

Marlborough Kaikoura Rural Fire Authority



TRAINING NOTES FOR RESPONSE VEHICLE DRIVERS

FOUR WHEEL DRIVING



Foreword

These training notes are designed to give you an insight into four wheel drive vehicle operation in off road situations. The information will give you the basic understanding of the drive trains available in 4WD vehicles and operating techniques to ensure you can achieve the best from your vehicle to get through the off road obstacles without endangering yourself, passengers or vehicle.

The workshop is an introduction to four-wheel driving in off-road conditions. It is focused on the safety issues associated with 4WD operation and designed to teach both the vehicle limitations and more importantly driver limitations in off-road operations. You will not leave the day knowing everything there is to know about 4WD but you will have a sound foundation upon which to build through further experience and practicing the techniques taught.

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A handwritten signature in black ink, appearing to read 'R. McNamara', written over a horizontal line.

Richard McNamara
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Safety

Safety is utmost in all situations. A good off-road driver is one who knows their personal limitations and the limitations of the vehicle they are operating and drives accordingly

Remember, the driver always get the best ride because they are aware of what will happen next. Passengers could, for instance, be harmed by hitting their head on the roof etc. Always warn passengers of rough sections of track so they can brace themselves.

All passengers must wear seatbelts while the vehicle is moving

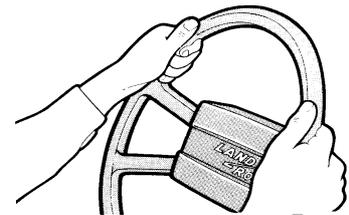
Ensure all equipment is secured and contained so that it cannot fall or escape from the vehicle.

Cross-country driving forces a change in mechanical handling techniques and a heightened increase in situational awareness.

The following points apply to all types and classes of (4WD) vehicles, although, clearly, light and heavy 4WD vehicles have differing capabilities and handling requirements.

Before embarking on cross country driving in any situation you must be aware that they may encounter a predicament from which their vehicle needs to be recovered. With that in mind you must always carry suitable recovery equipment

Always drive with your thumbs outermost on the steering wheel to prevent them from coming into contact with the spokes should the wheel move suddenly.



If cross-country driving is being undertaken in convoy, there must only be one vehicle negotiating a hazard at a time.

Always consider - **What If** the vehicle doesn't make it?

Always take the easiest option.

Vehicle Familiarisation

It is important to be familiar with the vehicle being driven. There are a variety of 4WD vehicles used within the MKRFA, and a variety of drive systems are available but there are only two types of drive train that are fitted to individual vehicles:

Part-Time Four Wheel Drive

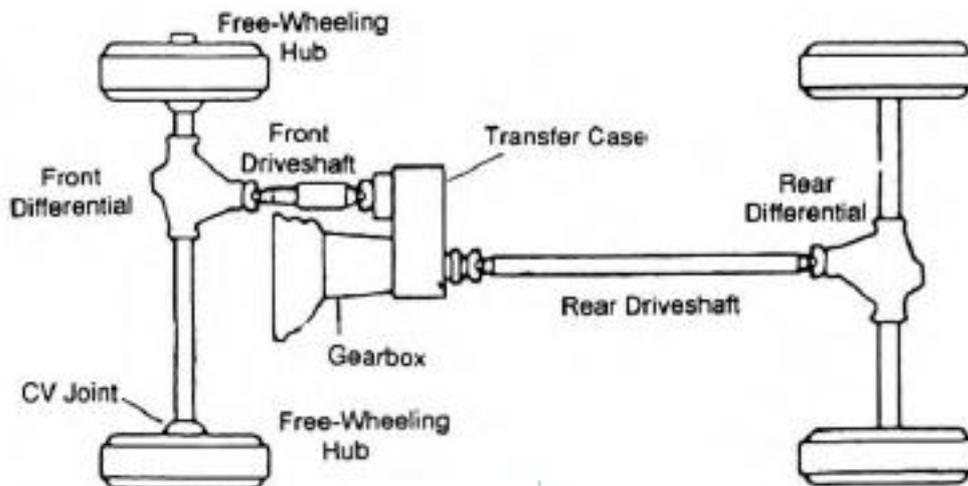
Part-time four-wheel drive (4WD) allows a vehicle to be driven in the two-wheel drive mode for ordinary road driving (which reduces drive-train friction and tyre wear for improved fuel economy and tyre life), and allows it to be switched to four-wheel drive when extra traction is needed (as when driving off-road, on gravel, snow, ice or mud).

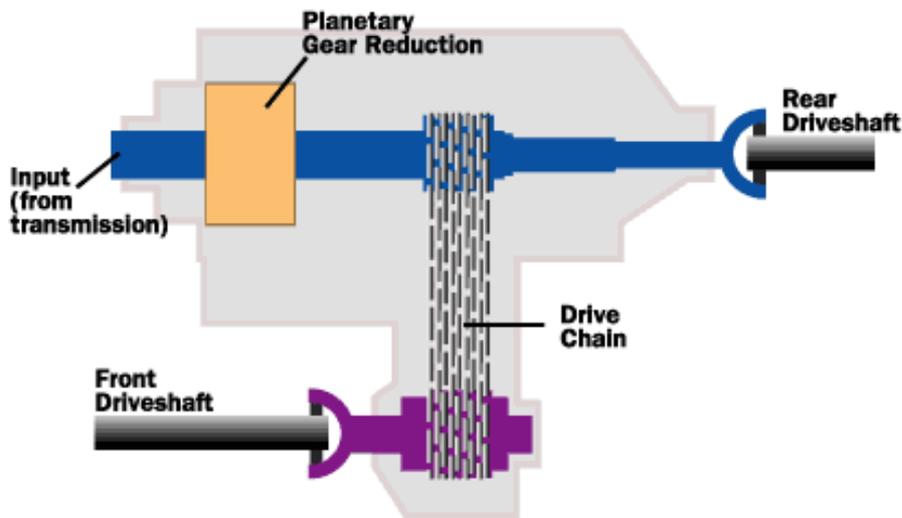
Vehicles with part-time four-wheel-drive usually have **locking hubs** on the front wheels. When four-wheel drive is not engaged, the locking hubs are used to disconnect the front wheels from the front differential, half-shafts (the shafts that connect the differential to the hub) and driveshaft. This allows the differential, half-shafts and driveshaft to stop spinning when the car is in two-wheel drive, saving wear and tear on those parts and improving fuel-economy.

