). In the LOCK position, the axle is connected to the wheels by a dog clutch system enabling power to be delivered to the wheels when 4WD is selected. (See Figure 1:2).
- 1.17 When placed in the FREE position, the dog clutch is disengaged and the wheels rotate independent of the axle. This allows the front drive shaft, differential and axle to remain stationary for highway travel.

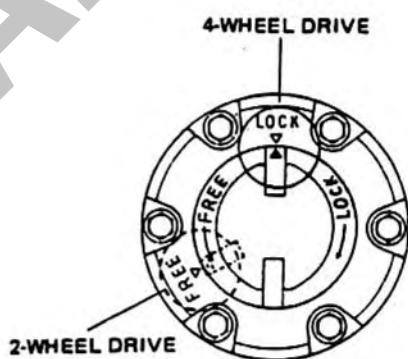


Figure 1:2  
Free-Wheeling Hub

#### 1.18 USAGE PRACTICES

Free-wheeling hubs need to be engaged periodically to 'work' the gear train and agitate the differential lubricant (refer to the manufacturers handbook for details). During field operations it is best to leave the free-wheeling hubs in LOCK unless travelling more than 50 kilometres on sealed or surfaced roads.

## **1.19 PRECAUTIONS WHEN SELECTING FOUR-WHEEL-DRIVE**

Ensure that the free-wheeling hubs are locked in before selecting 4WD. It is a good practice to lock the free-wheeling hubs when you anticipate 4WD may be needed.

## **POWER TAKE-OFF OPERATION**

- 1.20** Some vehicles are fitted with a special attachment to the transfer case that allows ancillary equipment, such as a winch, to be driven by the vehicle engine. This attachment is called a 'power take-off' (PTO). To engage the PTO refer to the manufacturers handbook.

## **TRANSMISSION WIND-UP**

- 1.21** Because there is normally no differential (place of slippage) between the front and rear axles, in most 4WD's, stresses are built up in the transmission when 4WD is used on hard surfaces. This stress is due to the minor relative differences in rotation between the front and rear wheels. The build-up of this stress is known as transmission wind-up and can lead to steering difficulties and in extreme cases cause mechanical damage.

## **1.22 MAIN SYMPTOMS**

At low speeds wind-up can be absorbed partially by tyre flex. At high road speeds wind-up cannot be absorbed, and will lead to steering difficulties, rapid tyre wear and eventually mechanical damage. The two main symptoms of severe wind-up are:

- a. steering difficulties (steering becomes very 'heavy' and difficult to turn and may 'kickback'); and
- b. difficult selection back into two-wheel-drive.

## **1.23 REMEDIES**

Once wind-up has occurred, the two recommended methods of releasing stress in the drive line are to:

- a. reverse, when safe to do so, for a short distance whilst applying pressure to the transfer lever towards 2WD; or
- b. drive with one side of the vehicle on loose ground for a short distance, thus allowing a wheel to slip.

## **AXLE TWIST**

- 1.24** This occurs when a driving wheel sinks into soft ground, or drops into a hole, causing the diagonally opposite driving wheel to lift thereby losing traction. This situation does not occur when a vehicle is fitted with a limited slip differential or differential locks.

## TERMS AND DEFINITIONS

Following is a list of terms and definitions for 4WD vehicle operation:

- a. **Anchor**—A fixed strong point used in a recovery system.
- b. **Bull (or Brush) Bar**—A protective device fitted to the front of a vehicle. Designed to protect from minor impact. It is not an anchor.
- c. **Decline**—Ground sloping down from a reference point.
- d. **Degrees (of Slope)**—The angle of terrain relative to the horizontal.
- e. **Free-wheeling Hubs**—Mechanical devices fitted to the front axles of a 4WD which enable disengagement of drive between the wheels and the axles.
- f. **Ford**—A negotiable water crossing.
- g. **Gradient**—The angle of a slope expressed as a ratio between the horizontal and vertical planes. A 45 degree slope would be expressed as a gradient of 1:1.
- h. **Hand Throttle Start**—A technique used for uphill starts in steep country.
- i. **High Centring**—A condition where ground obstacles strike underparts of the vehicle, which may result in the vehicle getting stuck on an obstacle.
- j. **Horse Power**—Engine output power expressed in kilowatts.
- k. **Incline**—Ground sloping upwards from a reference point.
- l. **Key Start**—Initiating downhill vehicle motion by engaging the starter motor while the gears and clutch are engaged.
- m. **Low Range**—Selectable low gear ratio usually of 2:1.
- n. **Payload**—Carrying capacity of a vehicle.
- o. **Pay-Out**—Extend a winch rope.
- p. **P.T.O. (Power Take-Off)**—A mechanical device designed to transmit engine power to ancillary equipment, eg, a winch.
- q. **Recovery**—Retrieving a vehicle from a disabled or unsafe position.
- r. **Reel-In**—Wind in a winch rope.
- s. **Torque**—The twisting force exerted by the engine. Maximum torque generally occurs between one half and two thirds rated RPM.

- t. **Transmission Wind-Up**—Transmission stress caused by operating in 4WD on hard surfaces.
- u. **Wheel Chains**—A chain web which is fitted to the wheels of a vehicle to assist with traction.

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## CHAPTER TWO

### ATTITUDE AND SAFETY GENERAL

- 2.01** Driver attitude plays an important role in all driving. Improvement of the attitude of emergency service drivers should not be necessary as they should set a driving example for the general public.
- 2.02** Driver attitude is the mental or emotional regard for self, for others, for the vehicle and for prevailing conditions. A driver with a poor attitude usually looks for so-called 'legal' reasons why the other person, the vehicle, or driving conditions are wrong. Attitudes are not inborn but are created and, therefore, can be corrected.

#### **2.03 ATTRIBUTES**

The following is a list of good attributes for a driver:

- a. **Skill** — will develop with practice.
- b. **Knowledge** — of relevant laws, organisational policy/rules, rules for safe handling and mechanical maintenance.
- c. **Correct Attitude** — an attitude is an overall, learned core disposition that guides a person's thoughts, actions and feelings. — attitudes are learned and therefore can be changed.

- 2.04** The following is a list of dangerous attitudes for a driver:

- a. Self-righteousness.
- b. Impatience.
- c. Casualness.
- d. Recklessness.
- e. Aggressiveness.
- f. Over-confidence.
- g. Inattentiveness.
- h. Ignorance.

#### **2.05 DEFENSIVE DRIVING**

Professional drivers adhere to the defensive driving code which is listed below:

- a. Drive without having a preventable accident.

- b. Have a knowledge of and adjust driving with regard to hazardous, abnormal, unusual or changing conditions, mechanical functioning, road surface, weather conditions, visibility, traffic and your physical and mental state.
- c. Have knowledge of, and observe all traffic laws.
- d. Be alert to the actions of other drivers and road users and make necessary adjustments to avoid potential accidents.
- e. Be confident.

## A DRIVER'S ATTITUDE TO FOUR-WHEEL-DRIVING

### 2.06 LIMITATIONS

There are definite limits to where a 4WD vehicle can be taken. They depend on both the operator's ability and the vehicle's capability. Before driver's attempt to negotiate difficult terrain, they must first ask themselves these questions:

- a. Do I have to go there?
- b. Is the vehicle capable of going there?
- c. Am I capable of driving the vehicle there?

The correct answers are entirely up to the individual. If all three answers are 'yes', then the chances of a successful and safe crossing are good. But should the driver attempt to cross a difficult piece of terrain without first giving any thought to how it can safely be crossed, the chances of getting into trouble are high!

### 2.07 ENVIRONMENTAL RESPONSIBILITY

The potential danger of damage caused by driving off-road vehicles in environmentally-sensitive areas is great:

- a. Be considerate of others, and respect their rights to peace and solitude.
- b. Stay on the roads or tracks wherever possible. Resist the urge to make your own tracks.
- c. Minimise disruption to stock and wildlife.
- d. Help keep the Australian landscape free from rubbish; take your rubbish home with you.
- e. Leave gates as you find them.
- f. Take particular care when operating on access roads and tracks at times when boggy or slippery conditions exist. Your forced access may prolong the time the road is closed.

## **2.08 DRIVING POSITION**

Safe operation of a 4WD commences with the driver correctly sitting:

- a. Adjust your seat slightly forward of your normal position; this enables you to see the ground closer to the front of the vehicle. This also allows better control in difficult terrain.
- b. Ensure that you can fully de clutch.
- c. Adjust the seat back to enable you to sit up as straight as possible.
- d. Fit your seat belt. (Be aware of the potential for inertia seat belts to lock when used in conjunction with pneumatic seats).
- e. Whenever possible keep both hands on the steering wheel.
- f. Keep your thumbs on the outside of the steering wheel, otherwise a broken thumb can result.
- g. When operating in scrub or timbered areas it may be necessary to keep the windows up to prevent branches protruding into the vehicle.

## **VEHICLE FAMILIARISATION**

### **2.09 DAILY INSPECTION**

Before driving any vehicle complete a daily inspection. It helps identify the differences between makes and types and identifies the ancillary equipment. Obtain a copy of your organisations approved inspection check list.

### **2.10 CABIN CHECKS**

Carry out cabin pre-drive checks such as:

- a. seat adjustment;
- b. rear view mirror correction;
- c. locate and identify all instruments, controls and switches; and
- d. ensure all services (brakes, steering, etc), operate correctly while driving in first gear and within the first few metres of motion.

## **PERSONAL SAFETY**

- 2.11** In order to prevent personal injury—when operating in or around 4WD vehicles—care must be exercised to ensure rings are removed from fingers. If it is not possible to remove a ring, tape should be wrapped over it to give a 'snag free' surface. Other items of jewellery, neck ties/scarves, long hair etc can also be hazardous.

## **FUEL**

### **2.12 RESERVE ALLOWANCE**

Consideration should be given to the amount of fuel that may be required for a trip. Don't assume that because you can get there on half a tank of fuel that you will be able to get back on the other half a tank. A rule of thumb is to allow one third of a tank to get there, one third to return and one third reserve.

## **2.13 CONTAINER SAFETY**

Where it is necessary to carry extra fuel it must only be carried in approved containers. Wherever possible, spare fuel should not be carried inside the passenger compartment of the vehicle.

- 2.14** When fuelling a vehicle from drums be aware of the danger of static electricity. Also, open drums carefully as pressure may have built up inside.
- 2.15** When storing fuel beware of the possibility of water entering the fuel and/or condensation building up inside the drum.

## **NIGHT OPERATIONS**

- 2.16** Off road operation of a 4WD during the hours of darkness demands great concentration and the exercise of extreme care if it is to be achieved safely.

## **2.17 LIGHTING**

Consideration should be given to problems created to vision and where necessary, headlighting may need to be increased or reduced, guides posted, or reflectors positioned to enable tracking across difficult terrain.

- 2.18** When operating with other vehicles during darkness, additional distance should be kept between vehicles to allow for sudden changes in speed etc of the lead vehicle.

## **REVERSING/MANOEUVRING**

### **2.19 USE OF GUIDES**

When reversing/manoeuvring in confined spaces, dangerous areas and amongst crowds, position a person to act as a guide. In such situations, one should consider:

- a. using experienced guides if possible;
- b. using pre-arranged signals;
- c. positioning guides where they can be easily seen; and
- d. if not satisfied with the situation, stop and re-assess it yourself.

- 2.20** Where a guide is not available consider moving to a better area before manoeuvring if possible; if not, get out and check the area, marking it if necessary.

## **USING VEHICLES FOR PROTECTION**

**2.21** Consideration should be given to ways the vehicle can be used for personal protection. Even a disabled vehicle can offer a degree of protection and the vehicle should not be abandoned without careful consideration. The following are some factors to bear in mind:

- a. The vehicle contains a range of equipment including personal and safety equipment.
- b. A vehicle will provide protection from the elements eg cold, sun, bushfire radiant heat etc.
- c. A vehicle using warning lights can also be used for protection from oncoming traffic etc at the site of an incident.

## **OTHER SAFETY CONSIDERATIONS**

**2.22** Other safety points to consider include the following:

- a. Check your radio operation and arrange radio schedules where necessary.
- b. If likely to be out of radio range, tell someone where you are going and nominate a time after which a search should be considered if you have failed to return.
- c. Carry appropriate maps of the area.
- d. Carry appropriate equipment (see Chapter 5—Equipment).

## CHAPTER THREE

### VEHICLE SERVICING, MAINTENANCE AND EQUIPMENT

#### SERVICING AND MAINTENANCE

**3.01** Regular servicing and maintenance of 4WDs is even more important than it is for highway vehicles if a relatively trouble free life is to be expected. In addition there is the need to ensure all service equipment such as brakes, steering and fitted accessories operate at peak performance when needed in adverse off road situations.

#### **3.02 REGULAR INSPECTION**

A competent 4WD operator must have the right attitude towards servicing and maintenance. Servicing includes the regular inspection of the vehicle, and all ancillary equipment usually on a daily basis, for obvious faults and the replenishment of consumables such as fuel, oil and water.

#### **3.03 MAINTENANCE CATEGORIES**

- a. **Preventative (Scheduled)** —This type of maintenance is generally set by the manufacturer or the organisation and prescribed in terms of kilometres run or as elapsed calendar time.
- b. **Corrective** —This maintenance is carried out as a result of component failure, such as changing a flat tyre.

