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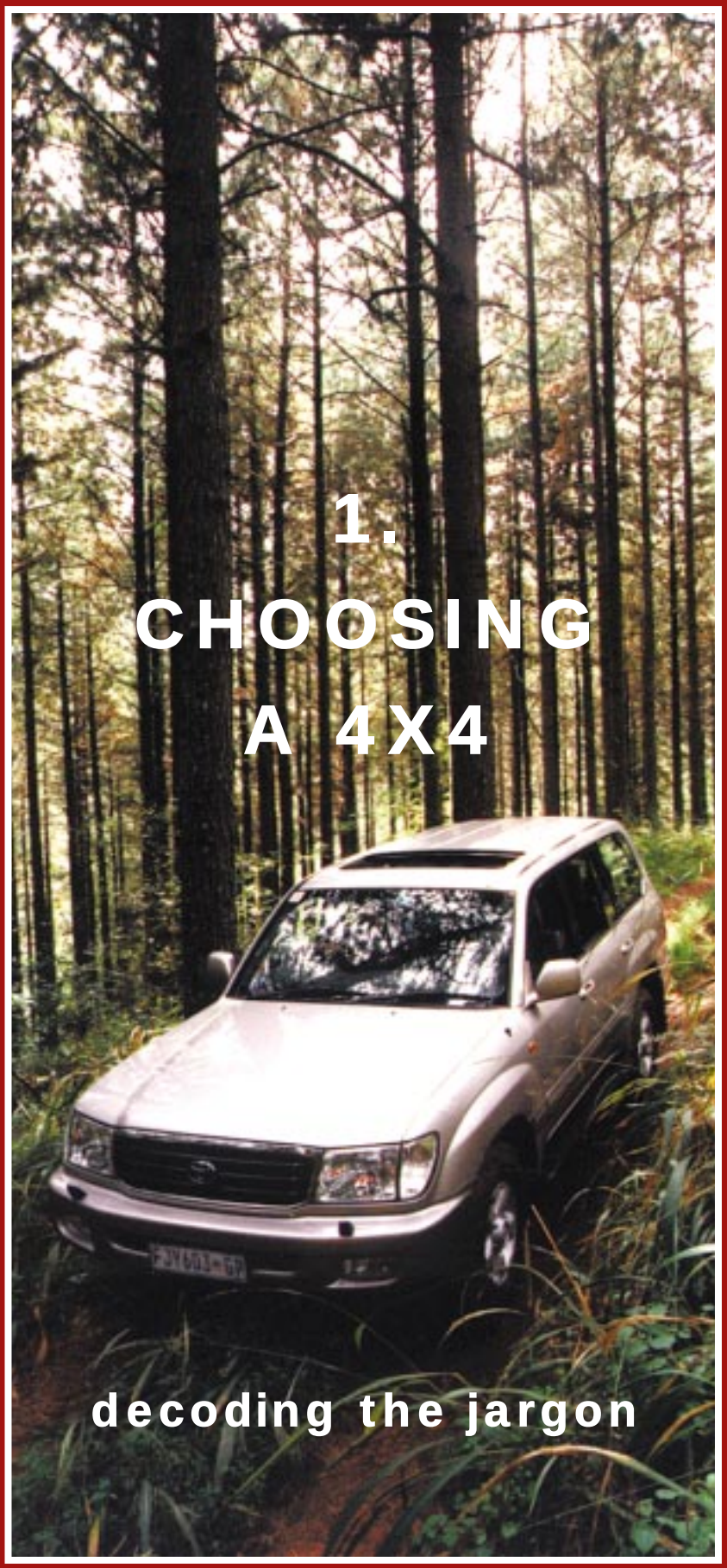
A sincere thank you to the following people who provided invaluable support for this edition :
Julian, Blake and Kelvin Snijman - travelling companions and all-round assistance
Jacques Maritz - travelling companion
Graham Eagle, Nissan South Africa - vehicles and other support
Wayne Asher, Continental Tyres - great tyres and endless support
Michael Lester, Toyota South Africa - vehicles and other support
Gwynn White, Sam Wrench and Carol Stephens



1.
CHOOSING A 4X4

decoding the jargon

The four-wheel drive vehicle has changed a great deal since it was first produced in any number, but at no time has this change been as swift as in the past 15 years. Between 1948 and 1968, vehicles like the Jeep CJ, Toyota Land Cruiser and Land Rover changed very little – they remained utilitarian, functional machines. In the late 1960s and early 1970s the market changed and Jeep built the Cherokee with power steering, Toyota produced a station wagon with wind-up windows, and Land Rover created the coil sprung Range Rover. Even the Range Rover, the leader in the leisure 4x4 market for decades, was a year and a half in production before any carpets were fitted.

Comparing the sales brochures of many of these originals with their modern equivalents reveals a completely different marketing strategy - vehicles that were once photographed climbing mountains are now seen in the polished environment of a studio. This illustrates how the image for most 4x4s has changed from rugged working machine to urban fashion statement. And now to compound the problem of choosing a suitable vehicle, manufacturers are creating 4x4s without true off-road ability and advertising them as off-roaders.

It is true that in the modern world comfort is as important as off-road working ability, but many four-wheel drives are becoming so sophisticated that while being brilliant off-roaders are totally unsuitable for wilderness travel. Sophistication makes servicing and repairs complicated, and not something to look forward to when in the bush miles away from civilisation.

As a result, all civilian four-wheel drive vehicles are a compromise between a town vehicle and an off-roader. Therefore, in selecting a vehicle designed for this double life, the buyer should ask this question: 'How much time will I be spending on tarred roads and how much off-road?' and 'If I intend to go off-road, do I want to travel into the wilderness?'

Every aspect of a four-wheel drive vehicle is compromised to some degree. What follows is a guide to variations in design and equipment that will be encountered when selecting a four-wheel drive vehicle.

ENGINES

The ideal powerplant for an off-roader is able to produce its power at low RPM. Engines that do this can be driven in higher gear ratios in difficult terrain which is advantageous because the higher the gear ratio, the less chance of wheel-spin and the more delicately the driver can control the engine's power output. Engines designed with long piston strokes tend to do this.

Good off-road driving technique calls for selecting the right gear for the conditions. If the gear ratio selected is too high, a more powerful engine may still have the torque to get through, but if the gear selected is too low, a big engine could, if not handled skilfully, cause excessive wheel-spin and bogging down. For a novice driver therefore, high power is often a disadvantage. For long distance travel, larger engines are more reliable than small ones because they rev slower – but the penalty comes in higher fuel consumption.

COMPARISONS: PETROL VERSUS DIESEL

PETROL ENGINES	DIESEL ENGINES
petrol engines are quiet	some models are very noisy
more mechanics understand petrol engines	fewer mechanics understand diesel engines
many multi-valve petrol engines produce top torque at high revs	diesel engines produce high torque at low revs
less frequent servicing required	more frequent servicing required
more complex electrical systems	more complex fuel systems
less economical, less range	more economical, more range
cheaper to service	more costly to service
fuel less pungent but more volatile	fuel more pungent, safer to transport

DIESEL ENGINES

As a rule, diesel engines produce their highest torque at low RPM. They are more economical than petrol engines and in many Third World countries diesel fuel is more readily available. Also, electrical problems caused by water, for example when wading, do not present a problem for the diesel engine. Although diesel engines are more fuel efficient than petrol, service intervals are shorter and in some cases will nullify any savings made by their lower fuel consumption. Regular servicing is especially important in Africa as the sometimes poor quality of diesel fuel can threaten engine life.

In Third World countries, fuel is frequently contaminated with dirt and water, with the result that fuel related problems cause more breakdowns than any other single factor. Ideally dual fuel filters systems should be fitted. At the very least, spare fuel filters must be carried.

Turbocharged diesel engines

Direct injection turbo-diesel engines have become a commonplace engine option with most four-wheel drive vehicle manufacturers. All turbo-diesel engines suffer from turbo-lag; the pause between

the time that the accelerator is pushed and power is applied to the wheels. The smaller the engine the more noticeable the lag. If the engine produces low torque before the turbo is working, driving very slowly at low engine revs will be difficult. If the engine produces high torque before the turbo is effective, then driving over obstacles at low engine speeds will be easy. This characteristic makes for a good off-roader. Some engines suffer from such severe turbo-lag that almost all off-road driving needs to be done in low-range first, and in this case vehicles tend to struggle.

As a long distance cruiser, turbo-diesels can be a real pleasure as they offer excellent on-road performance with superior fuel consumption, good torque for steep climbs, thick sand and mud. Another advantage of a turbo-charged engine is that altitude has less effect on performance than it has with a normally aspirated engine.

Some turbo-diesels are fitted with an intercooler, a radiator which acts to cool the hot air pumped by the turbocharger, which itself is powered by hot exhaust gases, before it enters the combustion chambers. They often increase power outputs by over 25%. As they are unsophisticated they are no burden for wilderness travel.

PETROL ENGINES

There are still many parts of Africa where diesel and leaded petrol are the only fuels available. Engines designed for unleaded petrol are therefore unsuitable for use as touring vehicles in Southern Africa. Poor quality petrol found in rural areas can also create problems with sophisticated high compression engines, clogging fuel filters and affecting sensitive fuel injection systems. Ideally, petrol engines in long distance touring vehicles should be simple to maintain and spare fuel filters should always be carried.
Unfortunately, modern 4x4s are being fitted with engines so complex that even basic servicing is designed to be done only at a dealer. I found out on a recent trip, after a deep wading incident had caused water to contaminate a Pajero's electrics, that special tools are needed to remove a Pajero's spark plugs. In this case the vehicle was abandoned and trained service personnel were taken to the stricken vehicle a week later. The petrol Pajero is not the only vehicle to fall into the category: 'If it breaks you will probably need professional help to fix it'.