Manual locking hubs used to be quite common. To engage four-wheel drive, the driver actually had to get out of the truck and turn a knob on the front wheels until the hubs locked. Newer systems have automatic locking hubs that engage when the driver switches into four-wheel drive. This type of system can usually be engaged while the vehicle is moving.

Whether manual or automatic, these systems generally use a sliding collar that locks the front half-shafts to the hub.

Vehicles with part-time 4WD also have a "transfer case" that splits drive torque between the front and rear axles. On some vehicles, the vehicle must be stopped or going slower than 5 km/h before the transfer case can be shifted from 2WD into 4WD. On others, the transfer case can be shifted on the go regardless of speed.





Transfer Case

This is the device that splits the power between the front and rear axles on a four-wheel-drive car. For normal sealed road use, power is transmitted to the rear axle only **2WD High Ratio**. For slippery surfaces and very minor off-road driving it is appropriate to engage the front axle drive **4WD High Ratio**

The **transfer case** on a part-time four-wheel-drive system locks the front-axle driveshaft to the rear-axle driveshaft, so the wheels are forced to spin at the same speed. This requires that the tyres slip when the car goes around a turn. Part-time systems like this should only be used in low-traction situations in which it is relatively easy for the tyres to slip. On dry concrete, it is not easy for the tyres to slip, so the four-wheel drive should be disengaged in order to avoid jerky turns and extra wear on the tyres and drivetrain.

Some transfer cases, more commonly those in part-time systems, also contain an additional set of gears that give the vehicle a **low range**. This extra gear ratio gives the vehicle extra torque and a super-slow output speed. In first gear in low range, the vehicle might have a top speed of about 8 kph, but incredible torque is produced at the wheels. This allows drivers to slowly and smoothly creep up very steep hills.

The transfer case selector has different layouts depending on the manufacturer and each position is designed for a specific purpose. In all older models the transfer system is controlled by a floor mounted lever however it is becoming more common to remotely control the shift positions utilizing dash mounted buttons or rotating switches

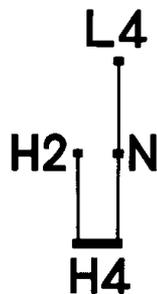
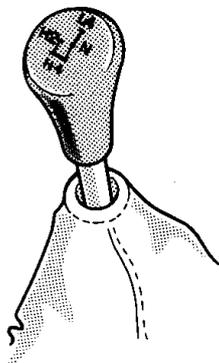
The position and purpose of each selection in the transfer case are detailed below:

High 2 (H2). Used for all normal driving on hard surfaces, level ground and good roads that a non-4WD vehicle would be capable of being operated.

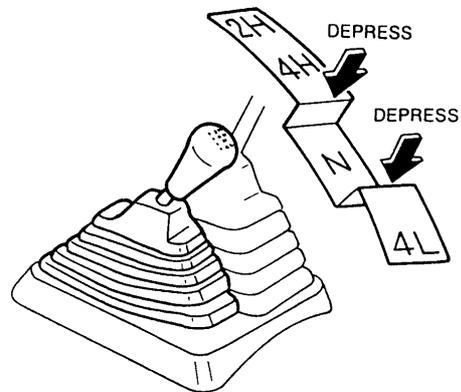
High 4 (H4). For use in conditions when the rear wheels could slip in H2 such as in snowy, icy or sandy conditions.

Neutral (N). Selected when equipment driven by the power take-off system is engaged – such as a winch - while the vehicle is stationary.

Low 4 (L4). When there is a need for maximum traction and power such as when climbing or descending steep grades, or operating in deep snow, mud or sand. Slower speeds in all gears including reverse. This lower set of gears unloads the clutch and main gear box and allows extra torque to be taken up by the heavier shaft and bearings in the transfer case. A good rule of thumb is to always select Low Range 4WD anytime you are off-road



Toyota Hilux Transfer Case Lever



Nissan Nivara Transfer Case Lever

Engaging 4WD (High Ratio) in a 4WD fitted with manual Transmission

Systems vary, but most vehicles allow 4WD high range (4H) engagement whilst driving at moderate road speeds (see owner's manual for speed limits).

Remember those vehicles fitted with manual free-wheeling hubs must have the hubs engaged to allow 4WD engagement. Some vehicles have automatic disconnecting differentials. These systems engage the front differential utilizing vacuum or electronic motor prior to engaging the drive at the transfer case.



The correct method for engaging 4WD ratio is as follows:

1. Reach for the transfer lever without taking your eyes off the road
2. Lightly shift the lever from the 2WD position to the 4WD high position.

Note: Should the lever vibrate, or a grating noise is heard then the hubs are not engaged preventing the shift, stop and engage the hubs before carrying out the above shift again

Engaging 4WD (Low Ratio) in a 4WD fitted with manual Transmission

The correct method for engaging 4WD low ratio and the only method to be used is as follows:

1. Stop the vehicle and depress the clutch.
2. Shift the transfer lever to required position.
3. Release the clutch.

Note: If difficulty in engaging 4WD is encountered, the clutch is to be released whilst slowly applying light pressure against the transfer lever.

Disengaging 4WD

The correct method for disengaging 4WD is:

1. Stop Vehicle. Depress clutch
2. Select High 2
3. Release clutch
4. Unlock front Hubs

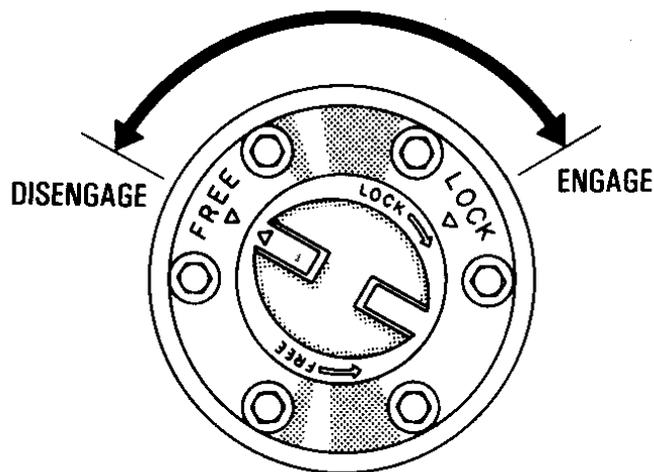
Locking Hubs

Each wheel in a car is bolted to a hub. Part-time four-wheel-drive vehicles usually have **locking hubs** on the front wheels. When four-wheel drive is not engaged, the locking hubs are used to disconnect the front wheels from the front differential, half-shafts (the shafts that connect the differential to the hub) and driveshaft. This allows the differential, half-shafts and driveshaft to stop spinning when the car is in two-wheel drive, saving wear and tear on those parts and improving fuel-economy.