**3.04** Regular maintenance will reduce total maintenance costs and protect you against mechanical failure. The right attitude towards servicing your 4WD vehicle is important.

#### **3.05 FREQUENCY**

Carry out servicing on time and in accordance with the manufacturer's recommendations.

#### **3.06 CLEANLINESS**

Keep clean any utensils used for handling oils. Wipe grease nipples before and after greasing. Make an effort to ensure that bulk oils and grease are not contaminated by dust or dirt.

#### **3.07 THOROUGHNESS/CHECKS**

Have any defects repaired and worn parts replaced. Don't allow small problems to develop into major trouble when you least want it.

**3.08** Drivers of emergency vehicles should ensure that the following checks are carried out after use, so that the vehicle is again ready for immediate operation:

- a. Check oil level in engine crankcase.

- b. Check coolant level in radiator (header tank).
- c. Check brake and clutch fluid.
- d. Check water level in windscreen washer reservoir.
- e. Check fuel level.
- f. Clean windscreen.
- g. Check all lights: head, spot, tail, stop, interior and traffic indicators, etc.
- h. Walk around the vehicle, looking for damage or missing components.
- i. Check tyre pressures and look for cuts and embedded nails, etc.
- j. Check winch and other ancillary equipment.

For all other servicing details refer to the manufacturers handbook.

## **EMERGENCY REPAIRS**

- 3.09** In the event of a mechanical breakdown you should use your normal organisational procedure to have the vehicle repaired and/or recovered. Where there is no alternative, the following points may help. **It is stressed that the following procedures should only be used as a last resort and after consulting the manufacturers handbook. They should be regarded as temporary measures only.** Before attempting any emergency repairs, stop , and consider all the options.

## **SAFETY POINTS**

### **3.10 RADIATOR CHECKS**

It is preferable to allow the engine to cool as much as possible before removing the radiator cap but, if it is necessary to remove it while the engine is still hot, do so slowly to release pressure, using a cloth or glove to protect your hand.

### **3.11 JACKING**

It is not safe to work under a vehicle which is only supported by a jack. Support the vehicle with axle stands or solid blocks and ensure the wheels are chocked. It is also important to chock the wheels where there is any risk of the vehicle moving.

## **FUEL SYSTEM**

### **3.12 WATER IN PETROL**

If the engine stops running due to water in the petrol, drain the water from the carburettor, fuel bowl and if possible fuel tank. Methylated spirits will absorb water in petrol. Pour the methylated spirits into the fuel tank. Approximately one litre is sufficient for a full tank of fuel.

### **3.13 DIRT IN PETROL**

If the fuel in the tank of a petrol vehicle is so dirty that stoppages are frequent, disconnect the fuel line from the fuel pump. Blow into the fuel tank through filler hole. This may expel the dirt out of the fuel line. If no fuel flows from the fuel line, the line is blocked. It may then be necessary to blow the line back towards the fuel tank. Ensure that no fuel is swallowed as this can result in internal injuries.

### **3.14 LEAKING FUEL TANK**

A small leak can be temporarily repaired by smearing soap into the hole. A sharpened stick, smeared with soap and driven into the hole may block the hole. A self-tapping screw with fibre washer may also be tried.

## **ELECTRICAL SYSTEM**

### **3.15 BROKEN/FAULTY HIGH TENSION COIL/DISTRIBUTOR LEAD**

Replace with a spark plug lead. The engine will still run but will miss on one cylinder. This will get you home.

### **3.16 JAMMED STARTER MOTOR**

To release select top gear rock the vehicle back and forth until the pinion releases itself.

### **3.17 WORN BATTERY TERMINALS**

If a battery terminal is damaged or worn so badly that the battery lead clamp cannot be properly tightened and electrical contact cannot be made remove the clamp and wrap a thin strip of brass or tin around the terminal and replace the clamp. If this does not work, try placing a piece of metal (nail) between the battery lead clamp and the terminal post before tightening.

## **COOLING SYSTEM**

### **3.18 BROKEN FAN BLADE**

If the blade can be removed, detach it and the blade opposite. Fans with an odd number of blades will need to be removed altogether as they will be out of balance.

### **3.19 RADIATOR LEAKS**

Small leaks in a radiator can be temporarily stopped by using one of the many commercial radiator sealants. The filler cap can be left off to reduce the pressure within the cooling system. Leaking radiator tubes can be stopped by crimping the tube's ends, using pliers. Epoxy glues can also be applied externally to the leaking area and allowed to dry.

### **3.20 LEAKING RADIATOR HOSE**

Adhesive or insulating tape can be wound around the leaking hose. Strips of cloth, smeared with soap, tightly wrapped may also be used. The radiator cap can be left off to reduce water pressure.

### **3.21 BROKEN HOSE CLIP**

Wire can be used to clamp the hose ends. A few turns around the hose end and tightened with pliers will usually do the job.

## **AXLES AND WHEELS**

### **3.22 BROKEN WHEEL STUDS**

If all wheel studs of a wheel have been sheared off, then remove one stud from each of the other three wheels and fit to the disabled wheel hub. Drive carefully.

## **EN ROUTE CHECKS**

- 3.23** When operating off road it is important to periodically check the vehicle. To avoid potential problems, regularly check:
- for damage (especially tyre damage/pressure);
  - for snags eg, branches, wire, etc;
  - for build up of grass etc around exhaust system;
  - security and condition of loads;
  - for rocks lodged between dual wheels;
  - engine temperature, oil pressure, fuel levels, etc; and
  - radio operation.
- 3.24** Before leaving off-road conditions it is important to check that the vehicle is roadworthy and safe to drive at normal road speed/conditions. It may be appropriate to check the above points. It may be also be appropriate to clean and check operation of lights and lenses, clean windows and unlock freewheeling hubs.

## **EQUIPMENT**

- 3.25** A list of equipment appears at Annex A to Chapter Three. This shows equipment that should normally be carried and also lists equipment that may need to be carried in particular situations. The list is not exhaustive and does not attempt to cover specialist emergency service equipment that may also need to be carried.

### **3.26 SAFETY**

For detailed instructions on the safe use of particular items of equipment refer to the manufacturers instructions. General safety information relating to recovery equipment is included in Chapter 7—Recovery.

## EQUIPMENT LISTS

<b>a. Suggested Normal List</b>	<b>b. Tools</b>
Spare fan—ancillary belts Manufacturers handbook Torch Spare wheel Fire extinguisher Jumper leads Spare fuses Tie wire Toilet paper First aid kit Drinking water Protective goggles Leather gloves	Plug spanner Wheel brace Tyre pump Jack C.W. base plate Insulating tape Cake of soap Spanners—socket set Shifting spanner Hammer Pliers—vice grips Assorted screw drivers Bolt cutters WD40 or equivalent Length of plastic tubing
<b>a. Special/Environmental List</b>	<b>b. Recovery Kit</b>
Spare radiator hoses Air filter Fuel filter Additional spare wheel Rope High lift jack Bull bag Wheel chains Shovel Axe Pickets Sledge hammer Ground sheet/radiator blind Chain saw—bow saw Spare fuel and funnel Trailer light adaptors 'D' shackles for trailers	Winch Slings 'D' Shackles Spare shear pins Snatch block Hessian bags

## CHAPTER FOUR

### LOADS AND LASHING

#### **INTRODUCTION**

**4.01** In addition to the operation of a vehicle, drivers have responsibility for the loads they carry. Positioning and securing a load correctly to eliminate loss and or damage requires a combination of common sense and skill by the driver. In order to successfully carry out an assigned task, the driver must adhere to certain basic principles.

#### **RULES OF LOADING**

**4.02** Before loading the vehicle, the driver must check that:

- a. the vehicle is suitable for the load;
- b. the engine is off, handbrake is applied and gears are engaged;
- c. wheels are chocked if necessary; and
- d. suitable packing or tie-downs are available, if required.

#### **PRINCIPLES OF LOADING/CARRYING**

##### **4.03 WEIGHT**

If dealing with heavy articles, ensure that:

- a. the load does not exceed the vehicle capacity;
- b. the load is kept as low as possible by utilising maximum floor area;
- c. the load is secured to prevent movement during transit;
- d. the load is not dropped on the vehicle floor causing damage;
- e. road traffic regulations are complied with in the case of heavy or over-size loads; and
- f. the load is correctly balanced.

##### **4.04 BULK**

In the case of articles which are very bulky for their weight, the tendency is to exceed the vehicles bulk capacity, making the load dangerous or insecure and thereby possibly losing articles during transit. Points to avoid are:

- a. excessive height;
- b. overhanging on sides or at rear; and
- c. insecure loading.

#### **4.05 AWKWARD LOADS**

Loads may have to be carried on a vehicle not designed for the task. These loads may project over the rear and sides making them dangerous to other road users. Points to observe are that:

- a. loads are secure;
- b. loads are evenly distributed;
- c. route checks are carried out for width and height of bridges, cuttings, overhead wires etc;
- d. when possible, travel during quiet periods on roads; and
- e. road traffic regulations governing the operation of over-dimension loads are observed.

#### **4.06 CARRYING PERSONNEL**

State and organisational regulations regarding the transportation of personnel must be adhered to. The driver must consider that personnel being carried may be required to perform when they reach their destination and he/she needs to drive accordingly. In the interests of passenger safety, the following points must be considered. Passengers should not:

- a. stand whilst a vehicle is moving;
- b. sit or stand on the sides or tailgate of a vehicle whilst moving;
- c. be carried in a trailer;
- d. be carried in the rear of a loaded vehicle where there is a likelihood of injuries resulting from movement of the load; or
- e. be carried in the rear of a vehicle carrying dangerous goods.

#### **4.07 CARRYING LIQUIDS**

If liquids are to be carried in containers, check carefully for leaks prior to loading. If carrying bulk liquids in a vehicle not designed for the purpose, ensure that tanks are securely wedged, lashed and chocked to prevent movement, and if possible tanks are more than three quarters full to prevent surge.

#### **4.08 CARRYING VEHICLES**

Check that the vehicle being carried:

- a. has the handbrake on and reverse gear engaged (In park if an automatic);
- b. is restrained appropriately;
- c. has the wheels chocked;

- d. has no personnel riding in it; and
- e. has movable objects secured.

#### **4.09 CARRYING FOODSTUFFS**

When transporting foodstuffs care should be taken to avoid contamination (especially in mixed loads) and damage due to moisture, dust and breakage of containers. Particular care should be taken in the case of perishables.

#### **4.10 CARRYING FUEL, OILS AND FLAMMABLES**

Ensure that containers are stacked according to container design, and examine for leaks during loading. No smoking on or near the vehicle. Personnel should not be carried with this type of load. Vehicles carrying fuels, oils and greases should be parked apart from other transport and should display the necessary warning signs. CH4

#### **4.11 CARRYING DANGEROUS GOODS**

It may at times be necessary to carry dangerous goods. The situation may also arise where a mixed load of individually harmless goods is being carried which has the potential to be hazardous should contents come into contact with each other. Drivers should:

- a. be aware of what is being carried;
- b. consider the potential dangers of a mixed load;
- c. ensure that goods cannot mix during transit;
- d. seek specialist advice if in doubt;
- e. comply with state and organisational regulations relating to the carriage of dangerous goods; and
- f. not carry potentially dangerous loads in vehicle cabins.

#### **4.12 SECURING LOADS**

Vehicle cargo is subjected to severe forces created by deceleration/acceleration, rough terrain, etc. Cargo must therefore be restrained by use of loading boards and anchor points/tie rails on open goods vehicles. In vans, station wagons, etc, fitting of approved cargo barriers or other restraints should be considered.

#### **4.13 Drivers should observe the following procedures when securing loads:**

- a. Pad edges, to prevent chafing and cutting.
- b. When placing chains around the vehicle tray or over a load that could be damaged, use wooden blocks under the chain on the corners.
- c. For safety reasons, whenever possible, stand on the near side of the vehicle to tie the load down.

- d. Do not over-tension tie-downs.

#### **4.14 POSITIONING OF LOADS**

Prior to positioning a load on a vehicle, you should consider:

- a. size and weight of the load;
- b. type of terrain to be negotiated;
- c. position of load in relation to axle weight capacity;
- d. weight on the front wheels for efficient steering; and
- e. anchor points for tie-downs.

#### **4.15 ANCHOR POINTS**

Load anchorage points must be able to cope with the maximum forces likely to be imposed on them.

- 4.16** If carrying loads such as metal bars, beams, pipes, girders, sheets, etc, which are liable to penetrate the vehicle cabin in the event of failure of the securing devices, the headboard must be adequately reinforced.

#### **4.17 CENTRE OF GRAVITY**

It is essential that the centre of gravity (COG) of the load be kept as low as possible at all times. If the main gravitational force acts between the wheels of a vehicle on a slope, the vehicle will not roll over. If it falls outside the wheels, the vehicle may roll over. (See Figure 4:1).