Altitude also affects engine performance. A petrol engine with a compression ratio of about 8.5:1 will run well on 87 octane fuel above 5 000 feet or 93 octane at sea level. With a compression ratio higher than 8.5:1, a higher octane fuel would have to be used – 93 octane fuel at altitudes above 5 000 feet or 97 octane at sea level. It is important to consult the operator's handbook for recommended fuels. A fuel's octane rating is calculated from the rate at which the fuel burns. Running a low compression engine on high octane fuel will do no damage. In contrast, running a high compression engine on low octane or poor quality fuel could cause serious damage.

ENGINE MODIFICATIONS

Performance means different things to different motorists. For a 4x4, performance means flexibility; on-road power suitable for towing a boat, trailer or caravan, as well as low speed power and torque giving the vehicle the ability to traverse difficult terrain while maintaining low engine revs essential for driver control.

The four-wheel driver's vehicle has two kinds of life – on and off the road. However, different applications can affect performance; modifications to improve on-road performance may have detrimental effects on the vehicle's off-road abilities.

Vehicle manufacturers always strive to increase engine power without increasing the engine's size or weight. One of the ways of doing this is to improve the engine's capacity to breathe. Increasing the amount of air that can be consumed by an engine during the combustion cycle increases engine power. Fitting fuel injection, larger carburettors, free-flow exhaust systems or larger inlet and exhaust ports will increase this air flow.

Although the technology is not new, the trendy way to do this is to build engines with lots of valves. Multi-valve engines tend to have one thing in common: they develop higher power than similar standard valve engines, but at higher RPM, and this is a disadvantage in off-road driving. These engines have overhead camshafts, are normally fed by electronic fuel injection and are complex and expensive. They are built to withstand the stresses of running at very high revs, where they produce their maximum power. Maximum torque will also report for duty at higher revs.

Modifications to engine components to increase performance are many and varied. Some carburettor modifications are unsuitable for a vehicle expected to work in difficult off-road conditions, since many off-road vehicle carburettors are fitted with special float chambers which allow them to operate when tilted during steep ascents and descents. Fuel injection systems do not suffer when the engine operates at odd angles.

Fuel injection versus carburettor

Modern fuel injection systems are as reliable, if not more so, than carburettors and have the added benefit of lower maintenance requirements and better fuel efficiency. The drawback comes when a breakdown occurs. Fuel injection requires specialist knowledge to repair, unlike the carburettor, which is a relatively simple device requiring basic auto mechanical understanding to maintain or repair.

Beware of modifications that are unsuitable for off-roaders

Engine modifications which include increased breathing capacity, for example Brospeed conversions to Hilux, requires cutting a great big hole out of the air filter housing to increase air flow. This mod is not mentioned in the sales talk but renders the vehicle unsuitable for any (even shallow) wading. Many performance specialists are doing this and I have seen this mod on Land Rovers, Isuzus, Land Cruisers and Hiluxes.

Free-flow exhaust systems

Free-flow exhaust systems consist of big bore pipes and free-flow silencers. Standard engine exhaust manifolds are often cast iron, heavy, cheap to manufacture and inefficient. In the free-flow system there are big bore pipes bent and welded that allow the gas to flow more freely. The remainder of the exhaust is similar to the standard system but is made using big bore pipes and free flow silencers.

The advantages of free-flow exhausts are numerous:

- *They improve fuel economy and thereby increase a vehicle's range.*
- *They improve acceleration without negatively affecting the power and torque output rev-range.*
- *In many cases they are cheaper than a genuine factory part.*

Although not spectacular, individually these improvements are noticeable and make the vehicle more pleasant to drive. When fitted to my own vehicle, fuel consumption improved by about 1.5 litres per 100kms. I calculated that at today's fuel prices, for a new free-flow exhaust system to pay for itself in fuel savings, I would need to travel over ninety thousand kilometres!

If your existing exhaust system is due for replacement I recommend investigating fitting one of these systems. It is important to make sure that there are several mounting points and that the job is done well. Exhaust failures are common in rough country.

Electronic ignition

Electronic ignition systems are becoming very complex and in some cases ignition components have become unrecognisable. Familiar devices such as distributors are changing shape and, looking into the engine bay of vehicles like the Isuzu Trooper or Mitsubishi Pajero, I can no longer recognise half the components. Like complex fuel systems, complex ignition systems improve efficiency but make the vehicle impossible to repair by the humble garage mechanic found in remote areas of the country.

Most modern 4x4s have an electronic ignition fitted as standard equipment and it is therefore essential that a workshop manual be carried in the vehicle in the event of breakdown. Even though you

Toyota Land Cruiser Prado 4-cylinder in-line 3-litre turbo-charged diesel is typical of modern turbo-diesel engines. It is superb for off-road use as it produces enough torque before the turbo boosts power to allow easy off-road manoeuvring at very low engine speeds.

may not be able to understand its contents, with any luck the mechanic you find, should you break down, will.

Electronic ignition has distinct advantages over the old fashioned contact breaker type. Briefly, contact breaker ignitions have components that wear and must be regularly adjusted or replaced. If you have modified your ignition system with an 'off the shelf' breakerless ignition system, I strongly advise you to carry spare parts of all the components that will allow you to replace your ignition with the original system.

Take a lesson from my own experience. In 1982 I replaced my Range Rover's troublesome contact breaker system with the very well-proven Ilumenition electronic type. Early one morning, six months later while camped in central Botswana the engine failed to start. After a brief check I discovered that the plugs were not firing and that the ignition system had failed. The system proved irreparable and the only solution was to refit the original system, the components of which I carried in my spare parts box. The safari continued without further problems.

Turbo chargers

As already mentioned when we discussed multi-valve engines, improving the breathing ability of an engine will result in increased power. Turbo charging is a highly sophisticated way of doing this, except it goes one step further – it actually forces air under pressure into the inlet manifold. This is done by fitting a turbine that uses the pressure of the exhaust gases to push air under pressure into the combustion chambers. The fitting of turbo chargers is highly technical and should be left to the specialist. A turbo charger cannot simply be 'bolted on'. Normally the engine has to be rebuilt with a lower compression ratio. The exhaust, as well as numerous other components, have to be modified to install the turbine.

Advantages of turbo charging:

- *Combined with petrol engines, turbo-chargers offer enormous power increase for little extra weight and little loss of fuel efficiency.*
- *Combined with diesel engines, turbo-chargers offer increased power, remarkable fuel efficiency and excellent driveability.*
- *Power is less affected by altitude.*

Disadvantages of turbo charging:

- *Throttle lag can be a problem which is sometimes difficult to overcome. A time lag on the throttle can make off-road driving very difficult.*
- *If the system is not well fitted or not well designed, the result could be severely increased engine wear.*
- *Complicated – learn about the system fitted to your vehicle before you leave home.*

FOUR-WHEEL DRIVE
TRANSMISSION SYSTEMS

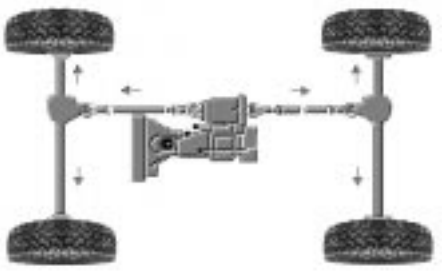
Transmission systems for off-road vehicles are unique. Unlike a normal road vehicle where the gearbox is a single unit, off-road vehicle gearboxes comprise two, three and sometimes four units:

1. The main gearbox
Similar to a normal road vehicle's gearbox but built to withstand heavier torque loads.

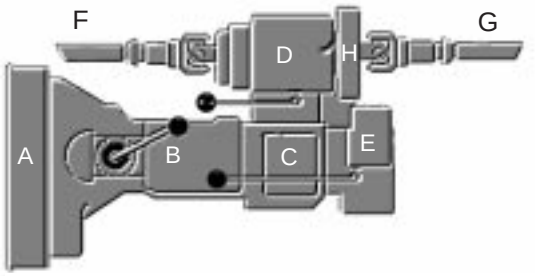
2. The transfer gearbox
Power from the engine is transmitted via the main gearbox to the transfer gearbox which is a two-ratio unit reducing the overall gearing. The result is two individual sets of forward and reverse gears. The lower gear ratios are used for off-road work or starting off on a steep slope when towing heavy loads. From here power is transmitted to the front and rear propshafts in the case of part-time four-wheel drive vehicles and to the centre differential in the case of permanent four-wheel drive vehicles.

3. The centre differential
Located between the front and rear propshafts, this third differential is only fitted to permanent four-wheel drive systems. They require a locking device that, when engaged, locks the front and rear propshafts together and is used when the vehicle traverses difficult terrain.

4. The overdrive unit
Fitted as optional equipment to some older vehicles, the overdrive is a gearbox that adds an additional high gear ratio to extend the legs of vehicles for highway use. Overdrives are built for the relatively light duty of motorway cruising and must never be used in conjunction with low gear ratios.



Four-wheel drive transmission layout



A. Bell Housing
B: Main Gearbox
C: Transfer Gearbox
D: Centre Differential (full-time 4x4 only)
E: Overdrive (older 4-speed models - optional)
F: Front Propshaft
G: Rear Propshaft
H: Transmission (hand) brake (on selected models)

Four-wheel drive central transmission components

MANUAL VERSUS AUTOMATIC TRANSMISSION

Manual transmission is the obvious choice for a vehicle that will be hard working. It gives superior engine braking when descending slopes and better control when driving over rough ground. Automatic transmission does have some advantages when in difficulty though – it allows very gradual application of power to the wheels which would only be possible by slipping the clutch with a manual gearbox. In this way wheel-spin can be avoided when starting off on slippery ground. Also, the technique of 'rocking', as a method of getting a vehicle out of a near-bogged situation in mud, is made easier.