Manual locking hubs used to be quite common. To engage four-wheel drive, the driver actually had to get out of the truck and turn a knob on the front wheels until the hubs locked. Newer systems have automatic locking hubs that engage when the driver switches into four-wheel drive. This type of system can usually be engaged while the vehicle is moving. In more modern 4WD vehicles, automatic-locking hubs are often used which, as the name implies, engage automatically when 4WD is activated from inside the vehicle. The main advantage is that the driver does not need to leave the vehicle to activate 4WD, or drive the vehicle in 2WD with the front axle engaged.

The disadvantage with this system is that most designs require the vehicle to move some distance (usually a whole wheel turn, often going backwards) after engaging 4WD, in order for the hubs to engage or disengage (in many cases, 4WD can be engaged with the vehicle moving). This might not be possible if the vehicle gets completely stuck before 4WD has been engaged, meaning automatic hubs require more caution on the driver's part.

Whether manual or automatic, these systems generally use a sliding collar that locks the front half-shafts to the hub.



Constant (Permanent) Four Wheel Drive

Full-time four-wheel drive, on the other hand, is just what the name implies. All four wheels are constantly driven by the engine to provide maximum traction. This type of setup is used on some performance cars to enhance handling traction. Most such vehicles have a "viscous coupling" in the drivetrain or transfer case that allows a certain amount of "give" in the drive torque between the front and rear wheels. This is necessary to compensate for the different speeds at which the front and rear wheels rotate when turning a tight corner. This arrangement gives improved handling but on its own is not helpful in true off-road conditions. One undesirable side effect is that if just one wheel loses traction and spins the differential would provide all the power to the spinning wheel resulting in no drive. To overcome this setback, vehicle with permanent 4WD have a centre differential lock

Centre Differential Lock

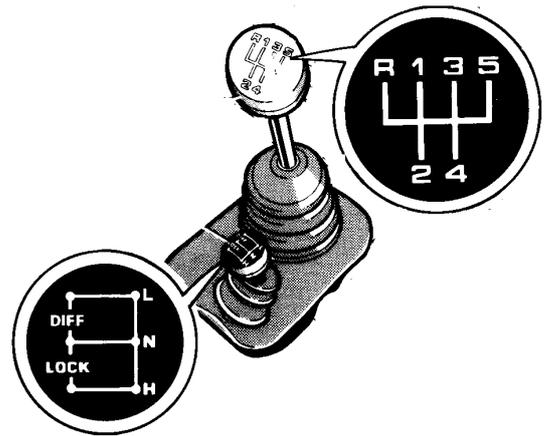
A manually operated differential lock creates a solid link that transmits power to both the front and rear axles on a 50/50 basis it effectively converts your all-wheel drive vehicle and makes it like a *part-time* four wheel drive in 4WD mode.

Transfer case Selections

Permanent 4WD has a third differential fitted in the transfer gearbox, which allows a high degree of mobility in off-road use. Entering conditions where traction is minimized, or is obvious that traction could or will be lost in a short distance in front of the vehicle the centre transfer differential can be locked by means of the differential lock control. This ensures a 50/50 split of power between the front and rear differentials.

Permanent 4WD transfer case positions and purpose are below

- *Fully Rearwards and Right*; Four-wheel drive and high ratio will be selected for use in normal driving conditions on hard surfaces and good roads.
- *Centre Right*; this position is selected when operating a winch or other equipment driven by the power take off (when vehicle is stationary).
- *Fully Forward and Right*; The Transfer gearbox low ratio is engaged for use in off-road conditions



- *Fully Rearwards and Left*; The High ratio is engaged and the central differential is locked for challenging off-road conditions such as those presented by sand or snow.
- *Centre Left.*; The Transfer box is in neutral and the centre differential is locked.
- *Fully Forwards and Left*; The Transfer gearbox low ratio and the centre differential are both engaged giving the vehicle maximum traction in the most severe off-road conditions.

Under certain conditions a slight delay may be experienced before the differential operates, with subsequent warning light illumination. This delay is a built in safety precaution and ensures that gears are correctly aligned before differential locking commences.

If the warning light does not extinguish, this indicates that the transmission is 'wound up' and in tension. The vehicle must be stopped and reversed a few metres to unwind the transmission, the warning light will then extinguish, and the vehicle can proceed.

Transmission Wind Up

When a part-time 4WD (without a centre differential) is in 4WD and attempts to corner on bitumen, all wheels need to rotate at different speeds, but without a centre differential they cannot. This creates the phenomena called "axle windup" or "transmission windup". High strain is placed on the drive shafts and transmission, eventually causing one of two things to happen. Either one of the wheels slips or spins to overcome the stress **or** the drive-shaft/transmission breaks. This is why part time 4WD's should **never** select 4WD on bitumen.

The centre diff lock should never be used on bitumen or non-slip surfaces for the reasons mentioned above.

Differentials

When a 4WD is travelling in a straight line all four wheels rotate at the same speed, but during cornering each wheel travels at a different speed due to the radius of the turn. All vehicles have a differential on the front and rear axles to allow the wheels on the same axle to rotate at a different speed.

Constant 4WD's have a central differential fitted to allow for different speeds between front and back wheels, but most part-time four-wheel drives do not.

In reality, a 4WD is only a 2WD drive with one front and one back wheel driving when traction is lost. One wheel on each axle spins while the other receives no drive at all due to the action of the differential. The exception to this is where a limited slip or locking differential is fitted. A limited slip diff allows a limited amount of drive to be applied to the stationary wheel before the other wheel on the same axle spins. A locking diff allows no slip at all and both wheels on the same axle turn at the same speed, regardless of the amount of traction.

Approach and Departure Angle

The approach angle is the steepest incline that the vehicle can approach from a level surface without touching any part of the vehicle. The departure angle is the same thing for the rear of the vehicle. The higher the angle, the lower the chance of impacting when climbing or reversing over obstacles.



Ramp over Angle

The ramp over angle is the largest peak that a vehicle can drive over without touching the underbody. A short wheelbase vehicle invariably has a better ramp over angle than a long wheelbase vehicle. The larger the angle the steeper peak the vehicle can travel over.