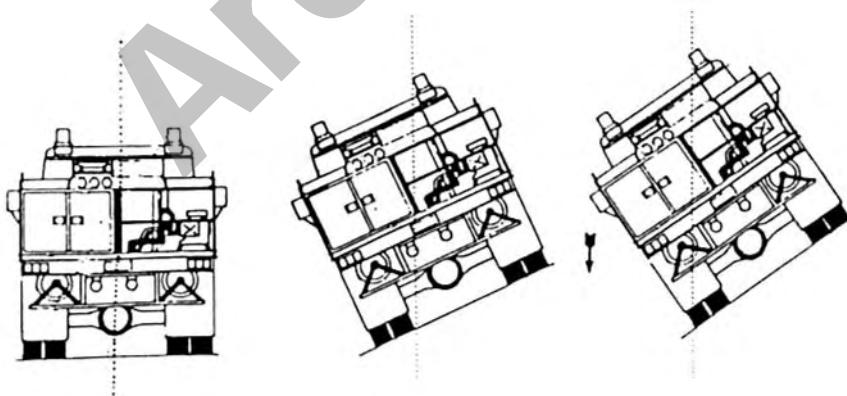


Figure 4:1  
Vehicle Centre of Gravity

### **USE OF ROPES**

#### **4.18 TERMINOLOGY**

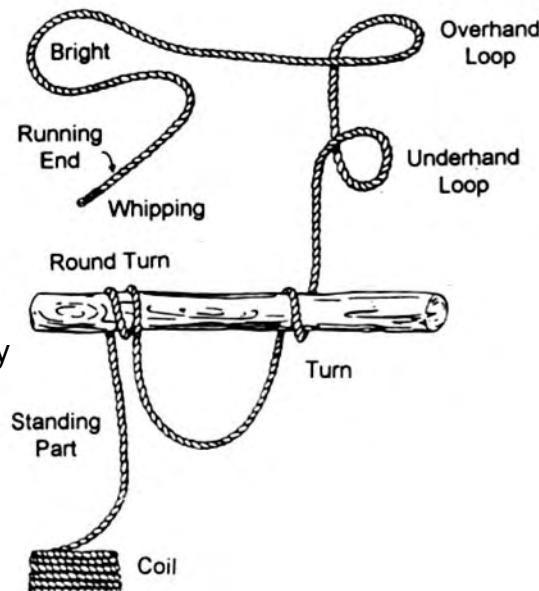
The following is standard rope and knot terminology:

**Anchored**

— Fastened to an immovable object.

<b>Bight</b>	— A simple bend in which the rope does not cross itself (Figure 4:2).
<b>Hauling</b>	— The act of pulling on a rope.
<b>Hitch</b>	— A closed loop on a rope; a simple fastening of a rope around some object by winding and crossing one turn so that one section of the rope bites on the other without actually knotting the rope.
<b>Mousing</b>	— Tying a piece of cord or wire across the jaws of a hook to prevent a rope or sling jumping out.
<b>Parcelled</b>	— When part of a rope is wrapped to prevent chafing.
<b>Paying Out or Easing</b>	— Reducing the tension on a rope so as to allow it to payout or slacken.
<b>Reeve</b>	— The threading of a rope through pulley blocks or snatch blocks.
<b>Round Turn</b>	— One complete turn of a rope round a spar or another rope (Figure 4:2).
<b>Running End</b>	— The free end of a rope (Figure 4:2).
<b>Standing Part</b>	— The part of a rope which takes the load (Figure 4:2).

Figure 4:2  
Rope Parts and Terminology



#### 4.19 INSPECTION OF ROPE

Check the exterior of the rope for:

- broken fibres (abrasions);
- cuts;
- soft spots (a sure sign of wear);

- d. decay or burns (heat and chemical); or
- e. any other deformation or irregularity.

**4.20** Check the interior of the rope for:

- a. broken fibres;
- b. powdering (indicating internal damage or overloading);
- c. dry rot or mildew;
- d. change in colour; or
- e. an odour indicating mildew, rot, etc.

If faults are found after any inspection, the rope should be replaced.

**4.21 CARE AND MAINTENANCE**

- a. Avoid cutting a rope unless it is essential to do so.
- b. Avoid permanent knots. They considerably reduce rope strength.
- c. If possible, avoid dragging ropes on rough or sharp surfaces.
- d. Always use proven knots and fastenings for ropes. Sharp bends or knots can cause some strands to become overloaded.
- e. Use the correct size sheave in pulley blocks. Any attempt to force a thick rope through a smaller block will cause damage.
- f. Avoid sudden jerks or violent stress on the rope.
- g. Avoid stepping or walking on rope as this will introduce damaging grit and dirt into the fibres.
- h. Avoid passing a rope over a sharp edge. If it is necessary to do this protect the rope with sacking or a piece of rounded timber.
- i. Ropes which have been hauled through mud, sand or grit always be cleaned after the work has been completed by thoroughly washing the rope with fresh running water. Do not use any cleaning agent.
- j. Do not dry ropes in front of a fire or other heat source. Spread the rope on a ladder, laid horizontally off the ground, to enable the air to circulate freely around the rope.
- k. Store ropes under cover, off the floor, preferably on racks in a place free from the extremes of temperature and out of contact with materials containing any acid or strong alkali.
- l. Try to keep the area free from rodents.

- m. If a rope has to be stored in an exposed location, cover it with a tarpaulin or some other form of protection.
- n. Replace damaged or defective ropes as soon as possible.

## **STEEL WIRE ROPE**

### **4.22 PRECAUTIONS IN OPERATIONS**

Wire ropes should not be bent sharply at any point. As a general rule the smallest diameter around which a wire rope is to be bent should be approximately six times the circumference of the rope—anything smaller than this will set up undue strain on the rope.

### **4.22 INSPECTION**

- a. Check the shackle used with the rope to see that it has not suffered distortion or strain and that the shackle pin is in good condition and easily screwed 'home' by hand.
- b. Examine the thimble and splice. The splicing cannot be seen as it is covered by the wire binding or 'serving', but if the binding is loose or shows signs of bulging, it is probable that the splice is starting to come undone.
- c. Wearing gloves, work along the rope, a hand's breadth at a time, checking that it is reasonably round, (ie it has not been flattened in use or suffered distortion which causes the wires to open and thus weaken the rope).
- d. Look for broken wires. A broken wire in a rope should always receive prompt attention. Delay may lead to serious accidents and will certainly cause damage to other wires. The method often used to deal with a broken wire, (by nipping it off with pliers) is by no means the best way, for this leaves a small jagged end. To save time and trouble, simply bend the wire backwards and forwards with the fingers until it breaks, or, in the case of a short end, use a piece of wood. In this way, the wire breaks inside instead of outside the rope, and the end is left tucked away between the strands where it can do no harm. CH42
- e. Look for kinks. When a rope has been kinked, the kink may pull out when the wire is stressed and although the rope appears reasonably sound, the structure of the rope has been distorted and damaged. The length affected by the kinking may only be small, but this becomes the weakest part of the rope. The presence of a kink in a rope is best detected when the rope is lying slack on the ground. Rope of any sort found defective should be labelled and placed apart from sound ropes until it can be examined by an expert.

## **SLINGS**

- 4.24** Most modern rescue slings are of the single leg type, with a hook at one end and a ring at the other, or an eye at either end. In all reputable brands the Safe Working Load is clearly marked on an information tag which will also

show safe usage and Australian Standards compliance. This information should be referred to before any slinging is undertaken.

**4.25** The most common types of slings are as follows:

- a. SWR single leg slings with swaged eyes at each end or with a hook at one end and a ring or eye at the other to AS 1666 of 1976.
- b. Superflex high-tensile plaited cable slings to AS 1666 of 1976.
- c. Synthetic webbing slings of single leg or round sling design to AS~`1353 Parts 1 and 2 of 1990.
- d. Polyester round slings with fibre core and braided sheath to AS~`1353.
- e. Polyester laid fibre rope slings to AS 1380 of 1972.
- f. Chain slings of various grades to AS 3775 of 1990.

**4.26 INSPECTION OF SLINGS**

Rescue slings must be inspected regularly, and after each operational use. Where slings are found to be defective they must be immediately withdrawn from service and the record of inspections must be properly maintained.

**4.27 INSPECTION PROCEDURES**

The recommended procedures for performing an inspection are as follows:

- a. Clean each sling prior to its inspection. Dirt will hide defects that may be obvious on clean slings.
- b. Each leg of the sling assembly should be measured to make sure that the length corresponds with the length stamped on the sling ID tag. An increase in length of more than three per cent (3%) indicates possible overload damage to the chain sling or other low elongation sling.
- c. Check each link of a chain sling for excessive wear, twisted or bent links, cuts, nicks, or gouges, and stretched links. If wear exceeds 15 per cent (15%) of the original diameter of the link, the chain should be removed from service. A five per cent (5%) stretch on any link should be considered the maximum allowable.
- d. Inspect master links, couplers, load pins, shackles, swaging and thimbled eye for wear or damage. If wear on any of these components exceeds 15~`per~`cent (15%) of the original materials, remove the sling from service.
- e. Check all stitching or splicing for signs of overload or damage.
- f. If hooks have been stretched out more than 15 per cent (15%) of their original opening width, twisted more than 10 degrees from plane, they should be removed from service.

- g. Attach a 'Danger-Do Not Use' tag to any sling taken out of service, and repair or destroy the sling as soon as possible.

#### **4.28 PRECAUTIONS IN OPERATIONS**

The method of slinging any given object must vary according to circumstances, but the following general rules and precautions should be observed to ensure safe working:

- a. The size and therefore Safe Working Load of the sling will be governed by the weight of the load.
- b. Timber packing must be inserted between the sling and the edges of the load to prevent the sling coming into contact with sharp edges.
- c. Hooks must be moused, preferably with factory-fitted automatic mouses.
- d. Wire rope or chain slings must not be bent around too sharp an angle. To prevent this, packing may be necessary.
- e. Avoid carelessness in hoisting. Particularly avoid shock-lifting or snatching loads.
- f. Slings should not be dragged along the floor or ground and should never be pulled from under a load which, when lowered, rests on the sling. Timber blocks should be placed to receive a lowered load to allow for easy removal of the slings.
- g. A common misconception when slinging, is that if the number of legs in the sling is increased, the Safe Working Load is the safe load on one leg multiplied by the number of legs in use. This is only true when all legs are in the vertical position.
- h. When rigging with two leg slings, or rigging two slings from anchor points to support a load, the angle formed by the legs must not be more than 120 degrees, and should preferably be less than 90~`degrees. The greater the angle, the higher the loading on each leg. (See Figure 4:3).
- i. Slings must never be shortened by knotting, as this will cause excessive stresses, and may result in damage or failure.
- j. Avoid 'tip-loading' of hooks. Open hooks are designed to support the load in the bowl of the hook. Be sure the hook engages freely at the lifting or pulling point so that the load's weight or force acts along the designed line of force in the bowl of the hook. Forcing the hook tip into the pulling point, where the load does not rest in the bowl, may damage and deform the hook, as well as cause complete failure.
- k. Always remove twists from slings before preparing to pull or lift.
- l. A rescue sling will break for one of two reasons: Either the chain was too light for the force applied; or there was a sudden application of a load which, except for the sudden shock, the chain would normally be

able to handle. Always lift or pull slowly to reduce shock-loadings, and use slings of the correct size.

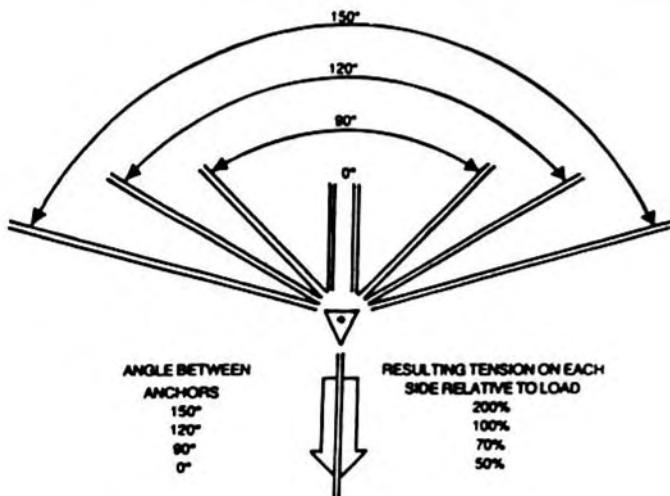


Figure 4:3  
Relationship Between Sling Angles and Tension

#### 4.29 SLING LOADING ANGLES

When the two legs of a sling system form an angle of 120 degrees, each leg is supporting 100% of the load. This is due to the fact that the legs start to pull against one another as the angle increases. Above 120 degrees, the tension begins to increase at an alarming rate. At 150 degrees, the load is 200% of the original load on each leg. (See Figure 4:3 opposite).

- 4.30 Operationally, 90 degrees is a safe relationship between the two legs of the system, and the smaller the angle, the lower the load on each leg. At an angle close to zero (such as when the rope is taken around a pulley) the load on each leg is around 50% of the original load.
- 4.31 This principle for loading angles holds when: using a two-leg sling to support a load; securing a load to two separate anchor points; or constructing a flying fox. It is a direct relationship of load and angle of attachment.

### KNOTS

- 4.32 Drivers should be familiar with the following knots. Knots must always be tied tightly, dressed down and inspected. Remember, a knot that does not look right almost certainly is incorrectly tied.

#### 4.33 THUMB KNOT

The thumb or overhand knot can be used at the end of a rope to stop it passing through a pulley, as a security with knots in synthetic rope or temporarily to prevent fraying of a rope end. The knot is formed by making a loop and passing one end through it.