Automatic Gearboxes

Advantages: They make for more relaxed driving on road. For a novice off-road auto transmissions are a pleasure.
Disadvantages: Off-road, they are less versatile than manual gearboxes and are often a source of frustration to the experienced driver. With some vehicles, engine braking with an automatic gearbox is effective, but with others it is not and descending steep slopes can be difficult.

Automatic transmissions are uneconomical, they often overheat if worked hard in heavy sand conditions and fewer mechanics understand them. A vehicle with an automatic gearbox cannot be push started, nor can it be towed without causing damage to the gearbox – this is because the rotating wheels will turn the gearbox without it lubricating properly.

Electronic Hill Descent Control

Electronic Hill Descent Control (HDC) is a Land Rover invention which acts in conjunction with the anti-locking brakes (ABS) to slow a vehicle on steep descents. It is particularly valuable with automatic gearboxes which are not effective in transmitting compression braking from the engine to the wheels. Other manufacturers are developing similar systems such as that fitted to the Mercedes M-class. It is very effective and valuable with both manual and automatic transmissions, especially for novice drivers.

The Freelander's hill-descent control button is found on the gearshift.

Traction Control systems

Various systems developed by manufacturers to cancel out the effects of axle differentials to improve traction range from electronic traction control working with the anti-lock braking system in the Mercedes M-class and Range Rover and hydraulic power transfer systems or Quadra-drive system of the new Grand Cherokee are beyond the scope of this book to illustrate in detail. It is enough to say that they assist traction when wheels leave the ground or spin when the surface gets slippery. The most outstanding of all these systems is Jeep's Quadra-drive system.

Because repairing 4x4 gearboxes is expensive, make it a priority to ensure that it is sound. In this case the Range Rover's inside had to be stripped in order to remove and refit the gearbox.

PERMANENT VERSUS SELECTABLE FOUR-WHEEL DRIVE

Permanent four-wheel drive

Permanent four-wheel drive has been an option for the off-road motorist for many years but only in the last 20 has it been recognised as the most reliable and user friendly type of four-whee drive transmission. It has been fitted to vehicles such as the Jeep CJ 6 & CJ 7 and the Range Rover since the early 1970s, the Land Rover 110 and 90 since the early eighties, and the Mercedes Gelandewagen and VW Syncro minibus and the Toyota Land Cruiser in the 1990s. The Mitsubishi Pajero and Shogun offer a choice of part-time and permanent four-wheel drive with a system called 'Super-Select'.

Most permanent four-wheel drive vehicles have a centre differential located between the front and rear propshafts to prevent wind-up caused by the different rotation speeds of wheels on sealed surfaces. (In the case of the VW Syncro bus and Range Rovers with automatic gearboxes it is a hydraulic viscous coupling). This differential can be locked for off-road work and with some vehicles, such as the Jeeps with the 'Quadra-Trac' system, the vehicle needs to be reversed to unlock this diff.

The advantages of full-time four-wheel drive transmission are numerous. It is very reliable and is highly suitable if the vehicle spends a lot of its time in difficult conditions. The driver does not need to make a conscious decision to go into four-wheel drive – it is there all the time, and if conditions are really tough, he may decide that centre diff-lock is needed which can be engaged while on the move. If the wheels are spinning at different speeds, the differential lock will not engage owing to safety mechanisms built

into the system to prevent transmission damage. In these situations, gently releasing the accelerator will allow all of the wheels to rotate at the same speed and the diff-lock to engage.

In any vehicle with the transmission locked in four-wheel drive, there is a tendency to display noticeable understeer. With a permanent four-wheel drive vehicle with the centre diff unlocked, the understeering tendency is less pronounced while traction is far superior to a vehicle in two-wheel drive.

On-road performance is also enhanced by the permanent four-wheel drive system. Try comparing the handling of a standard two-wheel drive VW Kombi with that of the four-wheel drive VW Kombi Syncro on a wet surface – the difference is staggering. Or, drive a Range Rover with the front propshaft removed – thoroughly unpleasant!

Contrary to popular belief, the permanent four-wheel drive system decreases tyre wear and does not affect fuel consumption greatly. Although there is no rule for the increase in fuel consumption caused by four-wheel drive while cruising, from the reports I have heard it may be as much as 5% – hardly significant considering the increase in safety it provides.

Selectable/Part-time four-wheel drive

This system is less expensive to produce owing to the absence of a centre differential, which is not required, since the front propshaft is disengaged when engaged in two-wheel drive.

When a vehicle with selectable four-wheel drive is engaged in four-wheel drive, it is equivalent to a permanent four-wheel drive vehicle with its centre differential locked. With selectable 4WD systems, because the rotation of the front axle side shafts and propshaft do not serve any purpose when travelling on firm surfaces, free wheeling hubs disconnect these components and will improve fuel consumption. Free-wheel hubs are covered later in this chapter.

Part time 4WD vehicles pay a penalty in that the rear tyres (those used for driving the vehicle when in two-wheel drive) wear out before the front. This is especially true of vehicles driven in rough conditions where 4WD should have been engaged but was not because the driver did not feel it was necessary. Frequent tyre rotation is therefore recommended.

Super-Select four-wheel drive

Super-Select four-wheel drive is found in the Mitsubishi Shogun and Pajero. This system gives the operator the full range of traction options: part-time four-wheel drive (as in the older Pajero, Hilux, etc.) or permanent four-wheel drive with a centre differential which can be locked (as in the Discovery and Lada Niva etc). In some respects this is the ideal system. Its most serious disadvantage is drivers not using the system to its best advantage and not engaging four-wheel drive when they should. Unless this expensive and complex system is used properly, the buyer has spent his money on a gimmick rather than a system that will benefit the driver.

HYDRAULIC VISCOUS COUPLING

The hydraulic viscous coupling is a fairly new technology and solves all of the problems of axle wind-up while at the same time operating as a non-slip differential. It replaces the centre-differential on vehicles like the automatic Range Rover, VW Syncro and Jeep Grand Cherokee. The hydraulic viscous coupling works like a centre differential which is permanently locked but still absorbs all wind-up caused when driving on firm surfaces.

The viscous coupling is a sealed unit containing a series of interleaved slotted steel plates. A second set of plates is attached to the drive shaft. The two sets of plates run equidistant to each other and allow a certain degree of slip between them. However, as this difference increases, the special silicon fluid inside the housing causes the shear forces to lead to a progressive locking of the plates. The result is a progressive locking of the coupling and the drive transferred to the axle which needs it most. Undoubtedly due to cost factors, these are not widely used in off-road vehicles.

DIFFERENTIAL LOCKS: CENTRE, AXLE LOCKING AND LIMITED SLIP

The subject of diff locks is one of the most confusing and misunderstood aspects of four-wheel drive vehicles. This is illustrated by many 4x4 magazine buyer's guides which indicate in their expansive charts if a vehicle is equipped with a diff lock. Indicating a 'yes' or 'no' is too simplistic and confuses the issue because not all diff locks have the same function. What a diff lock does depends on which differential is being locked AND what kind of 4x4 transmission is fitted.

For example, a Land Rover's permanent four-wheel drive is equipped with a diff lock. An Isuzu Frontier's part-time four-wheel drive also has a diff lock. And yet when both of these vehicles are in four-wheel drive with their diff locks engaged, the configuration of the drive to the wheels is different. This is because the Land Rover's diff lock is locking a centre diff, thereby locking the front and rear propshafts together and the Isuzu's diff lock is located on the rear axle locking the left and right rear wheels together.

1. Part-time four-wheel drive transmissions have two differentials; one on the front axle and one on the rear axle.
2. Permanent or full-time four-wheel drive systems have three differentials. One on the front axle, one on the rear axle and one in the centre dividing the front and rear propshafts.
3. A differential lock on an axle prevents differential rotation between the two wheels on that axle.
4. A differential lock in the centre, or between the front and rear propshafts, prevents differential rotation between the propshafts.
5. Some permanent four-wheel drive vehicles also have locks on their rear axles. These vehicles therefore have two lockable differentials - centre and rear axle.
6. A few permanent four-wheel drive vehicles have all three of their differentials lockable - on the front axle, rear axle and in the centre. Examples are the Toyota Land Cruiser 100 GX and the

On steep hill climbs where the track turns sharply, like this one in the Western Cape, a rear axle differential lock is a valuable piece of equipment. In this case we accused the driver of 'cheating'. He had engaged both the rear and front diff locks and the Cruiser drove up as if it was looking for parking.

Mercedes Gelandewagen. When all these differentials are locked this is the ultimate configuration – all four wheels are rotating at the same speed no matter what. These various concepts are illustrated in more detail below.

Centre differential lock

Vehicles with permanent four-wheel drive need a differential between the front and rear axles to prevent transmission wind-up caused by the different rotation speeds of the front and rear wheels when cornering. Wind-up on rough surfaces will be taken up by slight wheel slip that would not be possible on a sealed surface.

When these vehicles are taken off-road, the differential must be locked to prevent wheel spin occurring on a single axle, ie a front wheel spinning while a rear wheel remains stationary, or vice versa. The differential lock will then lock the propshafts, and therefore lock the front and rear axles together.