Four Wheel Driving Techniques

Ascending Slopes

Vehicles must only be driven straight up and down slopes and not across them. When a vehicle comes to a halt on a slope, either through lack of power or wheel spin, the clutch must not be engaged until the brakes have been applied and the vehicle stalled. The wheels should be 'chocked' as necessary.



Failure to Ascend

If forward momentum is lost whilst climbing a hill, the correct driving procedure is to:

- Apply the foot brake and clutch simultaneously.
- Select reverse gear.
- Gently release the clutch and brake together. Cover the brake pedal with the right foot and lightly utilize brakes if traction permits.
- Reverse under control down the slope. If the wheels lock, release the brakes until steering is regained, then re-apply the brakes gently.
- Hold the steering wheel firmly to avoid kickback.
- If engine stalls whilst in reverse, the brake pedal is to be released and the ignition key turned to restart the engine. Then, the brakes should be covered whilst continuing to reverse down the slope. It is important to ensure vehicle remains vertical on the hill.
- Keep the speed as slow as possible



Automatic Transmission Ascent Failure

While the basic principles still apply, the procedure in an automatic vehicle is as follows:

- Remove foot from accelerator and apply brake force with your left foot, evenly to ensure no excessive weight transfer is produced
- Select reverse in the transmission
- With your left foot on the brake apply throttle with your right foot to start the wheels turning
- Keep your throttle application at a constant level, this will force the wheels to turn
- Reduce pressure on the brake pedal and control the speeds of the vehicle through braking.
- Keep the speed as slow as possible
- On steep slopes control is attained through more throttle application

Important points to note to bear in mind whilst performing the above procedures are to ensure that:

- All actions are carried out in a deliberate, un-hurried manner.
- Gradual but firm braking is applied whilst simultaneously clutching in.
- A firm grip is kept on the steering wheel on the steering wheel if the vehicle should stall whilst reversing. At least one hand must remain on the steering wheel throughout the procedure to avoid kickback.
- Reverse gear is properly engaged.
- The clutch is slowly released, whilst easing the brake pressure.

Whilst procedures may need to be executed more quickly on slippery terrain, they should still be carried out in a deliberated, accurate and un-hurried manner.

If at any point the driver is unclear as to the alignment of the steering wheel to the track, the ignition key is to be turned off and the brakes are to be applied to enable a check to be carried out.

Stall Starts.

When forward momentum is lost whilst climbing a hill and the engine stalls the correct procedure is to:

- Allow the engine to stall and do not touch the clutch pedal.
- Apply the foot brake firmly.
- Gently press clutch to ensure that the brakes are holding the vehicle.
- Engage reverse gear and release the clutch.
- Ensure the way behind is clear.
- Release brakes gently to ensure reverse gear is properly engaged.

The left foot should be free of the clutch and the right foot should be hovering above the brake. The engine should start due to the gravitational effect on the vehicle.

ALWAYS ensure one hand is kept firmly on the steering wheel. The vehicle's attitude in relation to the slope is monitored since it is important that the vehicle is reversed straight down the hill. Immediately after stalling the vehicle may need straightening up.

If the brakes do not hold the vehicle on the slope, then reverse gear is engaged quickly as the vehicle starts to move backwards.

Descent of Slopes

Before descending a slope, carry out a reconnaissance to ensure a safety runoff area and to confirm approach and departure angles.

Check out any rutted areas which will aid with directional control ensuring they go where you want to go and are not so deep to hinder progress.

ALWAYS drive straight down a slope and never across it.

Once you have assessed the area is safe to descend the following procedures should be applied.



Engage low ratio 4WD

Select 1st gear before reaching the crest and never attempt to change gear during descent.

Slowly drive over the crest with the engine at idle and apply threshold braking to keep the vehicle speed as slow as possible.

At this point it is common to apply too much braking and the vehicle stalls. If this happens, release the brakes as you turn the key to start engine. Never engage the clutch.

Maintain good steering control and avoid over-steering throughout the descent

If the vehicle starts to slide due to loss of surface traction release some brake pressure to allow the wheels to turn. On slippery tracks or when debris builds up in front of the wheels you may need to gently accelerate to allow the wheels to gain speed to match the slide or climb over the debris. Once traction is re-established gently decelerate and brake as required.

If you are on an uneven track where two point contact is likely, apply more brake pressure as this will stop the vehicle from lunging forward as the vehicle moves from four point contact to two point contact

“If you have to brake continuously all the way down the slope, you are in too high a gear”.



Traversing (Sidling)

There may be occasions when the rule of “always driving straight up or straight down slopes” cannot be followed and you find yourself having to drive across the face of a slope. This can be a potentially hazardous practice and the following points **must** be followed in all situations.

Conduct a thorough reconnaissance of the area ensuring there is sufficient traction to avoid a slide and no hidden holes or lumps that could encourage rollover. Always ensure you have a safe run off area below the crossing route. Momentum will reduce the roll over angle of a vehicle so it must be ensured the vehicle is driven as slowly as possible across any sidling to avoid any build-up of momentum.

Steering control is critical as the natural tendency is to steer uphill reducing the surface area contact of the front wheels with the ground.

If the vehicle starts to tip or reach its lateral limits, quickly turn the vehicle downhill into the runoff area.

On a steep slope a wheel track dug on the high side of the vehicle will help lower the vertical angle and also act as a trench to hold the vehicle in throughout the crossing.

Traversing or sidlings are very uncomfortable for the driver and passengers (especially on the uphill side) and a sense of rollover will be felt well before the vehicle reaches critical rollover point.

Remember the procedures and don't panic because if the clutch is depressed an increase in momentum will be created with a rollover the possible result.

Fording of rivers

Before attempting to ford water, vehicles must be prepared according to the instructions contained in the manufacturer's handbook. In general, most vehicles are capable of passing through water to a depth that reaches the centre of the vehicle axle, without special vehicle modifications although most MKRFA vehicles have been modified to incorporate differential breathers (**maximum recommended fording depth for Nissan Nivara is 600mm, Isuzu is 1000mm**). Each differential has a small nipple attached to its casing with a long section of plastic tubing running up to the engine bay for the front differential or underneath the deck at the rear for the rear differential. When a vehicle enters water, differentials can cool very quickly. As a consequence, air inside differentials contract which creates a vacuum which can suck water through the hub seals. With differential breathers in place, the air inside the differential can move freely with no danger of water entering it.