Figure 4:4  
Thumb Knot

#### 4.34 FIGURE OF EIGHT KNOT

This knot is useful as a stop and is often used to prevent the end of a rope from running through a block. It can also be used to prevent fraying. In general it is more useful than the thumb knot as it is easier to undo. With the rope away from you, take the standing part in the left hand palm upwards and the running part in the right hand. Pass the running end over the top of the standing part making a loop, then carry on with the running end round behind the standing part, over the top then down through the loop which you have formed. Draw the running end tight and the knot should resemble the figure eight.



Figure 4:5  
Figure of Eight Knot

#### 4.35 DOUBLE SHEET BEND

This bend is used for joining natural fibre laid ropes, regardless of diameter. It is made by forming a loop in the thicker of the two ropes and holding this in the left hand. Pass the running end of the other rope up through the loop and around both thicknesses of the thicker rope twice and then under its own standing part without over-riding, so that the running ends of both ropes pass out of the knot on the same side.

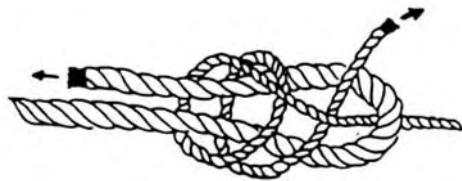


Figure 4:6  
Double Sheet Bend

#### 4.36 DOUBLE FISHERMAN'S KNOT

This knot is the only recommended method of joining synthetic lines and can be used to join together synthetic or natural fibre lines of equal or unequal sizes. Lay both ropes side by side in opposite directions. Make two round turns to the left with the right hand running part and feed the end under the two round turns. Make two round turns to the right with the left hand running end and feed the end through the two rounds turns. Dress and pull tight.

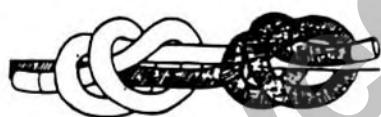


Figure 4:7  
Double Fisherman's Knot

#### 4.37 HALF-HITCH

This is formed by passing the running end of a rope around a spar (or around another rope) and under the standing part, so that, when pulled, one part of the rope binds on the other.

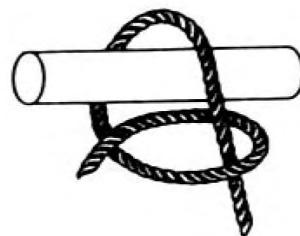


Figure 4:8  
Half-Hitch

#### 4.38 CLOVE HITCH

This knot is useful for securing ropes to tie rails. It can be used in the centre or end of a rope. To tie at the end of a rope (Figure 4:9), pass the running end over the pole, bringing it out underneath the standing part. Pass the running end round the pole again above the first half hitch, bringing the running end under itself to tighten, pulling both the running end and standing

part. When tied thus in the end of a rope, it is a good anchoring knot which is easily untied.

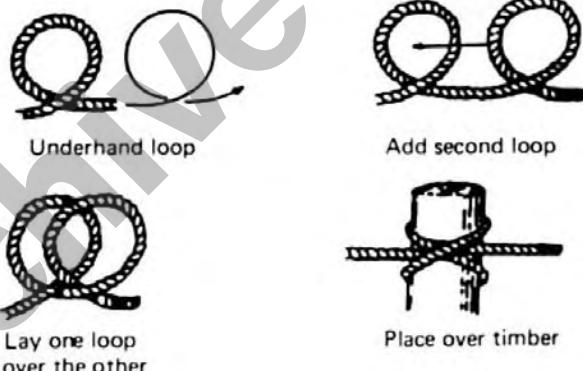
To tie in the centre of a rope (Figure 4:10) two loops are formed. one in the left hand (anti-clockwise) and one in the right hand (anti-clockwise) the latter being passed in front of the left hand loop. Both loops are then passed over the pole and drawn tight.



Figure 4:9



Figure 4:10  
Making a Clove Hitch



#### 4.39 ROUND TURN AND TWO HALF-HITCHES

This knot is used for securing the running end of a rope to a spar or ring. It is formed by a round turn on the spar or ring with two half hitches on the standing part of the rope. It has the great advantage of allowing a load to be adjusted using the round turn, then finally secured by forming the two half-hitches on the standing part of the rope.

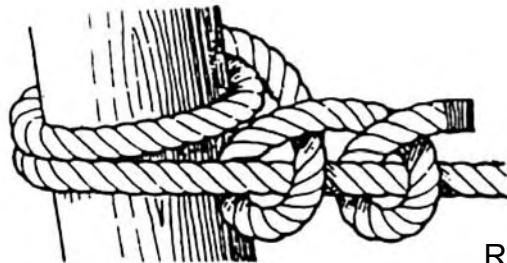


Figure 4.11  
Round Turn and Two Half-Hitches

#### 4.40 TIMBER HITCH

This is a quickly made hitch used to secure a rope to a plank or pole. It is formed by making a half-hitch on the standing part of the rope, leaving a long end which is twisted with the lay for a minimum of three turns around its own part of the hitch. When used for lifting spars, planks or poles, this hitch should be used in conjunction with a half-hitch at the upper end of the spar (Figure~4:13).

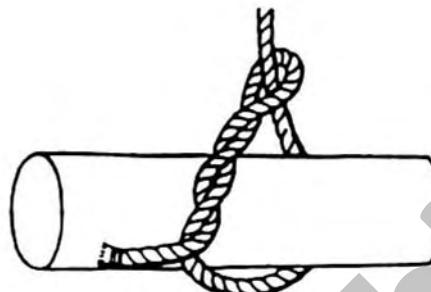


Figure 4:12  
Timber Hitch

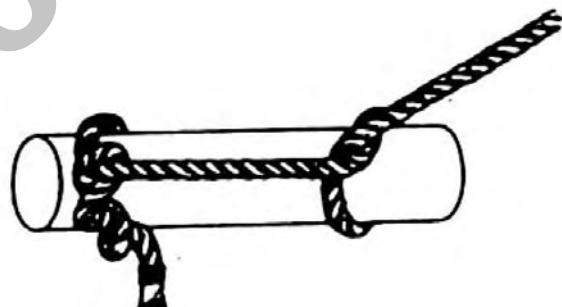


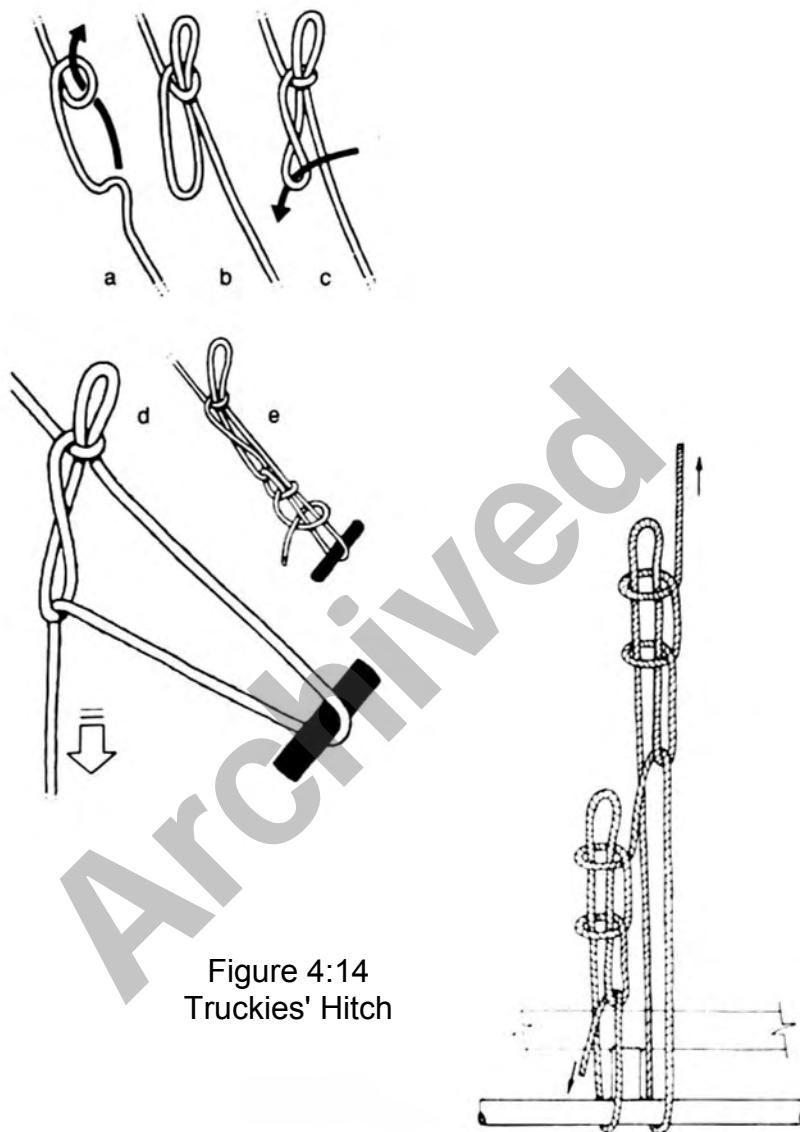
Figure 4:13  
Timber Hitch and Half-Hitch for Lifting Spars

#### 4.41 TRUCKIES' HITCH

This is a most useful knot used to apply tension at a tie down point, commonly employed to secure loads on vehicles:

- a. Make a loop, then further down, towards the end of the rope, make a bight.
- b. Pass the bight through the loop.

- c. Make a twist in the new lower loop. Pass the end of the rope around securing point and up through this twist.
- d. Pull on end to tighten.
- e. With end make two half-hitches around lower ropes to secure. Undo these to adjust and re-tighten.



## TARPING LOADS

- 4.42** Loads may need to be covered with a tarpaulin for protection from the elements or for added security. In order to prevent damage to the tarpaulin and the load the driver should:
- a. envelope ends;
  - b. tie down all ropes;
  - c. tie down so there is no loose or flapping tarpaulin;
  - d. tie down in a manner that the load is protected from the elements; and
  - e. pad sharp corners or edges to prevent rips and tears.

## CHAPTER FIVE

### 4WD TECHNIQUES

#### INTRODUCTION

- 5.01** Before attempting to negotiate difficult terrain, it is essential to first assess the situation. Different types of terrain require different techniques; experience has shown the following techniques are effective. In very rough uneven terrain, use low range 4WD. This will lower speed, reducing the vehicle's bounce, and will give better steering. The following general principles apply to most situations:
- a. Select the appropriate gear before attempting an obstacle.
  - b. Do not change gears whilst crossing an obstacle.
  - c. Drive steadily.
  - d. Keep good throttle control to reduce wheel spin.
  - e. When wheel spin occurs, always decelerate; never accelerate.

#### DRIVING IN MUD AND SAND

##### **5.02 DRIVING IN MUD**

Stop before the mud begins. Physically check the obstacle on foot and decide on the best route.

- 5.03** When driving in mud or slush the most efficient method is to select H4 first or second gear and maintain a constant but moderate speed which will ensure momentum for negotiating the softer sections. Do not exceed about 25 km/hr as the ability to steer the vehicle is greatly reduced. Momentum is more important than power.

- 5.04** Avoid changing gears and revving the engine when traction is lost. If forward progress is halted declutch immediately and select neutral to avoid digging in. Assess the situation. Take appropriate recovery action, do not try to 'spin your way out' as it can cause serious damage to the vehicle, particularly if it is fitted with a limited slip differential. If bogged try rocking the vehicle by alternating between forward and reverse gears.

- 5.05** If the wheels are spinning on a hard, slippery surface, deflating tyres to about 100 kPa (15 psi) often helps to increase traction and assist recovery. The following points should however be noted:

- a. If tyres are deflated, be sure that you can re-inflate them afterwards.
- b. Consider use of chains to provide extra traction, fitting them to all the wheels if possible. If only one pair is available, place them on the front wheels to improve steering as well as traction.

## **5.06 ASCENDING WET SLOPES**

Driving up (or down) hill in wet and muddy conditions is particularly hazardous. Should traction be lost during an ascent, simply use the stall recovery procedure. (See paragraph 5.39). This will enable control to be regained. Avoiding the situation is much better than trying to correct it.

## **5.07 DESCENDING WET SLOPES**

When driving down hill in wet, slippery conditions, select L4 first gear—avoid applying the brakes if possible. Allow the vehicle to descend under engine braking. Changing direction is effected by slight corrections of the steering wheel and a gentle 'stab' of the accelerator. Avoid large steering wheel movement as this often leads to rear end skid and its inherent dangers of roll over.

## **5.08 CONSUMPTION CHECKS**

Watch closely for increases in oil/fuel consumption and coolant temperature in prolonged driving through mud.

## **5.09 DRIVING IN SAND—GENERAL**

As with driving in mud, momentum is more important than power when driving through loose sand. Use 4WD, high range where momentum is required. The two kinds of sand driving coastal (beach) sand; and inland (dune) sand. Each demands similar driving techniques but each have different hazards which need assessment.

## **5.10 DRIVING ON BEACH SAND**

Before driving along a beach:

- a. determine the present tide situation (high or low);
- b. determine when high tide is due;
- c. assess how far up the beach the water will come at high tide; and
- d. assess alternative access points.

**5.11** While driving on a beach stay to the wet sand just above the water line. Do not accelerate or decelerate rapidly as wheel spin can break up the packed sand resulting in bogging. Watch for rocky outcrops and other hazards and soft sand at the mouth of streams.