Differential locks on individual axles

These prevent wheel-spin on opposite wheels on the same axle. They help tremendously in sticky situations particularly when two wheels on the same side drop into a trough and the axle is grounded, or when opposite front and back wheels leave the ground when traversing a ditch at an angle. Without axle diff locks, the two airborne wheels spin helplessly.

Axle diff locks can be a hindrance when engaged on flat ground where the surface is slippery but traction is similar on all four wheels. This is because a locked axle differential always causes understeer. Understeer causes disturbance and therefore increases the rolling resistance of the tyres which can cause a vehicle to bog down. Typical terrain on which this occurs is the beach. It is not uncommon for the inexperienced driver, who tends to use every tool at their disposal to prevent difficulty, to create more problems for themselves by locking an axle differential.

When diff locks are fitted to both the front and rear axles it is imperative that the rear lock is operated first. A vehicle moving over slippery ground with a locked front axle and an unlocked rear diff will want to spin out and may become very difficult to control.

Gearmax differential locks can be fitted to any South African-made rear axle.

Limited slip differentials

A limited slip rear differential does the same and gives the same advantages as a lockable differential but, as the name suggests, the advantage is limited. There is some slip, which can be an advantage and a disadvantage (see table on following page).

In most cases limited slip differentials are fitted on the rear axle only. This is usually advisable, for when fitted on both front and rear axles, some limited slip differentials can alter the vehicle's handling characteristics and even cause instability at speed. Modern examples are the Hydratrak LSD which incorporates a cartridge type fluid coupling which smoothly increases torque transfer to the wheel with slower rotation, and the Detroit Truetrac, which is claimed by the manufacturer to be suitable for fitting to the front axle of a 4x4 without causing the handling problems previously mentioned. These units are available in South Africa from Gearmax Parts and Service. See 'Post-delivery differential locks' on page 16.

ARB locker differential (top) and compressor (bottom).

COMPARISONS:
LOCKING DIFFERENTIAL vs LIMITED SLIP DIFFERENTIAL

LOCKING DIFFERENTIAL	LIMITED-SLIP DIFFERENTIAL
Engage/disengage controllability from inside the cab	No controllability
Misuse can lead to handling difficulties and excessive tyre wear	Misuse is not possible
Full locked position gives the best possible traction as the two wheels are locked together	Some compromise to traction as wheel slip can still occur, although far less than an ordinary differential
Additional wear and tear is negligible	Modern limited slips do not need regular rebuilding as do older types
Fairly costly	Less costly

* Automatic locking differentials are discussed below

Vacuum/Pneumatic differential locks

Until fairly recently the most common type of locking device was the air-locking diff, so called because it required a compressor to actuate the locking mechanism. These systems are still available and come from the USA, Australia and Great Britain. The ARB air-locker is one of the best available, especially if it is fitted to a front differential. This is because the mechanism disengages rapidly, very important when steering becomes difficult due to a locked front diff. Differential locks are also made in South Africa by Gearmax. They are engine-vacuum powered. They are simpler, less costly but because they rarely disengage on demand are unsuitable for front diffs.

Post-delivery differential locks

Don't fall into the trap and believe that a four-wheel drive vehicle must have an axle diff lock before it will be effective off-road. It is true that there are some obstacles that only vehicles with a lockable diff will negotiate with ease, but these can in so many cases be overcome with driving skill. However, if you intend tackling the very toughest off-road conditions then axle differential locks are essential. An axle diff lock is a 'nice to have' and not a 'must have' item.

The ultimate configuration is diff locks on the front and back but it is essential that the back diff is locked before the front. The best axle diff locks are the manually operated type and are a desirable addition to any vehicle expected to traverse very difficult terrain. Diff-locks are made in Australia by ARB and in South African by Gearmax Parts and Service.

Automatic locking differentials

Auto-lockers such as the Detroit Locker are automatic locking differential devices that lock when traction is needed, and disengage when a wheel needs to rotate at a different speed due to the vehicle turning on firm ground. No conscious decision has to be made to lock the differential – maximum traction is permanent. Automatic diff locks are a disadvantage in soft sand when the vehicle is turned, as the locking rear axle tends to cause drag on

the outside wheel hampering progress. Contrary to what the manufacturers claim, I do not advise fitting an auto diff lock to a front axle as it can cause severe handling difficulties on slippery surfaces. Because they cannot be manually disengaged, when steering becomes difficult, they are unsuited to front axles.

Auto and manual free-wheel hubs. Their only function is to save fuel on the open road. They must be engaged (manual) at the front wheels before the vehicle can be driven in four-wheel drive

FREE-WHEEL HUBS

Fitted to part-time (selectable) 4x4 vehicles, free-wheel hubs fit on the front wheel hubs and enable the side shafts and propshaft to be disconnected from the wheels. The one and only purpose behind free-wheel hubs is to prevent these components from rotating unnecessarily and thereby reduce fuel consumption when driving at speed on a firm surface.

Can free-wheel hubs, if engaged and operated on the road, damage the transmission? This is a very common question. The answer is no. However, the opposite is true; if hubs are left unlocked for long periods the following damage can result:

Bearing damage

On some vehicles the lubrication of the front hub bearings depends partly on axle rotation which sends oil to the bearings. With the front hubs disengaged, the axle remains stationary and the hub is not effectively lubricated.

Spline shaft damage

Spline shafts are located in the side shafts (in the case of vehicles with independent suspension) and in the propshafts (in the case of vehicles with solid axles) that allow for suspension travel as the vehicle moves over uneven ground. In conditions where the drive shafts are rotating, wear will be spread evenly over the splines. Should the drive shaft or propshaft remain stationary for long periods, as will occur if the hubs remain disengaged, the splines wear on a single plane. If serious uneven wear has occurred, drive shaft vibration will result. It is therefore important that, should you have free-wheel hubs fitted to your vehicle, you engage them once in a while and drive around.

If free-wheel hubs are not offered as standard equipment and you wish to fit them, do not skimp – cheap units fail when the going gets tough.

AUTOMATIC FREE-WHEEL HUBS

Portal axle on a Unimog.

Automatic free-wheel hubs engage the front wheels automatically when the front propshaft rotates under power, i.e. when 4x4 is selected in the cab. Old types of automatic free-wheel hubs did not lock when compression braking (descending steep slopes) or moving in reverse. Modern auto free-wheel hubs do operate when moving in reverse and down steep slopes.

Modern auto hubs are engaged simply by engaging four-wheel drive.

Auto-hubs have improved and have become as reliable as the manual types. For this reason many manufacturers are fitting these in preference to the manual types. Toyota, with their new Hilux elected to stay with manual types. The reason is that many fleet operators, already familiar with manual types, would not have to learn new techniques for new equipment. Many serious off-roaders still prefer manual types.

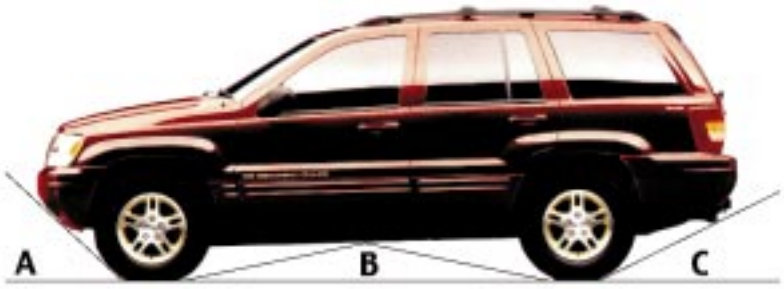
PORTAL AXLES

Reduction gearboxes fitted at each wheel hub serve to increase axle ground clearance. They are fitted to specialist off-road vehicles such as the Mercedes Unimog, Steyr-Daimler-Puch Pinzgauer and the Toyota Mega Cruiser.

GROUND CLEARANCE

Ground clearance is important not only under the vehicle but in front of, behind and between the axles as well. The front and rear overhangs (approach and departure angles), wheelbase in relation to wheel size (break-over angle) and centre of gravity (roll-over angle) are important factors which affect a vehicle's off-road ability. It can be seen by the following diagrams that a vehicle with a 'wheel in each corner' configuration, a short wheelbase and large wheels will be most effective off-road. However, this 'ideal' often gives the vehicle poor on-road handling characteristics.

When clearance specifications are given in data sheets issued by vehicle manufacturers they are normally the measurement taken from the lowest part of the vehicle to the ground on a flat surface. When a vehicle moves over ground this clearance moves constantly, more so if the suspension is of the independent type.



A. Approach angle; B. Ramp breakover angle C. Departure angle.

APPROACH ANGLE

This is stated as the maximum angle a vehicle can approach an obstacle without any part of the vehicle striking that obstacle.

DEPARTURE ANGLE

This is stated as the maximum angle a vehicle can leave an obstacle without any part of the vehicle striking that obstacle.

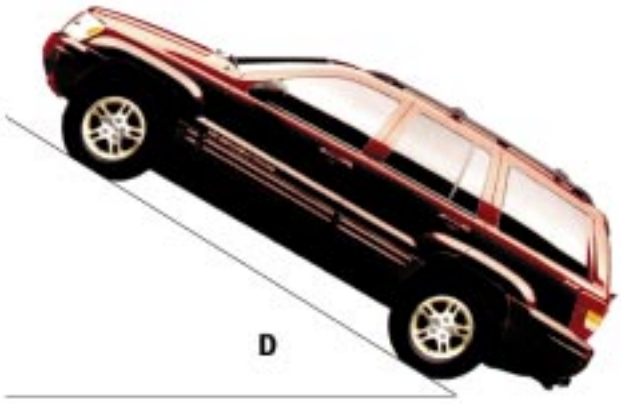
BREAK-OVER ANGLE

This is stated as the maximum angle a vehicle can ride over an obstacle without striking the obstacle between its axles. The longer the wheelbase the larger this angle becomes. On some vehicles, parts of the transmission protrude below the chassis and this also has a detrimental effect on the break-over angle. These components are prone to damage and the closer to the centre of the vehicle they are situated, the more vulnerable they are.