The best crossing place is at a recognised ford where the water is most likely to be at its shallowest. If there is no known ford, a place must be selected where the stream is at its widest, as this is likely to be the shallowest place. In every case reconnaissance is essential. The only way to do this is by walking into the water and testing for a firm riverbed and water depth. Though this is unpleasant, it is better than drowning or bogging the vehicle in mid-stream. Additionally, driver/operators must:



Ensure that entry and exit points are marked and that all drivers know which side of the markers to drive.

Identify and mark an alternative exit point further down river, for use in case of an emergency, prior to commencing crossing.

Check vehicle air intakes and be aware of their position before proceeding through the crossing.

Enter the water slowly in a low gear whilst maintaining a constant steady speed through the water (the gear used depends on the type of vehicle and conditions that may prevail).

Avoid changing gear whilst in the river.

Once clear of the river, in an appropriate location, stop the vehicle to wait for next vehicle in case they need to be recovered.

Ensure that vehicle air filters are clear of water or condensation.

Check the vehicle under-body for damage.

Ensure that on leaving the water, brakes are applied frequently while the vehicle is moving, until they have dried out and are working properly again although care should be exercised not to cause brake overheating (and subsequent damage) through applying them too harshly.

Note lower tyre pressures since cuts to the tyre will probably occur when the tyre pressure is low.

Rocky Surfaces

When crossing rocky ground, tyres should be kept at standard pressures or even raised. External cuts will probably occur when the tyre pressure is low. The best way to cross a boulder strewn or rocky piece of ground is to survey it first on foot and select the most suitable course. Driver/operators must appreciate the ground clearance of the vehicles and avoid passing over obstacles which are likely to damage the vehicle under-body. The driver is also to be aware of the running parts and low points of the vehicle and take this into account when crossing this type of terrain.

Mud and Swamps

The crossing of muddy or swampy area must be avoided unless there is an operational necessity to do so and there is no other viable alternative to crossing them.

When planning to cross such areas:

- A survey of the area needs to be conducted to identify suitable entry and exit points.



- Ensure they have a suitable recovery area in case the condition of the area has been underestimated.
- Can set tyres at a lower pressure to increase their footprint, although pressure is not to be reduced below 25psi and a means of re-inflation is to be available to restore to the correct road pressure after deflation.

In attempting to cross such areas:

- The tracks of preceding vehicles can sometimes be followed if the surface hasn't been damaged too much (a quick check will confirm this).
- In deep ruts, no attempt should be made by the driver to steer the vehicle as this will merely increase the resistance to movement by pushing the front wheels against the walls of the ruts.
- If wheel spin starts, the driver is to ease the throttle and if the vehicle stops, they are to attempt to reverse out.
- Drivers are not to accelerate since this just digs the wheels in more deeply.
- If reversing is unsuccessful initially, the driver/operator is to try rocking the vehicle, by selecting forward and reverse gear using a controlled throttle application. If this method is unsuccessful, the driver/operator is to stop and carry out the appropriate recovery procedure.
- Places where there are signs that a preceding vehicle has bogged down are to be avoided. Existing tracks can be straddled. In really deep mud where the vehicle sinks to its main frame the only methods of recovery are digging and winching. If no winch is available, dig out the vehicle, make ramps of any available hard material and try to drive out.

Cold Weather Conditions

When operating in very cold and wet conditions the driver is to endeavour to prevent the formation of ice on the outside of the windscreen. The equipment fitted to most vehicles for de-misting and de-icing by means of hot air directed at the inside of the screen may not always be adequate and it may be necessary to stop from time to time and scrape any ice which may have formed from the outside of the screen. This is to be done with a piece of wood or plastic, but care must be taken not to scratch the glass.

Some types of vehicles have a tendency for brake mechanisms to freeze up in very cold weather, especially when parking. To prevent this, brakes can be dried by applying them lightly several times when the vehicle is still in motion, just before parking which removes any accumulated water or mud from mechanisms and later freezing. If there is any chance of a frost, consideration is to be given to parking vehicles in suitable places with the handbrakes **OFF**.

Under no circumstances should an attempt be made to free frozen brakes by the use of engine power. Instead, a waiting period is to be undertaken until the ice thaws or heat is to be used to melt the ice.



Special attention should be paid to temperature control devices (thermostats, radiator blinds, etc).

Particular attention should be paid to frost precautions, especially the daily checking of the Antifreeze solution.

It becomes more important in cold weather conditions to anticipate the movement of pedestrians and other vehicles, and to allow for any error of judgement which they make.

Snow and Ice

Falls of snow causes various road conditions to develop. Just fallen, snow is deep and soft and a 4WD can safely be used. In these conditions driving is fairly straight forward unless the snow is above the level of the axles, in which case the vehicle tends to push along and build up a bank of snow in front of it. Snow drifts of over three feet in depth will have to be cleared manually or by use of a snow plough as the vehicle is unlikely to be able to push through such a depth.

Immediately after a snow plough has passed, or when the snow has been cleared manually, there will probably be a depth of two to three inches of packed snow left on the road. In these conditions vehicles with sound tyre treads may have no difficulty, but in the case of worn tyres it may be necessary to fit chains.

When a road has been in use for some time the snow becomes smooth and hard and possibly frozen. In such circumstances it may be impossible to drive without the use of chains. Vehicles fitted with 4WD may, however, be able to make progress. There will be a far greater danger of skidding, speed must kept low and extreme care must be exercised in brake and accelerator usage. Lastly, it may occur that a thaw is followed by further freezing, with the result that the road surface may be covered in solid ice. In such circumstances only essential road-usage is to be undertaken.

No attempt is to be made to drive cross-country in snow, over un- surveyed ground. Driver must be aware that on road, more space is required in order to stop a vehicle on snow or ice covered roads than in normal dry conditions.

Smoke

In extreme conditions the driver should make use of a passenger or co-driver who can direct the driver as to distance from the edge. In extreme cases it may be necessary for the co-driver or passenger to walk to one side in front of the vehicle. Additionally:

- a. Lights are to be turned on dip at all times.
- b. Hazard indicators are to be used.



Towing Trailers in OFF-ROAD ENVIRONMENT

Extreme care and consideration must be given when towing trailers in off-road environments.