**5.12** Deflate the tyres to about 100 kPa (15 psi) before driving on soft beach sand. This is often necessary to get on and off the beach. After tyre deflation, restrict speed to 20 km/hr.

## **5.13 DRIVING ON INLAND SAND**

Before driving across inland sand consider:

- a. prevailing winds;

- b. texture of the sand (fine or rough/wet or dry); and
- c. type of vegetation (mallee roots will spike tyres).

**5.14** When crossing sand dunes drive straight up the incline (whenever possible). Stop at the crest and examine your descent path, prevailing winds tend to shape sand dunes like ocean waves and a vertical drop may be obscured.

**5.15** When descending a dune use L4 first gear and steer directly down the incline. DO NOT touch the foot brake. If you need to steer the vehicle use the same technique as used in steering in mud, a small change in steering wheel direction and a sharp, short 'stab' of the accelerator. Minimise steering changes when descending sand dunes as a rear end skid is likely.

## **DRIVING IN WINTER CONDITIONS**

**5.16** Driving on roads covered with snow or ice can be hazardous due to the lack of traction. Great care must be exercised when driving in these conditions.

### **5.17 WINTER DRIVING TECHNIQUES**

Drive slowly. Maintain large distances between vehicles. A four second time gap is recommended when driving in winter conditions so as to ensure sufficient stopping distance.

When driving in winter conditions:

- a. braking can be hazardous. Keep speed to a minimum and brake smoothly;
- b. use accelerator, clutch and steering wheel smoothly;
- c. drive cautiously and be aware that the vehicle could go out of control at any time;
- d. expect other vehicles to go out of control at any time;
- e. for an emergency stop, drive the vehicle into a snow bank or other obstacle;
- f. don't apply the handbrake when parking the vehicle (brakes could seize up due to the cold);
- g. lift windscreen wipers off the windscreen when the vehicle is parked so they don't freeze to the screen;
- h. add methylated spirits to windscreen washer reservoir to avoid the water freezing; and
- i. keep the fuel tank as full as possible (this reduces water condensation).

### **5.18 SLIPPERY SURFACES**

Slippery surfaces can be caused by compaction of the ice or snow. You may also find ice on bridges, in road cuttings, under tree overhangs, in any

shadow or shaded areas or in water run-off areas. Icy surfaces can also be caused by low temperature fog, or rain followed by a frost. Ice on the road can be very difficult to see, drivers therefore need to be aware of potential dangers.

## USE OF CHAINS

**5.19** If chains are required, they should be fitted to all four wheels. If only one set is available then fit them to the front wheels.

### 5.20 DRIVING WITH CHAINS FITTED

Do not use the full extent of the steering lock, as the chains may rub on the guards etc. Drive slowly, and expect the wheels to be out of balance. Chains increase stress to the vehicle's drive line components as they generate shock loading throughout the drive line. Some vehicle manufacturers may void vehicle warranty if chains are used while the vehicle is under warranty, check with your dealer.

## DRIVING IN SNOW

### 5.21 GENERAL POINTS

- a. Assess the situation and check type of snow (wet, dry, ice crust, compacted).
- b. Fit chains. (In marked bays or safe areas)
- c. Check depth of snow; generally a vehicle can negotiate powder snow that is twice the depth of heavy wet snow.
- d. Check the distance to travel, and look for possible snow drifts further along the road. (You may have to reverse all the way out.)
- e. Check where the road is under the snow.
- f. Don't 'bury' the vehicle by spinning the wheels.

### 5.22 PROCEDURE IF BOGGED

- a. Dig out snow around vehicle. Pack down a track, including between wheel tracks.
- b. Try to rock the vehicle out by alternating between forward and reverse gears.
- c. Choose the more favourable direction, (forward or backward), to free the vehicle.
- d. Consider jacking the vehicle and placing something firm under the wheels (branches, boards, etc). A base plate for the jack will probably be necessary in this situation.

## **DRIVING ON ROCKY TERRAIN**

**5.23** Driving over rocks is mechanically demanding on the vehicle and requires a high level of concentration from the operator. Before driving over rocks consider an alternative route, if not available, then walk and mark the chosen route, shifting small rocks to fill holes and make the path as even as possible;

## **5.24 ROCK-CROSSING TECHNIQUE**

When crossing rocks use the following technique:

- a. Use L4 first gear.
- b. Use throttle control to 'walk' the vehicle over the rocks.
- c. Ensure both hands are gripping the steering wheel, slightly tense up the arm muscles to resist wheel deflection—thumbs outside the wheel rim.
- d. Allow the vehicle to 'inch' its way across.
- e. Make changes of direction as necessary to prevent the vehicle 'hanging-up'.

## **5.25 INSPECTION AFTER CROSSING ROCKS**

Thoroughly inspect the vehicle after crossing rocks, paying particular attention to:

- a. brake pipes and hoses, (for fractures);
- b. steering linkages, (for damage); and
- c. tyre walls, (for cuts).

## **WATER CROSSINGS**

**5.26** Driving a vehicle through water is a hazardous exercise at the best of times, and care must be taken to ensure a safe crossing. Although your 4WD has features that enable it to cross water more easily than other vehicles—such as its greater ground clearance—too much water will stop any 4WD vehicle. This may happen as a result of:

- a. water entering the electrical system or air intake;
- b. loss of traction due to the nature of the bottom; or
- c. loss of traction resulting from vehicle floating off or being washed off the bottom. Where this occurs it may be necessary to open a downstream door to 'sink' the vehicle.

## **5.27 OBSTACLE ASSESSMENT**

Stop and assess the obstacle before committing yourself to it. Be sure that you have to negotiate the water crossing. You may be better off spending extra time on a longer route.

**5.28** Never drive into water of unknown depth or unknown bottom surface condition. Walk the crossing first, if necessary and safe to do so. Always determine for yourself the:

- a. current strength;
- b. water depth, (do not enter deep and/or fast water);
- c. bottom conditions; and
- d. location of obstacles.

### **5.29 PLANNING AND PREPARATION**

Mark all obstacles on the bottom (rocks, logs etc). Decide on the entry and exit points and stick to them. If possible identify a suitable anchor for a winch rope in case this is needed for recovery and consider access to recovery equipment if required. Always try to have the exit point slightly up stream from the entry, to maximise bow wave effects. (See Figure 5:1).

### **5.30 BOW WAVE TECHNIQUE**

If water reaches to the bumper bar or higher, upon entering the water accelerate until a **bow wave** forms in front of the vehicle (see Figure 5:1). Maintain this bow wave at all costs, to keep water out of the engine. Try to keep a steady pace using constant engine revs. The bow wave will keep water from entering the engine compartment; this technique will only be successful if the river bed is relatively smooth.

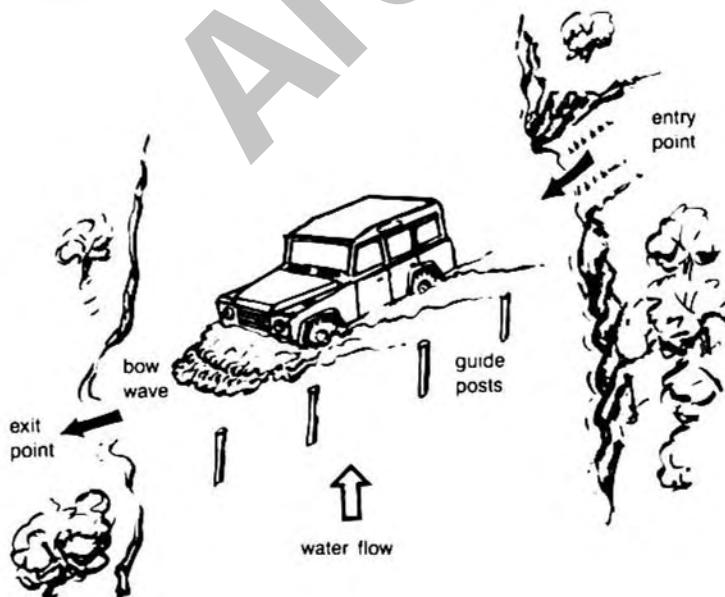


Figure 5:1  
Crossing—Bow Wave

### **5.31 DEEP WATER PREPARATION**

If water depth is greater than about 750 mm, prepare the vehicle as follows:

- a. Place a canvas sheet/tarp or hessian bag across the grille to prevent water entering the engine bay.

- b. If available, fit a snorkel extension to the engine air inlet and exhaust systems.
- c. Spray the ignition system with de-watering fluid.

### **5.32 WATER CROSSING PROCEDURE**

To negotiate an expanse of water use the following procedure:

- a. Select L4 first gear (L4 second gear if the bottom is sandy).
- b. Position the vehicle with the front wheels on the embankment and just in the water.
- c. Enter and cross the water without stopping. A slight increase in engine revolutions may be needed to maintain the bow wave. Where the bottom is rough or rocky it may be advantageous to set the hand throttle.
- d. Do not touch the clutch while the vehicle is in the water as this may allow water to enter the clutch and slippage to occur.
- e. If wheel spin occurs, select neutral without using the clutch and carry out recovery as necessary. Do not 'switch off' the engine while in the water.

### **5.33 CROSSING EXIT**

Allow only one vehicle in the water at a time and clear the exit point for each vehicle. 'If possible ease off throttle as vehicle exits crossing; this will reduce bow wave erosion effects on exit ramp from water. This has a significant effect on well-used crossings, and improves the chances of rear vehicles in a convoy completing a successful crossing in marginal exit ramp situations.'

**5.34** Dry out the brakes as soon as the crossing is completed by driving with light foot brake application.

**5.35** If a lot of water crossings are made, as soon as possible afterwards, have the condition of the oil in both differentials and gear boxes checked. If the oil is found to be a milky white colour, it means that water has contaminated the oil.

**NOTE: After deep water crossings, the vehicle must be serviced as soon as possible.**

## **DRIVING IN OPEN GRASSLAND**

### **5.36 HIDDEN DANGERS**

4WD may not be required for driving in open grassland. However, there are still many things for a driver to consider in what may appear to be the easiest of off-road driving conditions.

- a. Avoid the temptation of travelling at high speeds, as grass can and does hide many hazards.

- b. When driving in long grass, especially with long nosed vehicles, it is prudent to have someone walk in front of the vehicle to detect holes, stumps, rocks etc.
- c. In fire conditions, the added problem of smoke can reduce visibility to almost zero, thus increasing the possibility of collision.
- d. Be aware of the danger of vehicle exhaust causing a fire.
- e. Be aware of engine overheating due to grass fouling the radiator core.

## **NEGOTIATING BURNT GROUND**

- 5.37 When operating on ground recently burnt be aware of the dangers that exist to the vehicle through:
- a. hot spots which may cause tyre or other damage;
  - b. ash intake into engine air cleaner and vehicle cabin;
  - c. falling branches from fire-damaged trees;
  - d. downed power lines;
  - e. tyre damage (side wall) due to staking;
  - f. entanglement in fencing wire; and
  - g. engine overheating.

## **NEGOTIATING STEEP TERRAIN**

### **5.38 ASCENDING STEEP SLOPES**

Always aim for a successful first ascent. Recovery from failure can be difficult and dangerous. Use the following procedure:

- a. Stop and look.
- b. Check the grade before you commit yourself.
- c. Look at surface condition and exit point.
- d. Choose the appropriate gear.
- e. Approach a steep grade square on. Do not traverse across the slope.
- f. It is important to select the required gear before you attempt the ascent. When in doubt use L4 first gear.
- g. Use a slow and steady approach. By approaching the grade in the correct gear with engine revs at maximum torque, the vehicle will steadily climb the hill without problems.

- h. If wheel spin occurs it may be reduced by slightly turning the steering wheel repeatedly from side to side so as to use the lugs of the tyres to gain extra traction. Gently pumping accelerator may also assist by creating a 'spin-grip' action by the tyres on the track surface.

### **5.39 STALL-STOP AND RECOVERY**

(Also see Annex A—Stall Procedures Aide Memoire)

When ascending steep slopes, if progress is halted due to obstacles or loss of traction, use the following procedure to stop and recover to a safe area:

- a. Release the accelerator, apply the foot brake firmly and hold it on, and allow the engine to stall in gear—Do not use the **clutch**
- b. Apply the hand brake and turn the ignition off.
- c. Recover your thoughts and plan your actions.
- d. Ensure the track is clear behind you and select an aiming point.
- e. Gently depress the clutch, so as to ensure that the brakes are holding the vehicle, select reverse gear, release the clutch. If the gear will not engage hold the lever against the gate and flick the key to start position and back to the off position, the gears will align and engage without difficulty.
- f. Release the hand brake if applied. Ease off the foot brake allowing the vehicle to rest on the gears, do this gently as vehicle movement will occur as the gear train slack is taken up.
- g. While looking into the rear vision mirrors, turn the key to 'start' and allow the engine to start with the clutch engaged.
- h. Allow the vehicle to descend under engine braking and control the speed with the foot brake as needed until you reach the pre-selected safe place.
- i. If during the descent to a safe place, you become concerned for the safety of the vehicle apply footbrake to stall the vehicle in gear. Reassess the situation and repeat procedure as appropriate.