If you are fitting protective equipment or towing apparatus to your vehicle, consider the effect it may have on these angles.

UNDER-CHASSIS CLEARANCE

Vehicle specifications supplied by manufacturers offer a minimum ground clearance figure. This is measured from the part of the



D. The maximum climb angle, which can be represented as degrees from horizontal or a percentage of a one-in-one slope (100% = 45°) Figures supplied by manufacturers are based on a vehicle moving on a traction-perfect flat surface. In the real world, things are very different.

vehicle, excluding the wheels and tyres, closest to the ground. Some manufacturers hide poor clearance figures by measuring from the lowest part of the chassis ignoring suspension components which jut out lower. Critical to this figure is that the measurement is only true when the vehicle is stationary on a flat surface. The instant the vehicle moves, this figure changes, especially when the vehicle moves over uneven ground. Therefore this figure does not necessarily represent the vehicle's ability off-road.

When a wheel on a solid axle rides over an obstacle and lifts, it lifts the differential (normally the part of the vehicle closest to the ground) with it, thereby increasing ground clearance and clearing the differential over the obstacle. With independent suspension, the axle is independent of the differential and it is left in a vulnerable position closer to the ground. A second advantage of a solid axle is that it keeps the wheels perpendicular to the road surface during the increased roll caused by the high centre of gravity of an off-road vehicle when cornering. This improves road holding and handling. But, because solid axles are very heavy, independent suspension reduces the unsprung weight and this contributes to ride comfort on-road.

With a low centre of gravity and well-tuned suspension such as the Mercedes G-wagen has, at no time during this axle-twisting obstacle did the vehicle feel as if was going to roll over. If this vehicle had been equipped with a roof-rack I would not have attempted this obstacle. Note the rear wheels firmly on the ground.

ROLL-OVER ANGLE

This is the angle at which a vehicle will roll when traversing a slope at right angles. This value is a result of the distance of the vehicle's centre of gravity above the ground. Some manufacturers supply this figure under vehicle specifications.

WHEELBASE

The choice of wheelbase should be determined by the kind of work the vehicle is likely to undertake and the loads to be carried. Long wheelbase vehicles can carry heavier payloads and have a higher seating capacity. They handle better on the road and handle better on corrugations and on fast unsurfaced roads.

Short wheelbase vehicles, however, have the edge when driving off-road. The break-over angle is better and they are lighter to steer and more manoeuverable. They are generally lighter and this means that smaller engines can drive them. They are also therefore more economical.

SUSPENSION

No compromise made to improve off-road ability or on-road comfort is more noticeable than those made to the suspension. The type and rating of the springs, the configuration of the axle location and the axle design all have a significant effect on a vehicle's ability and comfort both off and on the road.

AXLE ARTICULATION

No single compromise to the suspension system is more noticeable than axle articulation. Axle articulation is the suspension's ability to allow the wheels to move vertically, to drop into deep ruts and follow the contours of the ground without ever leaving it and thereby losing traction. Articulation is therefore very important to an off-road vehicle but to a road cruiser it is a curse because it allows the body to roll as the vehicle is cornered.

A very good comparison can be made in this instance when two very similar vehicles are compared – the Land Rover Discovery and the Mitsubishi Pajero. The Discovery has beam axles and coil springs all round with light-duty anti-roll bars. The Pajero on the

The original Range Rover's axle articulation is the best of any vehicle in its class and makes the vehicle very easy to drive over rough ground. The downside is high body-roll when cornering. Full-time four-wheel drive compensates for this by ensuring negative steering and outstanding road holding

other hand has independent front coil springs and a solid rear axle, also on coil springs. It is also fitted with rather heavy anti-roll bars. Off road the Discovery is superior, due principally to its excellent axle articulation and solid axles. The Pajero suffers from a lack of axle articulation but scores on the road in every respect.

AXLE DESIGN

Two types of axles are fitted to off-road vehicles – independent and live/solid beam axles.

Springs

Two types of springs are fitted to off-road vehicles – coil springs and leaf springs. Solid beam axles are either fitted with leaf or coil springs while independent axles are fitted with coil springs or torsion bars, or both. Another system, based on pneumatic cylinders in place of springs, permits variable ride-height adjustment from the cab and is fitted to the new Range Rover. This highly sophisticated system is controlled by a computer.

Solid/live axles versus independent

If the vehicle is going to spend most of its time in the bush or will be worked hard in very rough country, rigid solid beam axles, also known as 'live axles', are stronger and more reliable than independent suspension. Solid axles are also better suited for difficult off-road conditions. Although independent suspension is able to offer superior axle articulation because the axle is independent of the differential, this is not the case with the current range of vehicles available today, with the possible exception of the giant Toyota Mega Cruiser. In general, vehicles with the best axle articulation are those with solid axles and coil springs front and back.

Coil versus leaf springs

Coil springs make for a better ride both on and off the road. This is because they absorb vibration better than leaf springs and suspension designers can take advantage of unrestricted axle articulation offered by coil springs.

Coil spring designs require axle location arms to locate the axle to the chassis – a job which leaf springs do themselves. These arms come in the form of radius arms at the front, trailing arms at the rear and panhard rods or similar to locate the axle laterally. These suspension systems can absorb irregularities in the road surface so efficiently that vehicles get damaged often long before the driver realises the damage he is doing. One of the philosophies behind maintaining the production of 4X4s with leaf spring suspension for so long was the fact that an uncomfortable ride limits the driver's endurance before limiting the vehicle's. With the smooth ride given by coil springs, vehicles are driven faster and often with excessive speed over rough ground.

Axle straps

Some vehicles, often those equipped with leaf springs, have heavy duty nylon straps attached to the chassis and looped around the

axle at each hub. These prevent spring breakages where suspension travel over uneven ground allows the axle to drop too far.

Shock absorbers

Shock absorbers correct the oscillation of the road springs. When operating off-road they work harder than on-road because the axle travel is greatly amplified. Because of this they are a vital part of the suspension system and in most cases, those supplied by the vehicle manufacturers are the minimum required for safety and vehicle controllability. If you are considering improving the ride and handling upgrading the shock absorbers is the first thing to consider. These and other suspension modifications are discussed in chapter 3, 'Auxiliary Equipment'.

SUSPENSION CONFIGURATIONS

These diagrams illustrate the variations in suspension systems fitted to off-road vehicles.

Front coil springs and a solid axle are always combined with a similar setup on the rear, the illustrations being of the new Nissan Patrol. This setup offers the best combination for off-road ability. Examples: Land Rover 90,110 and 130, Mercedes Gelandewagen & Unimog, Toyota Land Cruiser FJ80, some imported Land Cruiser FJ75s, Nissan Patrol and old Range Rover.
(diagram 1 courtesy of Nissan)

Rear coil springs and a solid axle are also combined with independent front suspension such as the Mitsubishi Pajero/Shogun and Isuzu Trooper.
(diagram 2 courtesy of Nissan)

Front independent coil springs or torsion bars are found on vehicles such as the Mitsubishi Pajero/Shogun Isuzu Trooper, Ssangyong Musso and bakkie-based vehicles like the Nissan Tracker, Sani and Hardbody, Ford Courier, Mazda B, Isuzu KB and Frontier.
(diagram 3 courtesy of SsangYong)

Rear leaf springs (diagram overleaf) and a solid axle are found on all bakkie-based 4x4s such as the Nissan Sani and Hardbody, Ford Courier, Mazda B, Isuzu KB and Frontier, early Pajero. (diagram 4 courtesy of Toyota)

Leaf springs on a front axle are found on older designs such as the Land Rover series I,II & III. Toyota Hilux, Land Cruiser FJ40, FJ60, FJ75, FJ60 and

earlier models, Suzuki SJ40, Jeep CJ, old Chevrolet Blazer, old Nissan Patrol, SVM, Asia Rocsta, Mahindra and Jeep CJ. They are always matched with similar systems on the rear.

An all-four independent suspension configuration is found on vehicles such as the VW Syncro Bus, Toyota Mega Cruiser, Styre-Puch Pinzgauer and Haflinger.

OTHER FEATURES TO CONSIDER

LOADING CAPACITY

When travelling through remote or unpopulated areas, food, water, fuel, tools and camping equipment will have to be carried. Therefore your vehicle should have a large enough loading capacity in terms of volume and weight. Water weighs one kilogram per litre and fuel almost as much. Heavy duty suspension should be fitted to those vehicles asked to carry loads close to their limits over rough ground. Heavy duty shock-absorbers will also assist.

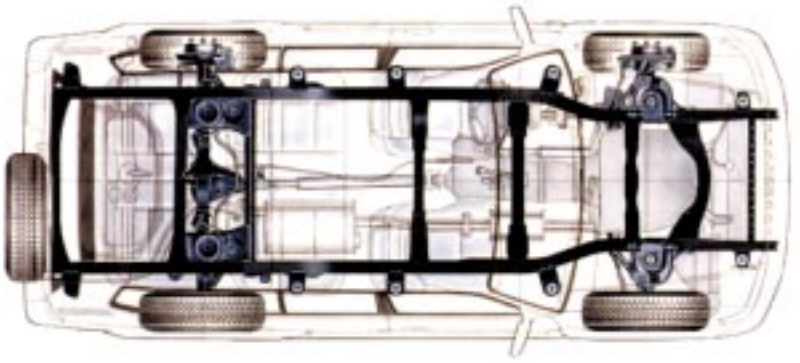
When selecting a 4x4, it is worth asking how much weight can be carried on the roof. Unfortunately I have never seen this specification published in a sales brochure, so this information may be hard to find.