Key Considerations must include

- Loading - Ensure the trailer is correctly loaded keeping the weight forward on the vehicle drawbar while keeping the COG as low as possible. The load must be correctly secured
- Braking - The vehicle with trailer attached will take longer to stop and watch for the trailer fish tailing during heavy braking
- Ascending - Careful assessment prior to ascending is important, as it is difficult to conduct ascent failure techniques with a trailer attached. Extra weight will affect a vehicles ability to ascend in most cases. You may need to unhook the trailer first and get a feel for the hill to ascertain suitability.
- Descending - The trailer will push the vehicle during descents which may result in loss of traction and the trailer may start to fish tail resulting in the need to accelerate to pull straight
- Articulation - Watch for the trailer cutting in on tight turns and appreciate approach and departure angles will be different.
- Reversing - Always use extreme care when reversing trailers in off road environments. It is best to utilise a guide in all situations where possible

Environmental considerations when towing trailers.

- Wind May affect trailer stability
- Visibility: Can be adversely affected by weather conditions.
- Traction: Additional combined weight of the combination will affect capabilities.
- Ground : Consider a route to maintain vehicle and trailer clearances. Coupling design limitations will dictate safe route selection.

Recovery Techniques

There are various types of recovery techniques, and every recovery situation is different. When encountering any situation;

- Ensure that no further damage/injury is done to the vehicle or personnel.
- Assess the situation to decide the best remedial action, whether to push ahead or recover rearwards.

It is almost certain that the first attempt is the best attempt. Clearly, if a vehicle is hanging precariously, then the first attempt may be the *only* attempt!

Types of recovery equipment which aid vehicle recovery greatly are:

- Winches, either electric or manual.

- Snatch blocks.
- Shovels.
- D' or Bow Shackles.
- Chains.
- Tow ropes.
- Axes and Machetes.
- Tree strops.
- Hi-lift jacks.
- Portable anchor equipment.

Potential recovery techniques are:

Digging.

An obstruction can be removed by digging. This method is time consuming and labour intensive but is a very effective if you are on your own. Ensure the vehicle is free by checking the under-body, the wheels and front and rear of the vehicle. Care must be taken not to reduce the ground clearance through digging out tyre tracks without removing under body restrictions

Remember: Work safely when working as a group when digging around a vehicle

Towing.

Ensure the rope intended for use is serviceable and of sufficient strength to recover the vehicle. To assist the tow, remove the suction from around the tyres and dig slopes in the direction of the pull

Key points when towing:

- The recovery vehicle has sufficient area to recover the immobile vehicle, and is positioned such that it is facing the direction of the recovery. This ensures the front and weaker differential is not overloaded
- The vehicles are joined together by means of the rope using only recognised towing connections. (Under no circumstances must the bumper or tow-ball be used).
- If towropes are to be joined, the method shown right is used.
- Always have the vehicles lined up as straight as possible.
- Communication and discussion is undertaken between the drivers of both vehicles. Subjects discussed are to include gear ratios, recovery techniques, and communication during the recovery.
- Check all equipment before conducting the tow and ensure all bystanders are well clear of the area





Vehicle Checks

Due to the harsh and unforgiving nature of the 4WD environment there are additional checks we should carry out prior to entering the environment to minimise vehicle damage and improve driver safety

Pre Checks

- Mirrors in (as required).
- Load checked for security.
- Select 4WD and lock hubs.

On completion of the 4WD operation checks must be carried out to confirm no damage has occurred while off-road and to make sure the vehicle is safe to travel back on the road.

Post Checks

- Disengage hubs and select 2WD.
- Check Air Filter for water or excessive dust.
- Oil level and colour.
- Lights for cleanliness and operation.
- Loose Debris.
- Equipment check.
- Under-body Check comprising:
 - Steering Linkages and Arms
 - Front and Rear Differentials and Axles
 - Suspension
 - Cables and Wires
 - Skid Pans

Clean licence Plate and ensure all licencing documentation are still displayed, tyres are not damaged and inflated correctly

Any defects should be rectified prior to operating the vehicles back on road at high road speeds and with other road users

Remember these notes are only a basic guide to 4WD. You will have learnt practical skills to promote safety first when operating in off-road environments

The changing nature of the 4WD environment means that experiences gained through practical involvement is the only way in which to further develop skills and improve confidence in operating 4WD vehicles

The key is to always know your own limitations along with the limitations of the vehicle.

Questions to ask yourself as the driver

What is the best route and approach through?

Is there an alternative, safer route I can take to avoid this hazard?

Can I get to a safe point and back to where I started?

Am I capable of negotiating this hazard with my experience?

Be brutally honest. As a hurried decision could lead to trouble

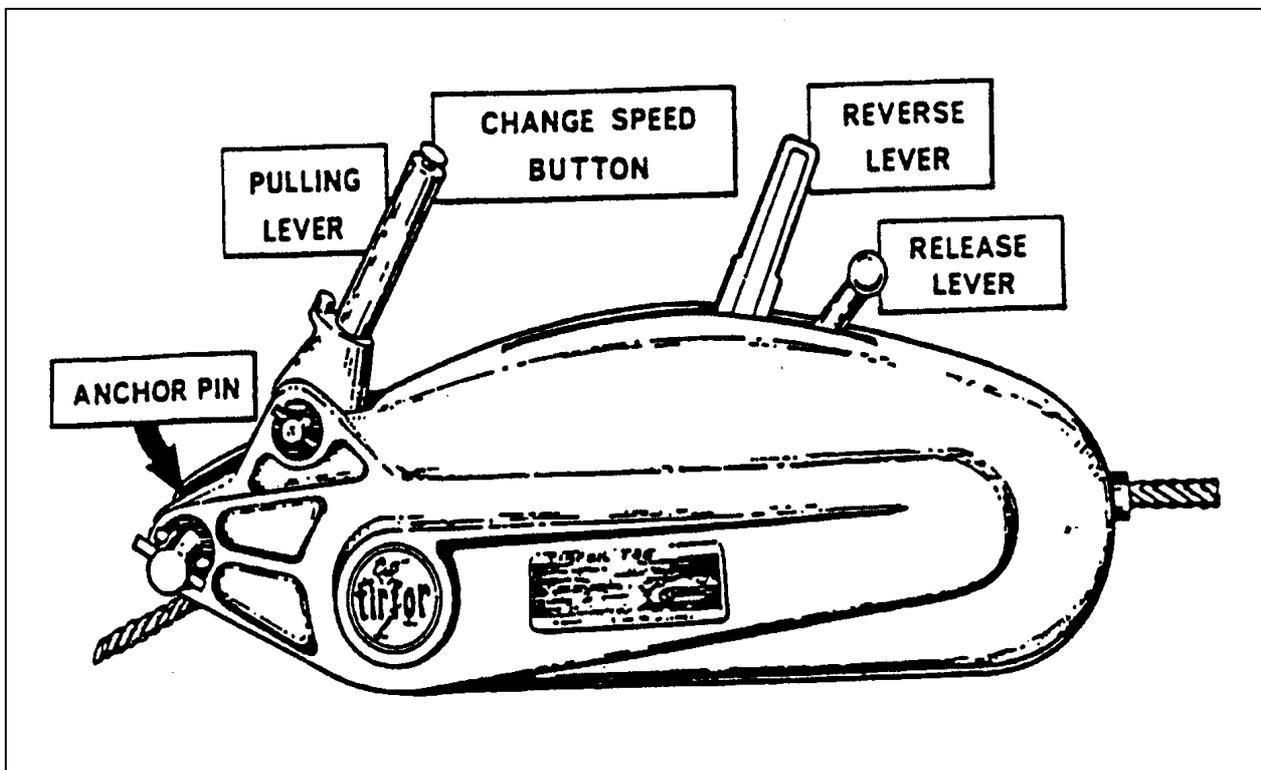
Is the vehicle capable of negotiating this hazard with my experience?