### **5.40 DESCENDING STEEP SLOPES**

Adopt the following safety procedure for steep decent:

- a. Stop at the top and look.
- b. Check the gradient before committing yourself.
- c. Walk down the hill if you cannot see the bottom, or any section.
- d. Adopt a 'square-on' approach.
- e. Use low range 4WD first gear; do not change gear on the hill.

- f. Allow the vehicle to descend on engine compression. Gently apply brakes to maintain safe speed.
- g. If wheels begin to skid, keep front wheels pointing down hill. Gently ease off brakes to get wheels rolling again, then gently re-apply brakes.
- h. The stall-stop and recovery technique can be used to regain control of the vehicle if necessary.

#### **5.41 PLANNED STOPS ON STEEP SLOPES**

If you need to stop on a very steep slope use the following procedure:

- a. Turn ignition off.
- b. Apply the foot brake, stall the vehicle in gear. Do not touch the clutch.
- c. Apply the hand brake.
- d. If you have to get out of the vehicle, engage first gear (if not already engaged) and chock all wheels.

#### **5.42 STARTING ON STEEP SLOPES**

When restarting on steep slopes there are three alternative methods that may be used, these are:

- a. **Key Start** —As described in stall-stop procedure and used for all downhill restart situations. This technique is not suitable for uphill starts.
- b. **Hand Brake Start** —Used for uphill situations, as follows:
  - (1) With the vehicle stopped, in gear and foot brake applied, apply the hand brake.
  - (2) Depress the clutch and select L4, first gear, start the engine and release the foot brake.
  - (3) Now, using the accelerator to control engine speed, bring the clutch to 'friction point', release the hand brake and drive off.
- c. **Throttle Start** —Used for uphill situations, as follows:
  - (1) With the vehicle stopped, in gear and foot brake applied, depress the clutch and select L4, first gear.
  - (2) Start engine and increase RPM to an appropriate level (say 1500 – 2000 RPM) using the hand throttle.
  - (3) Engage the clutch to 'friction point'. Release the hand brake and gently release the foot brake allowing the vehicle to move off by simultaneously releasing the clutch.
  - (4) Release the hand throttle as soon as you are in control.

**WARNING: Do not ride the clutch during these procedures, ie fully release the clutch as soon as possible .**

#### **5.43 CROSS SLOPE DRIVING**

Avoid side slopes whenever possible If you must drive across a slope be alert to the inherent danger of the vehicle losing traction and slipping sideways. An apparently safe (10 to 15 degrees) side slope can quickly become dangerous should the low side wheels drop into a small stump hole or the high side wheels ride up over a rock, log or mound.

#### **5.44 SHORT VERTICAL RISES**

A 4WD vehicle can negotiate a short vertical rise provided that the front bumper bar or front spring hangers can clear the top of the rise. Ensure that beyond the rise there is a relatively even surface longer than the vehicle's wheel base to avoid it becoming 'high-centred' or 'hung-up':

a. **Ascending:**

- (1) Stop and assess the situation. (Do you have the necessary clearance?)
- (2) Use L4, first gear.
- (3) Adopt a 'square-on' approach. Both front wheels must climb the rise simultaneously.
- (4) Move slowly and steadily allowing front wheels to climb the obstacle. When front wheels are on top of the rise, back off the accelerator.
- (5) It may be necessary to maintain some vehicle momentum to assist the rear wheels over the obstacle.

b. **Descending:**

- (1) Stop and assess the situation.
- (2) Use L4, first gear.
- (3) Adopt a 'square-on' approach.
- (4) Move slowly and steadily allowing the vehicle to creep over the obstacle. Do not touch the clutch.
- (5) Gently apply foot brake if needed to allow a slow and controlled descent. Do not 'lock-up' the wheels.

#### **5.45 HUMPS AND DITCHES**

Approaching at an angle assists when negotiating ditches or humps that are narrower than the length of the vehicle. However you must be careful not to 'high-centre' the vehicle (that is, strand it on a hump with all wheels off the ground) and watch for excessive chassis twisting.

- 5.46** The technique is the same as that for 'short vertical rises' except that engine power is kept steady while the obstacle is crossed. When crossing water drains or wash-aways ease off the accelerator as the front wheels cross the hump to avoid becoming airborne.

## **BRIDGE ASSESSMENT/CROSSING**

- 5.47** Situations may arise where drivers need to cross a bridge of unknown or doubtful condition and strength. The following points should be considered in assessing the bridge:

- a. Look for load limit signs.
- b. Check approaches for:
  - (1) solid ground;
  - (2) slopes and grades; and
  - (3) wash-outs etc.
- c. Check decking for:
  - (1) holes;
  - (2) loose planks;
  - (3) split or broken planks;
  - (4) rotting sections of timber;
  - (5) loose or missing bolts;
  - (6) spikes;
  - (7) adequate width; and
  - (8) sufficient thickness of planks to carry load.
- d. Check beams for:
  - (1) size and strength;
  - (2) support at ends; and
  - (3) signs of overloading or failure (sagging, splitting).
- e. Check pylons for:
  - (1) rotting;
  - (2) bracing;
  - (3) connections to beams;
  - (4) damage caused by flood/floating objects; or

- (5) damage caused by fire.
- f. Check abutments for:
  - (1) washout of abutment; and
  - (2) gaps, or displacement of beams.
- g. If in any doubt about the bridge, consider whether there is a better way to cross?
- h. Test the bridge by slowly driving onto it with a guide watching and listening for signs of failure (cracking and movement).

## **DRIVING HEAVY VEHICLES**

**5.48** The techniques used in operating heavy 4WD/6WD vehicles (trucks etc) are the same as those listed earlier in this chapter. The driver of a heavy vehicle needs to consider the weight and dimension of the vehicle when assessing and/or crossing any obstacle or terrain.

### **5.49 DRIVING POSITION**

The seating position in a heavy vehicle is generally higher than a light 4WD and may be over or forward of the front axle in a forward control truck. The difference in view and seating position needs to be considered by the driver.

### **5.50 CENTRE OF GRAVITY**

The centre of gravity of a high load and/or high vehicle, particularly a water tanker must be considered and appropriate precautions taken.

### **5.51 TOWING TRAILERS**

Where heavy vehicles are towing trailers the driver needs to be aware that the trailer may be obscured. Where this is the case it will be necessary to check trailer, couplings, load security etc more frequently. It may also be necessary to use a guide when reversing/manoeuvring.

### **5.52 RECOVERY EQUIPMENT**

The ratings of recovery equipment needed for use with heavy vehicles needs to be carefully assessed to ensure that chains, cables, shackles etc are adequate.

## AIDE MEMOIRE

### STALL PROCEDURE

#### MOVING FORWARDS UPHILL

1. DO NOT TOUCH THE CLUTCH
2. FOOTBRAKE ON. (See Note a.)
3. HAND/PARK BRAKE ON
4. KEY OFF
5. EASE IN THE CLUTCH PEDAL. (Disengage)
6. SELECT REVERSE GEAR
7. CLUTCH PEDAL OUT. (Engage)
8. IF CONTINUING UPHILL, HANDBRAKE/THROTTLE START
9. IF RETURNING DOWNHILL, KEY START

#### MOVING FORWARDS DOWNHILL

1. DO NOT TOUCH THE CLUTCH
2. KEY OFF
3. FOOTBRAKE
4. HAND/PARKBRAKE ON
5. IF CONTINUING DOWNHILL, KEY START
6. IF RETURNING UPHILL, HANDBRAKE/HAND THROTTLE START

NOTE: When stalling uphill decrease revs before applying brakes

### KEY START

#### REVERSING DOWNHILL

HAVING STALLED THE VEHICLE, AND INTENDING TO REVERSE DOWNHILL.  
(REVERSE GEAR HAS BEEN SELECTED—DO NOT TOUCH THE CLUTCH)

1. HANDBRAKE OFF
2. FOOTBRAKE OFF SLOWLY. (Check vehicle holding on engine compression)
3. CHECK AREA CLEAR BEHIND
4. TURN STARTER KEY

5. KEEP STARTER ON UNTIL MOTOR RUNNING

### **HANDBRAKE START**

**USED WHEN THE VEHICLE IS MOVING OFF UPHILL**

1. 'EASE' IN THE CLUTCH PEDAL. (Disengage)
2. FOOTBRAKE SLOWLY OFF. (Check handbrake holding)
3. START ENGINE
4. SELECT GEAR. (1st or reverse)
5. EASE OUT CLUTCH PEDAL. (Until friction point is reached) (Engage)
6. HANDBRAKE OFF & ACCELERATE SMOOTHLY

### **HAND THROTTLE START**

**USED WHEN THE VEHICLE IS MOVING OFF UPHILL AND THE HANDBRAKE WILL NOT HOLD VEHICLE**

1. 'EASE' IN THE CLUTCH PEDAL. (Disengage)
2. FOOTBRAKE SLOWLY OFF. (Handbrake does not hold).
3. FOOTBRAKE ON
4. START ENGINE
5. SET HAND THROTTLE. (Approx. 1500 rpm).
6. SELECT GEAR (1st or reverse).
7. EASE OUT CLUTCH PEDAL. (Until friction point is reached)
8. FOOTBRAKE OFF & ACCELERATE SMOOTHLY
9. DEACTIVATE HAND THROTTLE

## CHAPTER SIX

### TOWING AND TRAILERS

#### **INTRODUCTION**

**6.01** Most 4WD vehicles are fitted with powerful engines that make them ideal for towing. It must be clearly understood that the towing of a trailer in off-road situations greatly reduces the vehicle's 4WD capabilities. For example, ascending very steep hills, the extra weight of the trailer reduces the vehicle's capacity to climb.

#### **6.02 HAZARDOUS SITUATIONS**

You could find yourself in a situation where the vehicle is part way up a steep hill and it either stalls or loses traction. Normally a simple 'stall recovery' procedure will return you to the bottom of the hill safely. If a trailer was being towed, it may not allow the vehicle to reverse back down the hill. When on a steep hill, you may not be able to unhook the trailer, or if it jack knifes while reversing, the vehicle may not be able to go forward. This could lead to a very dangerous situation.

**6.03** When descending a very steep hill while towing a trailer the extra weight may make it difficult to hold the vehicle on the hill, especially if the surface is slippery or loose. Crossing mud or sand, or negotiating short vertical rises and rocky outcrops, while towing a trailer can also be very hazardous.

#### **THE TOWBAR**

**6.04** The towbar and ball are a very important component and therefore only an approved type should be used. The towbar:

- a. carries the front of the trailer;
- b. tows the trailer; and
- c. is one means of braking the trailer.

**6.05** As the towbar carries the front of the trailer, a proportion of the weight is transferred, via the towing assembly, to the towing vehicle. This transfer, although a necessary one, creates the following problems:

- a. Weight (mass) transfer, and
- b. Torque transfer.

#### **6.06 WEIGHT (MASS) TRANSFER**

The static towbar load is often as much as ten to fifteen per cent of the total weight of the trailer. This could be up to 150 kgs where the laden weight of the trailer is 1000 kgs. This transfer puts a tremendous strain on the towing assembly of the vehicle. It is very tempting to have some of the weight

behind the axle of the trailer to counter-balance this heavy 'nose'. However, this is a very dangerous thing to do and could lead to sway and snaking.

- 6.07** The static towbar load of the trailer presses down on the towball of the vehicle, pushing the rear downwards. This causes the rear suspension to deflect giving a 'tail down' attitude. Spring assisters, extra springs and air adjustable shock absorbers can rectify this part of the problem. There is however, a second and possibly more important problem to consider. This problem is 'torque transfer'.

#### **6.08 TORQUE TRANSFER**

Imagine, a plank resting upon two trestles placed two metres apart in such a way that the plank overhangs one trestle by about one metre. Now press down on the overhung end and the opposite end soon lifts off the trestle. This is very much the same situation as a trailer pressing down on the towball of a vehicle. The towball is set a considerable distance behind the rear axle. The tendency is for the vehicle to pivot around the rear axle, tail down—nose up, which in turn affects the braking and steering of the vehicle.

### **THE TRAILER**

- 6.09** The trailer should be compatible with the towing vehicle. The following points should be considered when towing a trailer:
- a. Weight.
  - b. Height.
  - c. Width.
  - d. Length.
  - e. Braking system.
  - f. Suspension and tyres.
  - g. Trailer lights and electrical couplings.
  - h. Safety chains.
  - i. Clearances.

#### **6.10 WEIGHT**

The laden weight of the trailer must be within limits acceptable to the manufacturer of the towing vehicle and comply with road traffic regulations.

- 6.11** Allowance for the weight of the trailer must be made when accelerating, braking and turning. Acceleration and hill climbing will be much slower. Braking takes much more time and distance. On a slippery road or when travelling downhill, take great care. Trailers with no brakes and trailers with over-ride brakes are a risk in these conditions.

**6.12** Do not allow the engine to labour under heavy loads at low speeds. Where an automatic gearbox is fitted it may be necessary to engage a lower gear manually when ascending as well as when descending hills.

#### **6.13 HEIGHT**

The driver should be aware of the height of the loaded trailer and take appropriate precautions. Take care when driving near trees, roadside signs etc. Wind resistance and cross winds should be considered when towing high loads.