4x4 station wagons make great family cars. They don't only show their mettle when off-road.

Loading any roof rack too well forward will cause overloading of both roof pillars and front springs, which are not designed for this and structural failures from overloading show themselves in the form of cracks appearing in the windscreen. If you also have a winch, bull bar, power steering and air conditioning fitted, your front springs may well be pushed beyond their weight carrying limit. Overloading a vehicle's springs will quickly result in serious structural failures in rough terrain.

DISC VS DRUM BRAKES

All-wheel disc brakes are an advantage off-road. Apart from not being affected by water, like drums, they operate effectively in reverse. This is where the disadvantage, which can be significant off-road, comes when drum brakes are fitted on the rear wheels. Picture the following situation: a vehicle stalls while moving up a very steep climb. The vehicle must be secured before the clutch is depressed and the engine restarted or the reverse-stall manoeuvre performed. The foot brake and handbrake are used to hold the



True off-road vehicles are built to carry a load over punishing terrain and have a chassis built for the task. (diagram courtesy of Toyota)

vehicle. With the drum brakes on the rear axle doing almost all the work, and with the stalled engine and no brake-boosting assisting the effort, it may be impossible to secure the vehicle with brakes alone. In this case the vehicle must be left in gear and rocks packed behind the wheels to assist the braking effort before the clutch can be depressed.

Although all drum brakes are less effective in reverse than discs, not all drum brakes are totally ineffectual in reverse. Generally speaking, the older the vehicle, the worse they perform.

POWER STEERING

In the city, assisted steering is a great advantage when driving a heavy 4WD vehicle, but in the bush it adds mechanical complications should something need repair and it adds weight. Although it does make a large vehicle easier to manoeuvre, power steering lessens the driver's 'feel' and can make driving over uneven terrain more difficult. I have also found that power steering is less comfortable at high speeds. Power steering remains a personal choice.

VEHICLE RANGE

A vehicle that will be required to undertake journeys into unpopulated areas needs a good range to be effective. Otherwise, a payload capacity large enough to enable substantial additional fuel to be carried will be required. The adventurous traveller will need a range of no less than 1000 kms between fuel stops. Few standard vehicles will cover this distance without additional tanks or without jerrycans. Auxiliary fuel tanks are discussed in the chapter 'Auxiliary Equipment'.

High-lift jack points on a Prado

BUMPERS

One of the most useful auxiliary items for the vehicle that is going to drive off-road is the high-lift jack. It requires a suitable flat jacking surface on the vehicle for efficient use. Modern designs tend towards curved rounded body shapes and rounded bumpers. These are cosmetic changes done without much consideration for the off-road motorist. If you are purchasing a new vehicle and intend to take it off-road ensure that the bumpers are adequate in both shape and strength for use as jacking points and if not, suitable adaptations can be made so that a high-lift can be used with the vehicle. These modifications are rarely available from the manufacturers themselves but are often designed and fitted by off-road vehicle fitment specialists.

EASE OF ATTACHING ACCESSORIES

Do some homework to establish if the accessories you may want are easily fitted to a vehicle. For example, because the Land Cruiser 100 has no roof gutters, it took some months after its release before 4x4 fitments centres developed a roof rack for the vehicle. The fitting of high-lift jack points is another worthwhile question to ask. Fitting them to a Pajero can be tricky and often an air-jack is a suitable alternative. With the Prado they fit nicely, but simply looking at the two vehicles one could be forgiven thinking they are the same as they are both endowed with large wrap-around plastic bumpers.

GREY IMPORTS

Anybody selling a new vehicle who is not an authorised dealer will, most likely, be selling a grey import. These vehicles are imported without the permission or approval of the local manufacturer or distributor. There are some serious pitfalls in this practice.

The pitfalls of grey imports:

- *Local distributors will not service the warranty and spare parts will often have to be specially ordered.*
- *Because local agents (the reputable ones) have to service a warranty they don't mind spending time and money researching new models for new markets.*
- *Original manufacturers rarely sanction grey imports.*
- *Similar vehicles imported by the manufacturer have modifications to engine and gearbox, auxiliary equipment and design adaptions for local conditions. This may seem unimportant but consider just a few: differing sulphur/lead content and octane rating of fuels, air filter size, fuel filter type, road springs and clearance. The complete list is a long one.*
- *The advantage is a saving in the cost of the vehicle. In the long term it is unlikely that the vehicle will perform as well and will not last as long.*
- *Why not support local industry instead of another country's?*

BUYING SECOND-HAND

Buying a second-hand vehicle of any kind is a risky business and to do it successfully requires some know-how.

Bargains don't exist in used-car showrooms. When the value of these vehicles is calculated, the cost of the fountain of youth is included in the purchase price. The value of the probable guarantee claims is also added. The genuine mileage may not be genuine. I do not have a recipe for testing the authenticity of kilometre readings, nor can I tell you how and when to trust a used-car dealer. If a new car manufacturer puts its name behind a used-car, then you can be fairly sure that it will be covered by a worthwhile warranty.

These days, cars hold their value reasonably well and a well cared for 4x4 is no exception. For example my Land Rover 110 V8 lost 15% of its value in eight years; that is 1,87% per year depreciation (excluding inflation). With a second-hand 4x4, the mileage shown on the odo will not be an indication of how much life the vehicle still has in it. Due to the rough conditions that many 4x4s would have been subjected to, the wear and tear levels are difficult to estimate by simply looking at and driving a vehicle. The experience of the vehicle's driver is worth evaluating. The experienced driver would have put far less strain on components than the inexperienced driver.

To buy second-hand from private sellers or used-car dealers, you will need to be able to inspect and test drive the vehicle with a mechanical mind. Off-road vehicles that have had a working life will wear in specific places. Keep the following in mind:

If the vehicle has been used to tow and launch a boat, axle oils may have been contaminated with water and axle oil seals may be corroded.

If the vehicle has been used on the beach, rust will be a major concern. Even aluminium bodied vehicles such as Land Rovers suffer from chassis damage due to rust. No matter how good a vehicle

looks, if you suspect that it may have been submerged by an incoming tide, don't touch it!

If the vehicle has been used for towing, clutches and gearboxes, although normally heavy duty on 4x4s, will have been worked hard.

If overly heavy loads have been carried on the roof, the roof supports and windscreens often crack.

Bush work takes its toll on suspension components, such as bushes, bump stops, shock absorbers and springs.

Ask for a service record. A dealer service record will mean a well maintained vehicle and that means a great deal. In order to inspect a vehicle properly its body and chassis must be clean.

Your inspection should also include the following:

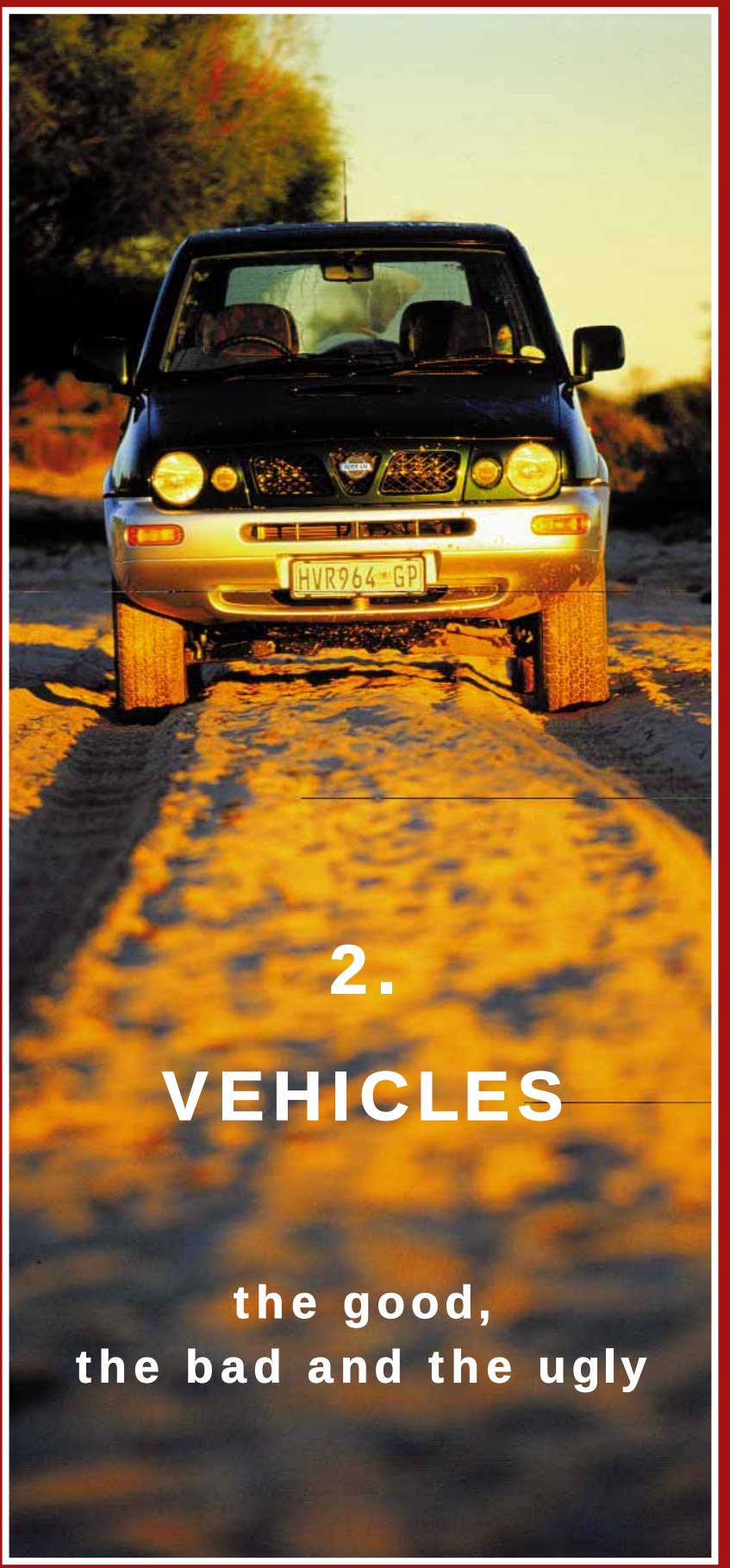
- *Look for oil leaks under the engine and around the gearbox – they could mean trouble. Axle hub oil leaks are given away by oil splashed on the inside of the wheel rim/s. These oil seals are fairly simple to replace although if oil has contaminated the brakes the pads will have to be replaced. Oil seepage around the front axle constant velocity joints (the shiny round thing on each front wheel hub) is normal, but the oil should not drip.*
- *Bounce and rock the vehicle on all four corners. The bounce should stop quickly. If it does not, the shock absorbers may be worn. Worn suspension bushes will cause clunks and knocks.*
- *Look for rust. Beware of a newly painted chassis – it may mean hidden rust. Some common places where body rust may be found are under the vent in front of the windscreen, the chassis near the suspension shackles and underneath the doors and door sills. Cracked paint on any part of the body could be caused by rust forming underneath. Establish if the rust is structural or cosmetic. If the surrounding metal is in good order then it may be repairable.*