Can I maintain traction?

Is it worth the risk? Is there sufficient safety margins?

Can I get to where I'm needed with no risk to my crew, my vehicle or myself?

**ALL QUESTIONS PRESENTED MUST HAVE A POSITIVE ANSWER BEFORE
IT IS SAFE TO PROCEED**

SUPPLEMENT TO 4WD - OPERATING THE TRIFOR HAND WINCH**SAFETY**

Ensure that leather gloves are worn whenever handling the wire rope.

Only the special Tirfor wire rope is to be used with the Tirfor T532.

Tirfor hand winch wire rope is not to be used to sling loads; a separate wire rope sling is to be reserved for this purpose.

Inspect the rope and hook for any damage; if the rope or hook is damaged, do not use.

Inspect the winch. If there are any signs of damage that may affect the use of the winch, do not use.



PREPARATION

Before setting up winch, ensure that there is a suitable anchor point available.

Unwind wire rope to ensure that there is enough length between the winch and the stranded vehicle.

SET UP

Once equipment has been checked and deemed serviceable connection of the winch can be carried out. Ensure that:

- The winch is properly connected to a suitable anchor point.
- The release lever is in the recess, in the release position.
- Before the cable goes into the body of the winch, it must be wiped to minimise the entry of dirt, sand and grit.
- The wire rope is fed through the front of the winch until most of the slack between the stranded vehicle and the winch is taken up.
- The wire rope is correctly attached to the stranded vehicle.
- All connections are safe, appropriate and secure.
- Dampeners are placed on the rope to add resistance in case of rope breaking.

PRIOR TO WINCHING

All non-essential people are removed from the area to a safe location at a distance at least 1.5 times the length of rope between the vehicle and the winch.

There are at least two people in attendance to operate the winch.

The winching area is declared 'live' only once it is clear of non-essential personnel.

All non-essential people remain at the safe point until such time as they may be required to assist in winching or the rope is declared 'dead'.

OPERATING THE TRIFOR WINCH

Operating the hand winch is identical for either lifting or pulling applications.

The forward operating lever is fitted with a shear pin to prevent overloads and protect the internal mechanism. If the shear pin is sheared, a new pin should be fitted (two spare shear pins will be found in the handle of the rope release lever).

The tail of the rope ejected from behind the machine is not to be used for any other purpose whatsoever whilst winching is in progress.

The machine is not to be left in the released position for long periods of time.

Regular cleaning and lubrication of the mechanism using oil SAE/EP 140 (or if not available a heavy motor oil SAE 10) is to be undertaken.



The progress of the operation and fatigue of operators is to be monitored. If a change-over of operators is required, the vehicle is to be secured and tension on the wire rope is to be released before permitting extra people into the area. Releasing tension can be done by selecting the reverse lever.

Once vehicle has been recovered, secure and release tension.
Disconnect wire rope from vehicle and declare rope dead.

APPENDIX 1

Driving Prompt Sheets



Pre and Post Checks

Pre Checks

1. Mirrors in (as required).
2. Aerial down.
3. Load checked for security.
4. Select 4WD and lock hubs.

Post Checks

1. Air Filter.
2. Oil level and colour.
3. Lights.
4. Loose Debris.
5. Disengage hubs and select 2WD.
6. Equipment check.
7. Under-body Check comprising:
8. Steering Linkages and Arms
9. Front and Rear Differentials and Axles
10. Suspension
11. Cables and Wires
12. Skid Pans

Basic 4WD Safety

1. Always take the easiest option.
2. Use four wheel drive only when required.
3. Check hubs every time you enter the vehicle as the driver.
4. Always recce and assess situations.
5. Seatbelts on (exception - rivers).
6. Only one vehicle in a hazard at one time.
7. Thumbs outside steering wheel.
8. Keep hands and arms inside the vehicle at all times.
9. Avoid driving across slopes, try where possible, to go straight up and down.
10. Always stow loose gear when traversing rough areas.
11. Track maintenance.



Ascents

Main Points

1. Recce the track.
2. Know your vehicle's capabilities, entry/exit and ramp over angles.
3. Position vehicle to drive straight up slope, not on any angle.
4. First attempt, first gear low range low revs.
5. Second attempt, first gear low range mid to high revs...this will increase your momentum.
6. Third attempt, second gear. Low range, mid to high revs.
7. Avoid sudden acceleration when ascending.
8. If traction is lost, decrease throttle to aid traction.
9. If momentum is lost, initiate failure to ascend action.
10. Decelerate upon reaching top.

Safety Points

1. Seatbelts on.
2. Ensure all loose gear stowed.
3. Always steer straight up slope.
4. If utilising stall start, ensure correct procedure used.

Failure to Ascend

Main Points

1. If forward motion is lost, apply foot brake and clutch simultaneously.
2. Select reverse gear.
3. Check way behind is clear.
4. Gently release clutch and brake together. Utilize "threshold" braking.
5. Reverse to base of hill. If wheels lock up, release brakes to regain wheel rotation then re-apply gently.
6. Hold steering wheel firmly to avoid steering kickback.
7. If engine stalls while in reverse, release clutch and brake pedals simultaneously, turn ignition key to restart engine, "threshold" braking and reverse down slope.
8. Ensure vehicle remains vertical on hill, i.e. watch excessive over steer

Safety Points

1. All actions are to be deliberate and not hurried.
2. Gradually but firmly apply brake whilst simultaneously clutching in.
3. Keep firm grip on steering wheel after stalling, at least one hand must remain on the wheel throughout to avoid kickback.
4. Make sure reverse gear is properly engaged.
5. Slowly release clutch, whilst easing the brake pressure.
6. Actions may need to be quicker on slippery terrain.
7. Ensure you know the position of your steering wheels.
8. Keep on the track whilst reversing, by utilising mirrors.
9. If unsure of position turn off ignition key and apply brake.