#### **6.14 WIDTH**

The trailer may be wider than the towing vehicle. This can cause trouble in traffic and off road. Allow plenty of room on both sides especially when turning and lane changing. Particular care needs to be taken when towing trailers off road. Consider clearances when towing amongst obstacles such as trees, rocks etc.

#### **6.15 LENGTH**

A vehicle/trailer combination is a 'long vehicle'. Most states have regulations which forbid 'long' vehicles travelling close together on open roads. Staying well apart permits faster traffic to overtake more easily. When overtaking or being overtaken, take the extra length into account. When turning remember that the trailer will 'cut-in'. The longer the trailer the greater the degree of 'cut-in'.

#### **6.16 BRAKING**

As different states have different regulations it is necessary to be aware of the regulations that apply to you. The following braking systems are the ones most commonly used.

#### **6.17 'OVER-RIDE' BRAKES**

A simple type of brake is the 'over-ride' type operated by cables or hydraulically. Whilst this type of brake is adequate in most situations it is rarely sensitive enough to deal with a long down-hill run or slippery roads.

#### **6.18 INDEPENDENT BRAKES**

These fall into two main categories which are:

- a. vacuum brakes (very rarely fitted nowadays); and
- b. electrical brakes.

**6.19** The vacuum type utilises the natural vacuum of the engine controlled by means of the footbrake pedal. The electrical type utilises electromagnets at the trailer wheels. Control is achieved via the footbrake pedal and an inertia sensitive controller or a rheostat.

**6.20** Both types normally include a device to regulate trailer braking sensitivity to compensate for road and load conditions. They usually incorporate a device to permit the brake on the trailer to be used independently of the vehicles brakes. Most have a 'break-away' device and so are suitable for heavy trailers where such a device may be required.

## **6.21 SUSPENSION AND TYRES**

The function of a trailer suspension system is to cushion the trailer and its load from road shocks and to keep the tyres in contact with the road. Most emergency service trailers are fitted with a suspension system. Where no suspension is fitted (eg small boat trailers) drivers should be aware of the potential for damage to trailer and load and of the resultant poor handling characteristics.

**6.22** The condition of the tyres on a trailer is just as important as the condition of tyres on the towing vehicle. It is essential that trailer tyres be inspected regularly and correct air pressures be maintained.

## **6.23 LIGHTS AND ELECTRICAL COUPLINGS**

Trailer lights must be fitted, used and maintained to conform with road traffic regulations. Trailer light and electrical couplings are often subject to damage. Drivers should ensure that the electrical system is maintained in good working order.

**6.24** Numerous types of trailer electrical couplings are in common use throughout Australia. Where possible emergency service organisations should endeavour to standardise trailer couplings. Where various trailers are towed it may be necessary to use adaptors.

## **6.25 SAFETY CHAINS**

A safety chain(s) is a short length of chain permanently fixed (welded) to the trailer drawbar. This chain is for attachment to the towing vehicle towbar by means of a 'D' shackle or similar.

**6.26** The safety chain should be attached to the vehicle so that it is long enough to allow the vehicle/trailer combination to turn but not so long that the drawbar of the trailer could hit the ground if the trailer coupling was to come off the tow ball. The rating on the chain, 'D' shackle and tow bar must be adequate for the maximum possible loading. Padlocks are not suitable to use to attach the safety chain to the tow bar as they are not load rated.

## **TOWING**

**6.27** No matter what vehicle, for safe and stable towing the laden weight of the trailer should not be greater than the unladen weight of the towing vehicle. Vehicle manufacturers specifications should also be considered with respect to towing capacity.

## **6.28 REVERSING**

While reversing with a trailer is a particular skill, correct towing techniques embrace all elements of driving. As a vehicle and trailer spend most of the time travelling forward, it is important to understand all aspects of towing.

- 6.29** In many cases the weight that a driver has to cope with doubles when a trailer is hitched up. This immediately affects the ability of the towing vehicle to pull away, accelerate, pass other traffic, climb hills and stop. It is essential to recognise these limitations that appropriate precautions. When driving with a heavily loaded trailer all actions should be smooth and without hesitation.

### **6.30 TRAILER STABILITY**

Factors that contribute to instability on the towing are:

- a. poor or worn suspension;
- b. under-inflated tyres; and
- c. poor vehicle attitude (front up, rear down).

On the trailer the factors that contribute to instability are:

- a. incorrect loading;
- b. overloading;
- c. insufficient drawbar weight; and
- d. axle steer caused by leaf spring reaction.

The effect of instability will most often be felt at high speeds.

### **6.31 TRAILER SWAY (SNAKING)**

Instability can cause trailer sway or 'snaking'. This is not a very common occurrence but its onset can be swift and frightening. The trailer should be loaded so that the design parameters are met. In general this means that the load is kept at, or near, floor level and properly distributed. Most trailers are designed to carry 60 per cent of the load forward of the axle and 40 per cent of the load behind the axle with heavy items as near to the axle as practicable. The load should be distributed evenly side to side. Under no circumstance should a load be placed at the rear of the trailer in an attempt to lessen the 'nose' weight.

- 6.32** Sway is sometimes induced by attempting to steer a straight course with short rapid movements of the wheel. This occurs in cross winds or when the vehicle is struck by the bow-wave of an oncoming or overtaking vehicle. The vehicle feels as though it is being blown off the road and the driver often responds too strongly. When travelling on gravel roads sway may well occur. In all of the instances above the driver should hold the wheel still and GENTLY increase the power. This will result in driving out of the trouble.

## **DO NOT BRAKE**

- 6.33** A much more serious situation can occur when the driver induces sway by late and heavy braking on a bend. This type of sway can rapidly become a 'jack-knife'. It is, therefore, essential that all braking be done whilst travelling in a straight line. A vehicle/trailer combination which is prone to sway should be examined by an expert to find the cause. The fault may often be the driver and not the combination.

## **6.34 MOVING OFF**

When moving off, allow the clutch to fully engage as soon as possible and delay gear changes until engine revs have increased.

## **6.35 ASCENDING**

When approaching a rise increase engine speed as much as possible before the hill. This may be limited by road conditions but if possible will make all the difference.

- 6.36** Change down gears sooner than you normally would. Keep the engine revs up. Changing gear before the vehicle has lost too much speed will make it easier for the engine to cope with the load.

## **6.37 DESCENDING**

Take extreme care when descending with a trailer. Resist the temptation to increase speed. When descending there is a tendency for the towing vehicle to be pushed by the trailer and become unstable. It may start to sway, especially at high speeds. Keep your speed in check until you can judge the extent of the hill and other road conditions. If the trailer is fitted with independent trailer brakes, use them to slow down. Once the trailer brakes are felt, apply the vehicle brakes gently for added effect. Sharp braking can make an unstable trailer snake and should be avoided. Never drive close behind other vehicles as your stopping distance is much greater.

## CHAPTER SEVEN

### RECOVERY

#### INTRODUCTION

**7.01** In regard to 4WD operations, recovery is the safe and successful extrication of an immobilised vehicle. It should be noted that speed is generally not a consideration in recovery operations.

#### REASONS WHY VEHICLES BECOME IMMOBILISED

**7.02** When vehicles are required to travel across country, there is a real possibility that they may become immobilised. The reasons for this situation are many and varied; here are some examples:

- a. Poor reconnaissance, involving:
  - (1) lack of knowledge of the ground or route; and
  - (2) poor appreciation of the terrain.
- b. Poor driving and lack of care for the vehicle.
- c. Stopping on poor surfaces.
- d. Mechanical breakdown.

#### SAFETY

**7.03** The driver is responsible for the vehicle and directs the recovery operation. Recovery work is arduous and often calls for considerable physical effort, however, an element of danger is often present. This danger can be minimised by proper direction and teamwork.

#### 7.04 HAND SIGNALS

If hand signals are used they need to be understood by all involved.

#### WINCHING OPERATIONS

#### 7.05 COMMON WINCHES

There are three different types of winches in common use:

- a. **Power Take-Off Winch** —This winch is powered from the vehicle's transfer case, via a drive shaft to the winch's worm drive. It can only be fitted to vehicles equipped with a power take-off facility
- b. **Electric Winch** —This consists of an electric motor (similar to a starter motor), a worm drive and drum. It can be fitted to any vehicle. The winch is powered by the vehicle battery. It has the disadvantage of drawing enormous amounts of current from the battery when in

operation. The fitting of dual batteries to vehicles with electric winches is recommended.

- c. **Hand-Operated Winch** —A number of these are available, including brands such as 'Tirfor', 'Anchor', 'Elephant Looper' and 'Thomas'. These are portable, hand (lever) operated winches. They can be easily carried and operated by one person, and come with their own cable and extension handle.

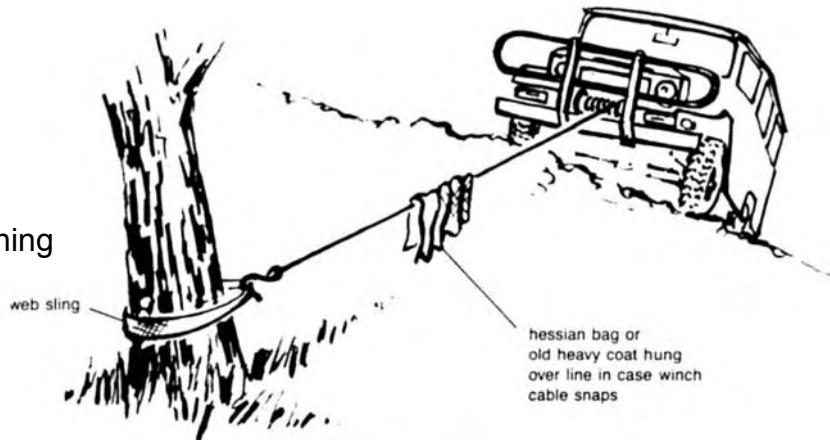
## 7.06 OPERATING HINTS

- a. Become thoroughly familiar with the winch's operation before you are forced to use it to get out of trouble.
- b. For power take-off winches, always carry spare winch shear pins (use only genuine shear pins).
- c. The winch cable should never be used for towing, even for a few metres. It could result in damage to the cable and winch.
- d. Always pull in as straight a line as possible. The fairleads are designed to help with minor misalignment, but cable strength is severely reduced when forced to go around a corner.
- e. Use the winch control switch or operating lever intermittently to take up cable slack and avoid shock-loads which can momentarily far exceed the winch and cable rating.
- f. Always stop winching when the hook is about a metre from the fairlead. Use the winch control switch intermittently to spool in the remaining cable.
- g. When using an electric winch, keep the vehicle engine running slightly above idle speed if possible, to provide charging for the electrical system.

## 7.07 DIRECT PULL

The direct method is the most commonly used. Never wrap the winch rope around the anchor point and back onto itself. Not only is this a dangerous practice, but can cause permanent damage to the winch rope. Always use a sling. This direct pull method is suitable only when the maximum possible loading does not exceed the rated safe maximum winch load. (See Figure 7:1).

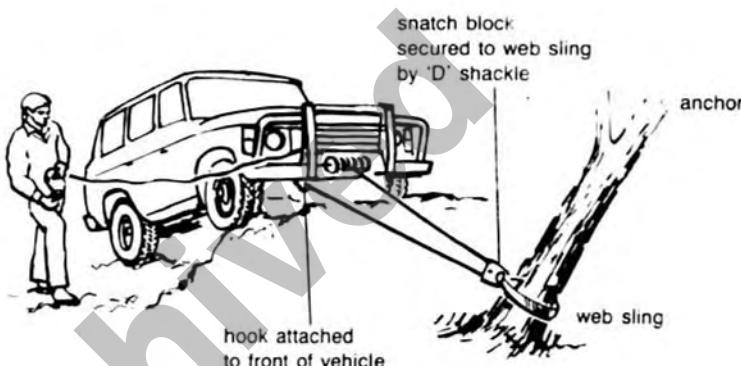
Figure 7:1  
Direct Pull Winching



#### 7.08 DOUBLE PULL

This method is used to gain a mechanical advantage. It is referred to as a 2 to 1 pull (2:1). Using a double pull may reduce the amount of force required from the winch to achieve the pull which in turn will result in the winch drawing less amperage than a single pull and therefore may be more appropriate for use with an electric winch in some situations. (See Figure 7:2).

Figure 7:2  
Double Pull Winching



#### 7.09 CHANGING DIRECTION OF PULL

This is when a SWR block is used to change the direction of pull. Mechanical advantage can then be obtained if required by attaching another snatch block to the load and running the winch cable back to the anchor point. (See Figure 7:3).