- *Open and close all of the doors, the bonnet and the tailgate.*
- *Wind all of the windows up and down.*
- *Test all the lights and indicators.*
- *Climb under the vehicle. Look for damage to the chassis frame, cross members and floor panelling that could have been caused by careless driving over difficult terrain. If there is absolutely no visual damage underneath the vehicle, it is an indication that the vehicle may never have been off-road, or if it has, it has been treated with a care. Look for cracks in the chassis rails, particularly close to suspension location points.*
- *Inspect the exhaust pipe. If it is not well secured, it may have been this way for some time and have developed cracks.*
- *Inspect the tail pipe. If it is a petrol engine it should be medium to dark grey. It should not be sooty black as this could be the telltale sign of worn rings or valve guides. If it is a very light grey and has not just returned from a long run then the vehicle may have burnt valves caused by a too lean air-fuel mixture. Exhaust pipe colouration is no sure way to diagnose engine problems. Further tests, such as compression, or air fuel mixture measurements should be made if you are in doubt.*
- *Open the bonnet. The engine should be clean. The battery terminals should not have white powdery deposits, but should be covered by a thin layer of grease.*
- *It may be difficult to establish whether a vehicle has been involved in an accident. Tap the bodywork all around, and the sound will change if body putty has been layered on thick. A small magnet used as a metal detector will also be useful. (This will not work with aluminium body panels.)*
- *Find the engine and chassis numbers and compare these with the registration form held by the owner. Make sure that these numbers have not been tampered with in any way. If you suspect that this may have occurred, don't go any further. Legislation makes it illegal to own a vehicle whose chassis or engine numbers have been changed without appropriate documentation.*

Here is a guide to what to look for when test driving a used 4x4:

- *Start the engine. It should idle smoothly between 700 and 900 rpm.*
- *Warm up the engine. Have someone stand at the rear of the vehicle. Quickly push down the accelerator as far as it will go and then release it. There should not be excessive smoke from the exhaust. The engine should accelerate quickly and smoothly.*
- *Listen to the exhaust from under the vehicle. Listen for escaping exhaust gas from anywhere but the tail pipe. Do this by putting your foot over the end on the tailpipe. This forces gas to escape from any leaks. Rust at the tail end of the exhaust is common and not serious, but rust in silencers is a more expensive problem.*

- *Listen to the engine – does it clatter or are there any knocking sounds? Sounds like these can indicate worn bearings, cam chains, rockers, etc... If the engine ticks, it could mean a simple problem of valve clearances that require adjustment. It is advisable to have an expert take a look and have a listen.*
- *When the engine decelerates it should not smoke. If it does, it may mean worn valve guides.*
- *Check the air filter – an excessively dirty one will mean a poorly maintained vehicle.*
- *Driving a 4x4 is different to driving a normal vehicle. Because of the complex transmission, and the heavy clutch and transmission backlash, smooth gear changes can be a little difficult to handle at first on some models.*
- *Test the brakes. Drive at about 50 kph and when it is safe, push on the brake pedal until the vehicle comes to a halt. There should be no tendency to veer from dead-ahead. The brake pedal should not sink all the way to the floor. If it does, there could be fluid seepage inside the brake master cylinder or wheel cylinder which would require a brake system overhaul.*
- *After driving for a few minutes, check the water temperature gauge. If it is equipped with an oil pressure gauge, check that also. Low oil pressure could mean worn engine bearings.*
- *Take the vehicle onto the motorway and run it up to a reasonable speed. There should be no undue vibration. Vibration, depending upon how and when, could mean a simple problem such as wheel balance, or, at worst, an unbalanced propshaft which could have caused gearbox bearing and oil seal failure. A quick inspection of the gearbox at the propshafts for oil leaks may reveal the source of the problem.*
- *Test all gear ratios. Accelerate and decelerate sharply in all gears. Doing this may cause it to jump out of gear – a common problem with well used 4x4 gearboxes.*
- *If fitted with free-wheeling hubs, engage them and drive a short distance. Make sure that they disengage easily.*
- *Testing a 4x4 off-road is not easy. It is not fair to the owner to go crashing through axle deep mud to see if the vehicle can cope – especially if you are an inexperienced driver. The best way to do this is to look closely at the vehicle specifications and to compare them with other vehicles. Ask other owners of the same type of vehicle for their comments. Do this and you will have a good idea of what you are buying in terms of performance.*
- *Army surplus vehicles have normally been abused and will need a great deal of rebuilding work to get them into a reliable condition.*



2.

VEHICLES

the good, the bad and the ugly

Choosing a vehicle for a specialist application such as off-road driving without knowledge of the subject is a risky business. The trouble is that modern off-roaders have dual personalities. They are required to cruise economically and comfortably and when the road ends these same vehicles are asked to climb hills that mountain goats baulk at. Armed with insight into how vehicles are designed to cope with these demands and how they work off-road will be of significant advantage to the buyer. So before making a selection, I suggest you read the first chapter and decide on what sort of vehicle you want.

In this chapter, vehicles are arranged in categories:

1. Lightweights. These vehicles range between two-seater open-top true off-roaders such as the Jeep Wrangler to four-wheel drive street-wise trendy runabouts like the Honda CRV. Some short-wheelbase variants of leisure station wagons are included here.
2. Workhorses and pick-ups. These vehicles range between light truck workhorses such as the Land Rover Defender to single and double-cab pick-ups such as the Hilux.
3. Leisure station wagons. These vehicles range between basic station wagon off-roaders like the Nissan Sani, through the luxury wagons like the Pajero, all the way to 4x4 limousines like the Cruiser VX and Range Rover.
4. Specialist and unusual vehicles.

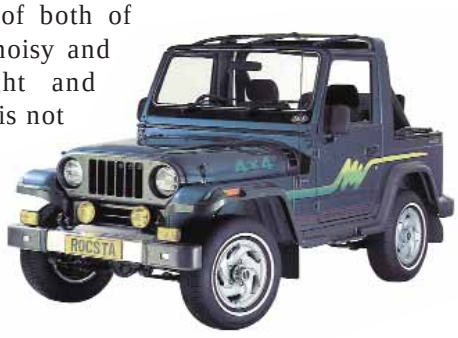
Comments are derived from my own experience and from the many off-road enthusiasts out there whose opinions I value.

1. LIGHTWEIGHTS

In this section, Asia Rocsta, Diahatsu Rocky and Terios, Honda CRV, Jeep CJ and Wrangler , Kia Sportage, Lada Niva, Land Rover Freelander, Mahindra Jeep, Mitsubishi Pajero SWB, Nissan Terrano, SsangYong Korando, Suzuki SJ and Samurai, Suzuki Vitara and Grand Vitara, SVM Mohican and Toyota RAV4.

ASIA ROCSTA

The Asia Rocsta is a CJ Jeep look-alike with basic features and dated technology. The makers use slogans like 'dirt cheap' and 'The most fun you can have with your top off' when describing their vehicle which gives you some idea of the position in the market. Performance is reminiscent of both of these vehicles - when on road, noisy and slow and when off-road, light and manoeuvrable. Ground clearance is not as good as one would expect for this type of vehicle. Spare parts are hard to find anywhere but in major centres.



DAIHATSU ROCKY and TERIOS

The Rocky is a Japanese lightweight Jeep style vehicle powered by a turbo diesel 4-cylinder 2,7-litre engine and is fitted with independent front double wishbone suspension and solid axle and coil springs at the back. The Terios is an altogether different vehicle; curvaceous and stylish, it tackles the Freelander, RAV4 and Grand Vitara market although it is considerably smaller than all of these. It has full time four-wheel drive with a lockable centre differential but no transfer gearing.