Engine stall during ascent

(Manual transmission only)

Main Points

1. Apply brake, then slowly engage clutch.
2. Select reverse gear.
3. Slowly release clutch, then brakes ensuring reverse has been correctly selected.
4. Turn ignition key to start engine. As vehicle starts to move, threshold braking and control descent to base of slope.
5. Ensure front wheels are steering in the desired direction, keeping the vehicle vertical to climb.

Safety Points

1. All actions are to be deliberate and not hurried.
2. Keep firm grip on steering wheel after stalling to avoid kickback.
3. Make sure reverse gear is properly engaged.
4. Maintain control of the steering wheel with at least one hand throughout procedure.
5. Use threshold braking.
6. Actions may need to be quicker on slippery terrain.
7. Ensure you know the position of your steering wheels.
8. Keep on the track whilst reversing.

Descents

Main Points

1. Recce track by walking, if necessary.
2. Know your vehicle's capabilities, entry/exit and ramp over angles.
3. Position vehicle to drive straight down slope, not on any angle.
4. First gear, low range, low revs.
5. Slowest possible speed at top of slope.
6. (Slow at the top, slow at the bottom).
7. Let engine braking do bulk of slowing vehicle.
8. Apply threshold braking.
9. Track maintenance.

Safety Points

1. Seatbelts on.
2. Ensure all gear is stowed and secure.
3. You may need to apply acceleration to regain traction.
4. Always steer straight down slope.
5. "Low and Slow".

Sidlings

Main Points

1. Carry out recce and safety margin checks, ie; safety run-off area.
2. Ensure ground texture can support weight of vehicle, so as to avoid breakaway.
3. Beware of hidden lumps/ holes on wheel path that may encourage rollover.
4. Be aware of loads, whether it the personnel or on roof racks, etc (unload if necessary).
5. Travel very slowly to avoid any build-up of momentum.
6. Always select lowest possible route.
7. In the event of a vehicle reaching the critical rollover point, turn steering down toward run-off area and accelerate.

Fording Rivers

Main Points

1. Widest point usually indicates shallowest depth.
2. Go straight across or slightly downstream.
3. Avoid crossing upstream of rapids.
4. Mark one entry and two exit points.
5. First exit straight across, alternative downstream.
6. Recce by walking, check for holes, soft areas, rocks, branches etc.
7. If exit is raised ensure it is approached straight on.
8. Brief everyone involved of entry/exit points...
 - of alternative exit point and...
 - which side of the vehicle the markers are on.

Safety Points

1. Only one vehicle in river at any time.
2. Driver is to ensure that all windows are down.
3. Driver is to ensure that all seat belts are off.
4. No gear changing.
5. Be aware of vehicles maximum fording depth.
6. Once across river, wait for vehicle following as a recovery option.
7. Ensure when leaving area brakes are dried off.
8. Carry out post checks
9. air filter check, under-body check.

Recovery Procedures

Main Points

Choose best method of recovery.

1. DIGGING... check attitude of vehicle.
 - a. Dig areas in front and back of wheels and sloping gently.
 - b. Underneath low points of vehicle.
 - c. The more work, the easier the vehicle is recovered.

Safety Points

- a. Watch for other people's hands and feet when using shovels.
- b. Don't get under vehicle.
- c. Watch for damage to tyre valves and vehicle parts with shovels.

2. TOWING...
 - a. Ensure towrope is serviceable and of correct SWL...Ropes may stretch.
 - b. Ensure towing vehicle has sufficient recovery area.
 - c. If possible face vehicles in same direction with same gears and ratio's.
 - d. If using a bridle, ensure clevis is "backed off" a quarter turn.
 - e. If joining two or more ropes, use correct linking procedure.
 - f. Brief all pers. involved in operation on
 - g. Gear selection,
 - h. Marshalling,
 - i. Communication between drivers of all vehicles.
 - j. Raise bonnet if towing equipment is attached to the front of the vehicle.

3. WINCHING...

Electric, as by hand with the following extras

 - a. Ensure familiarity with operation.
 - b. SWL changes as cable reels in (do not unwind winch cable beyond the last 5 turns – as indicated by red paint).
 - c. Engine on and switch on HEAT switch to charge battery.
 - d. Bonnet raised (if required).
 - e. Winch can get hot if operated for lengthy periods and will stop operating.
 - f. Ensure the remote control cable is in vehicle.

4. *WINCHING...By Hand*
 - a. Handle cable with gloves.
 - b. Visual check of cable to ensure: correct type, clean, no kinks or frays.
 - c. Ensure SWL not exceeded...use of snatch block.
 - d. Visual check of winch condition.
 - e. Proper use and observation of anchors for winching - i.e. dead-man etc.
 - f. Ensure cable is long enough.
 - g. Correct connection to vehicle... Bridle, clevis, ropes.
 - h. No stepping over "live cable".
 - i. All personnel out of "kill" zone.
 - j. Bonnet raised.
 - k. Safety person in towed vehicle.
 - l. Rotate staff.

Safety Points

1. Only one person in charge.
2. Don't step over cable or towrope when "live".
3. Bonnet raised during operation (if required).
4. All personnel out of "kill" zones and 1 ½ the length of the rope away from area.
5. Always wear gloves when handling steel wire winch cable.
6. Ensure operation is within correct SWL.
7. Monitor anchors during operation.
8. Bonnet raised during operation.
9. Ensure all equipment is accounted for and is properly stowed.



Swamp Driving

Main Points

1. Select shortest and safest route possible.
2. Check base/bed for condition:
 - a. vegetation mat
 - b. soft top layer with firm base
 - c. condition of base under water
3. Check water depth for intended path and be aware of vehicle's capabilities.
4. Mark entry/exit and any obstacles.
5. Assess situation for correct gear/ratio.
6. If first attempt unsuccessful reverse and attempt with more momentum, vehicle tracks?
7. Throttle control during passage.
8. Carry out post checks after exiting
 - a. dry brakes
 - b. vehicle components – under-body
 - c. air filter