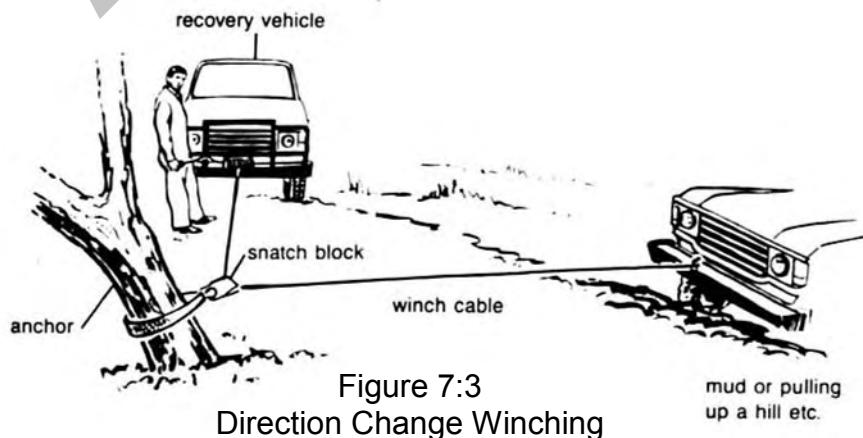


Figure 7:3  
Direction Change Winching

#### 7.10 SAFETY PRECAUTIONS (POWER WINCHES)

The following safety precautions are to be observed prior to and during a winching operation:

- a. One job, one boss.
- b. Check that all equipment is serviceable.
- c. Always wear gloves when handling wire rope and chains.
- d. Don't disengage the winch dog-clutch when the rope is under strain.
- e. Check the hook-up before and once strain is taken up.
- f. Ensure sufficient rope remains on the drum. (Normally six to eight turns. Check the manufacturers handbook).
- g. Don't walk behind a vehicle being winched up an incline.
- h. Ensure that signals if used are understood by all involved.
- i. Keep all personnel out of the rope danger arc (1.5 times the length of payed out rope).
- j. When re-engaging drive to a winch under strain, do so slowly.
- k. Never step across or stand over a winch rope or attached equipment whilst under strain.
- l. Never exceed safe sling angles. See Figure 4:3.
- m. Snatch blocks, rope etc should not be allowed to drag through the earth, rollers or skidding should be placed beneath the ropes.
- n. Place a bag, blanket or similar over the middle of the cable so that in the event of the cable breaking it will wrap around the bag and reduce whiplash.
- o. Always be aware of the manufacturers specifications and safe working loads, and operate the winch within those parameters.
- p. Do not hook the winch rope back over itself as this reduces the safe working load by up to 50% and damages the rope. Use an approved chain, wire or synthetic rope sling.
- q. Do not handle the cable closer than 750 mm from the drum when winching. A loose wire may snag the glove and draw the operator's hand into the winch.
- r. Do not use the winch for lifting casualties.
- s. Damaged wire ropes must be replaced.
- t. Winches must be mounted on vehicles in compliance with the manufacturers specifications and state/territory regulations.
- u. Some winches have a shear pin, which is designed to shear if the winch is overloaded. The shear pin should only be replaced with a genuine replacement pin.

- v. When winching, where possible, keep the cable straight ahead of the winch while under load.
- w. Before applying a load to a new wire rope, it should be run out to the last five turns on the drum and spooled onto the winch under a load.
- x. Always take out the slack in the rope before applying full power to the winch. Sudden jerks may exceed safe working loads.
- y. With a PTO winch, do not release the vehicle clutch rapidly as it could shear the safety pin.
- z. Always wind the cable tightly. A good method for winding the cable is to extend it fully, attach it to a holdfast, and then pull the vehicle with the brakes lightly applied. Wind the entire cable with this load.

## **7.11 SAFETY PRECAUTIONS (HAND WINCHES)**

Safety precautions specific to hand-operated winches:

- a. If a single operator cannot move the load with the telescopic operating handle fully extended, the load is too great for the machine and a steel wire rope block should be used to increase the mechanical advantage. The operating handle must not be extended in any way.
- b. Always use slings and anchors of sufficient strength to withstand the load.
- c. Keep the wire rope wound onto the reeler when not in use.
- d. Never allow any kinks in the rope to enter the machine as this causes internal damage.
- e. Only use the wire rope supplied with the machine.
- f. Never anchor the machine by the tip of the hook, always use a sling.
- g. Never apply tension to the running end of the rope.

## **7.12 NATURAL ANCHORS**

A large tree is probably the best anchor to use. Ensure that the tree is strong enough to withstand the load you intend to put on it.

## **7.13**

It is important that you do not damage a living tree or its bark while it is being used as a anchor. The best way to minimise tree damage is to use a web sling. The web sling is placed around the tree, as low as possible. If you intend to use a wire sling or chain around the tree to secure the winch cable, to prevent damage to the tree and possibly ring barking the following precautions can be used:

- a. Place a hessian bag or similar material between the sling and the tree.
- b. Place a number of small pieces of timber upright around the tree between the sling and the tree trunk.

7.14 If a tree is considered not to be strong enough by itself, it may be practical to strengthen the anchor by placing the sling around two or more nearby trees to form a strong collective anchor.

#### 7.15 STAKE/GROUND ANCHOR

This method is effective as an anchor point where no other suitable points are available. The materials required to construct this anchor are three or four steel pickets and a sufficient length of cordage. The pickets are driven into the ground on an angle. The cordage is then wrapped around from the top of one picket to the bottom of the other. The winch cable is then anchored using the chain. If the pickets pull out they will be required to be driven further into the ground or more pickets used (see Figure 7:4). For further detail on anchors see AEM—Disaster Rescue.

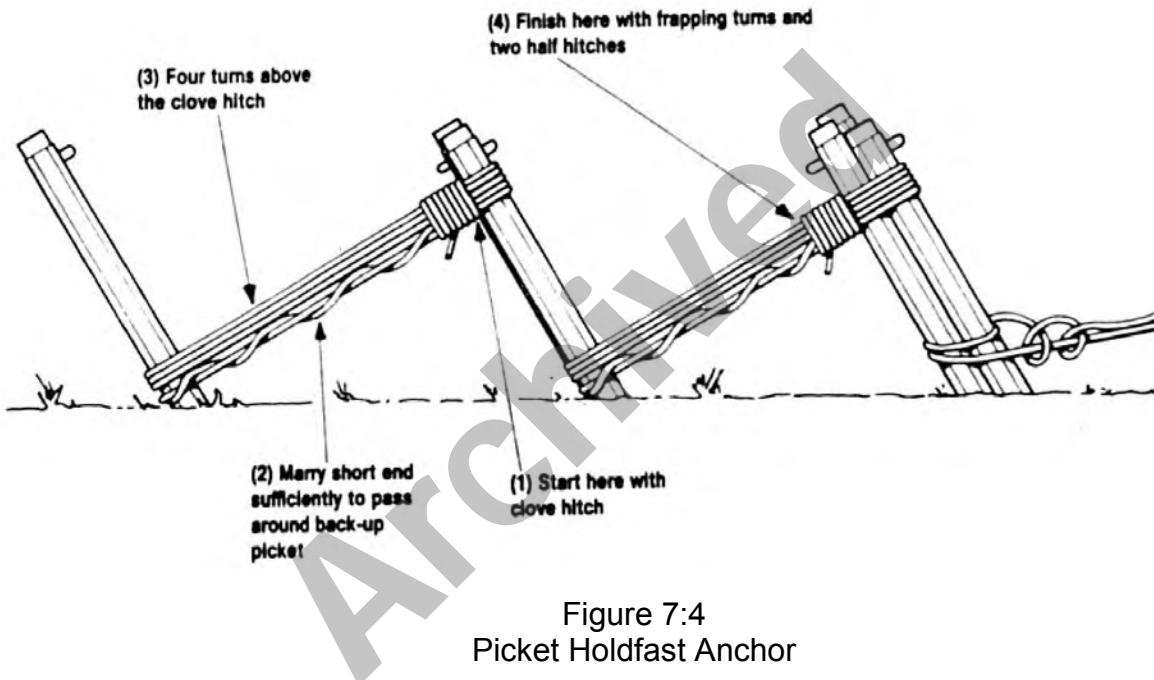


Figure 7:4  
Picket Holdfast Anchor

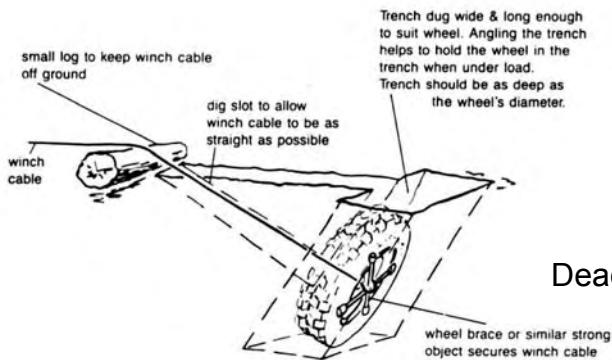
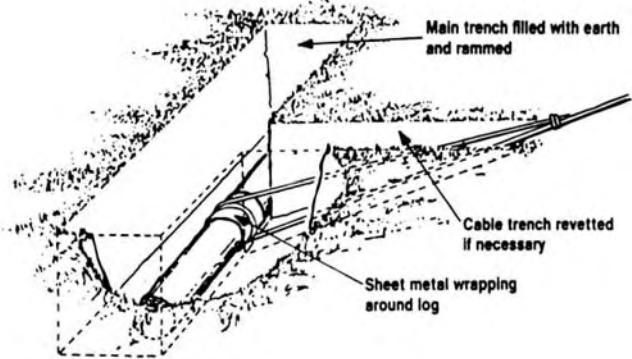
#### 7.16 'DEAD MAN ANCHOR'

The 'dead man' is used where the ground is suitable, but it must be remembered that its construction requires a large effort. Maximum resistance depends on: a. the strength of the buried timber; and b. the resistance of the earth.

7.17 In good ground, a trench is dug 1 to 1.5 m deep. A log or timber approximately 400 mm thick is placed in the trench (Figure 7.5 or the vehicle spare wheel may be used as an alternative).

7.18 The angle of the cable exit to the anchor trench must never be any greater than 30 degrees from the horizontal plane, less if possible, as the smaller the angle, the more earth there is providing resistance (See Figures).

**Figure 7:5  
Dead Man or Buried Anchor (Log)**



**Figure 7:6  
Dead Man or Buried Anchor (Spare Wheel)**

## 7.19 BACK-TIE

Caution should be exercised when using a winch mounted to your vehicle to recover another vehicle which is bogged. Owing to the enormous resistance created, the bogged vehicle becomes a hold fast toward which your vehicle will be drawn unless the resistance is overcome. Depending on the circumstances it may be necessary to back-tie your vehicle (using a conventional hold fast method) or, in extreme cases deliberately (temporarily) bogging your vehicle.

## 7.20 MINIMUM RECOVERY WINCHING EQUIPMENT

- Web sling about 3 m long, fitted with eyes both ends, nylon or similar material; appropriate capacity.
- Snatch block of 100 to 150 mm diameter single sheave, appropriate capacity.
- Short wire rope sling, 1 m long, fitted with eyes both ends, appropriate capacity.
- 'D' shackles, appropriate capacity.
- Leather gloves.

## 7.21 SLINGS

Refer to Figure 4.3 for information on safe sling angles.

- 7.22** For additional information on the subjects of ropes, winches and anchors, refer to AEM—Disaster Rescue.

## JACKING OPERATIONS

### 7.23 PRELIMINARY CHECKS

Check the following:

- a. Does the vehicle have a jack?
- b. How does it work?
- c. Have you got a jack handle, and a wheel brace to undo the wheel nuts?
- d. Do they fit the vehicle?
- e. Where are the lift points on the vehicle?
- f. How high does it lift?
- g. Do you have a jack base plate?

#### **7.24 JACK PLATES**

For jacking a 4WD vehicle, a jack plate is almost essential. This is a piece of timber (20 to 25 mm thick plywood is best) approximately 250~`mm square. It is used as a base for the jack when jacking on soft or uneven ground.

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#### **7.25 HIGH-LIFT JACK**

A high-lift (Wallaby) jack can be used to lift one end of a vehicle up to a metre off the ground to enable rocks or timber to be placed under a bogged or stuck vehicle so it can regain traction. In addition, a high lift jack can be used to lift one end of a vehicle off the ground so it can be pushed sideways to gain firmer ground. This jack in conjunction with chains and cable can also be used for winching.

#### **7.26** To be able to use a high-lift jack skilfully a little practice is needed. Practice before you are forced to use it in a real life situation.

#### **7.27 SAFETY INSTRUCTIONS**

Before using any jack refer to the manufacturers instructions to familiarise yourself with the safe operation of the jack.

#### **7.28 HIGH-CENTRING RECOVERY**

Should the vehicle 'bottom out' on a rock and become high-centred, the following procedure applies:

- a. Switch off engine and leave in gear with the hand brake on.
- b. Jack up the wheel most likely to provide necessary clearance. In doing this ensure:
  - (1) the wheels are chocked;
  - (2) the jack is stable;

- (3) the jack is high enough to just clear the obstacle—do not raise the vehicle more than necessary; and
- (4) you have packed under the wheel with suitable material.

NOTE: Jack up the lower side rather than the higher side (if roll over is likely, secure the vehicle using suitable rope and/or a winch before jacking).

- c. When clearance has been gained, remove the jack and wheel chocks, then 'inch' the vehicle over the obstacle.

## **SNATCH-EM-STRAP**

**7.29** A snatch-em-strap is a type of webbing tow rope that can be stretched like a rubber band. The snatch-em-strap allows the towing vehicle to build up momentum, and use the momentum combined with the vehicles normal power to pull a vehicle out of a bog.

## **7.30 DANGERS IN USAGE**

Snatch-em-straps can result in considerable dynamic loads. This has been known to cause tow bars to be sheared and flung into windscreens and 'D' shackles to be torn from mounting points and propelled through vehicle body panels. Only trained personnel should use this device.

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Four-Wheel-Drive Vehicles, Drivers Handbook Telecom Australia,  
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