HONDA CRV

Honda's good-looking lightweight leisure four-wheel drive is unsuited to true off-road travel in every sense - poor clearance, no low gearing and a four-wheel drive system that powers the second set of driving wheels only when they are needed. The system drives the front wheels and when it senses wheel spin the rear drive is engaged. When traction is regained the rear axle then disengages, leaving the vehicle in two-wheel drive until traction is needed again, when the process starts over. As a road cruiser the

ASIA ROCSTA

ENGINE		
Fuel	petrol	diesel
Cylinders/Configuration/cm^3	4 in-line/1789	4 in-line/2184
Max. power kW at RPM	63 @ 5500	53 @ 4250
Max. torque N.m at RPM	137 @ 3000	145 @ 2000
TRANSMISSION		
Type: Manual 5-speed. Part time four-wheel drive and two-ratio transfer gearbox.		
Differential lock/s	none	
SUSPENSION		
Front and rear: Solid axle on leaf springs and shocks absorbers		
DIMENSIONS		
Wheelbase (mm)	2132	
Ground clearance (mm)	205	
Fuel tank capacity	62	
Mass (kg)	1280	
Tyres	215/75 R15	
Std. body suitable for high lift jack	yes	

CRV performs very well with a smooth, quiet and economical cruise. It is roomy and carries a load well. In this sphere it is equal, if not superior to its main competitors, the Freelander and RAV4.

DAIHATSU ROCKY AND TERIOS

ENGINE	ROCKY	TERIOS
Fuel	diesel	petrol
Cylinders / Configuration / cm^3	4 in-line / 2765	4 in-line / 1296
Max. power kW at RPM	75 @ 3400	61 @ 6100
Max. torque N.m at RPM	245 @ 1900	105 @ 5100

TRANSMISSION

Rocky: Manual 5-speed, part-time four-wheel drive and two-ratio transfer gearbox.
Terios: Manual 5-speed, full-time four-wheel drive. No low transfer gearing.

Differential lock / s	none	centre

SUSPENSION ROCKY

Front: Double wishbone independent torsion bar and shocks absorbers
Rear: Solid axle on coil springs and shocks absorbers

SUSPENSION TERIOS

Front: Double wishbone independent torsion bar and shocks absorbers
Rear: Solid axle on coil springs and shocks absorbers

DIMENSIONS

Wheelbase (mm)	2530	2420
Ground clearance (mm)	210	185
Fuel tank capacity	60	46
Mass (kg)	1660	1040
Tyres	215 R15	205 / 70 R15
Std. body suitable for high lift jack	no	

HONDA CRV

ENGINE

Fuel	petrol
Cylinders / Configuration / cm^3	4 in-line / 1973
Max. power (DIN) kW at RPM	110 @ 5500
Max. torque (DIN) N.m at RPM	182 @ 4200

TRANSMISSION

Type: 5-Speed manual or 4-speed auto full-time four-wheel drive. No transfer gearing.

Differential locks:	none

SUSPENSION

Front and rear: Independent double wishbone and coil springs. Anti-roll bar at rear.

DIMENSIONS

Wheelbase (mm)	2620
Ground clearance (mm)	205
Fuel tank capacity (litres)	58
Mass Tare	1390
Tyres	205 / 70 R15
Std body suitable for high lift jack	no

JEEP CJ

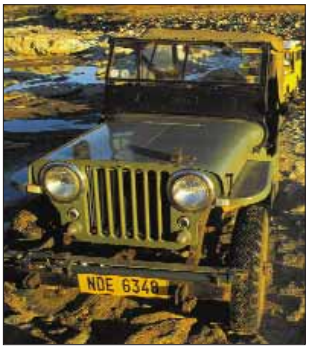
The first mass produced light all-purpose 4WD was the American World War II Jeep. At the outbreak of the war, the US Army required a 'Light Command and Reconnaissance Car' for use in the conflict. Four-wheel drive was a design priority and the American Bantam company soon had a prototype being tested by the US Army. Unfortunately for American Bantam, they could not cope with the volume of production that was required, so a number of other manufacturers were called in to evaluate the Bantam.

Both Ford and Willys-Overland took up the challenge and built their own versions to be assessed. Ford called their new vehicle the Pygmy or alternatively the Ford model GP, short for 'General Purpose'. Willys-Overland called theirs the Jeep, the name coming from a character in the Popeye cartoon series called Eugene - a little 4WD that could do virtually anything. So the 'Jeep' was born.

The final vehicle was a combination of the best of all three designs and built by all three manufacturers. Over 638 000 were built before the end of the war and after it Willys-Overland continued building light 4x4s, and the 'Civilian Jeep , the Jeep CJ series, came into being.

Both the Toyota Land Cruiser's and Land Rover's original design principles can be traced to the Second World War Willys Jeep.

The 'civilian Jeep' or CJ series was first offered as a military machine with minor modifications to suit the civilian market. The CJ2 was the first, and early models are rare collectors' items. The second model, the CJ3, with raised bonnet to accommodate the new powerplant, was first made in 1952. This machine is still made in India and is called the Mahindra, although with a different engine. All CJ Jeeps are excellent off-road machines, the CJ2 and CJ3 being the most favoured by the Jeep fanatics. No CJ is ideal for long distance cruising, being noisy and rather uncomfortable. Suspension is by solid axles and leaf springs. Depending on the model, they are available in part time or permanent four-wheel drive. Once built in South Africa by Volkswagen SA, there are quite a number of second-hand units available. New models are called Wrangler and come with either a 2,5-litre 4-cylinder or 4-litre 6-cylinder engine. The reintroduction into South Africa of Chrysler



From left to right: CJ2, CJ3 and CJ6.
Top: Jeep's current 'CJ', the Wrangler 4.0.

products has added well known brand names onto trails, among them the Jeep Cherokee and the Grand Cherokee station wagons and the classic-styled Jeep Wrangler which has a fair on-road and good off-road performance, although it does not match that of the early CJs off-road.

JEEP CJ

	CJ 5	CJ 7	Wrangler 4.0
ENGINE			
Fuel	petrol	petrol	petrol
Cylinders/Configuration/cm^3	4 in-line/2500	6 in-line/4200	6 in-line/3965
Max. power (DIN) kW at RPM	64 @ 4200	81 @ 3500	130 @ 4600
Max. torque (DIN) N.m at RPM	128 @ 2800	104 @ 3200	290 @ 3600
TRANSMISSION			
Type: Manual 4-speed manual. Part time 4wdrive. CJ7 and Wrangler has 5-speed manual and permanent 'Quadra-Trac' 4x4 system.			
Differential lock/s: Centre lock with Quadra-Trac, others none			
SUSPENSION			
CJ: Front and rear live axles, semi-elliptic leaf springs and shock absorbers.			
Wrangler: Front and rear live axles, coil springs and shock absorbers.			
DIMENSIONS			
Wheelbase (mm)	2120	2362	2373
Clearance (mm)	n/a	n/a	203
Approach angle	32°	32°	42.5°
Departure angle	31°	31°	30.3°
Breakover angle	n/a	n/a	154°
Tyres front	6L X 15 inch	H 78 X 15 inch	205/75 R15
Tyres rear	6L X 15 inch	H 78 X 15 inch	205/75 R15
Body suitable for high lift jack	yes	yes	no

KIA SPORTAGE

ENGINE	
Fuel	petrol
Cylinders/Configuration/cm^3	4 in-line/1998
Max. power (DIN) kW at RPM	94 @ 5300
Max. torque (DIN) N.m at RPM	175 @ 4700
TRANSMISSION	
Type: 5-Speed manual part time four-wheel drive with two-ratio transfer gearbox and auto free wheel front hubs	
Differential locks:	none
SUSPENSION	
Front: Independent double wishbone and coil springs.	
Rear: Live axle, coil springs four bar link.	
DIMENSIONS	
Wheelbase (mm)	2650
Ground clearance (mm)	216
Approach angle (degrees)	36
Departure angle (degrees)	33
Break-over angle (degrees)	21
Fuel tank capacity (litres)	60
Mass Tare	1928
Tyres	205/75 R15
Std body suitable for high lift jack	no

KIA SPORTAGE

Another Korean lightweight, introduced in the mid nineties, the Sportage has had a number of local distributors, the current being Kia Motors, South Africa. The Kia is a small engined vehicle challenging the Suzuki Vitara market. It has part-time 4x4 and low-range gearing. Ground clearance is not suitable for a true off-roader but the Sportage is light, manoeuvrable and similar in off-road performance to the Vitara. Approach and departure angles are among the best in its class.

LADA NIVA

The Lada Niva is built by AutoVAZ, 900 kilometres south of Moscow at Togliatti, a giant vehicle plant employing more than 130 000 people and turning out over 2000 units each day. Currently the factory exports over 140 000 vehicles every year and of these, 60% are Lada Nivas. No other Soviet vehicle has found the following that this unimpressive vehicle has and it is testament to the strength of the four-wheel drive market throughout the world that the only widely exported Soviet passenger car should be a four-wheel drive.

When looking closely at the Lada, it should only be compared to similarly-priced vehicles, although it is the only station wagon in its price range. When this is done the Lada is great. It is very mobile, highly effective off-road and better on-road than most of its competitors. Reliability problems continue to be the most serious drawback of the Niva.

The Lada has a live rear axle and independent front coil spring suspension, which has excellent articulation. Although the interior is reminiscent of a 1975 Fiat 124, suspension and transmission is of a fairly advanced design. It has permanent four-wheel drive with a lockable centre differential. Other minor changes have been made to cater for the Western market, namely improved sound-proofing, better seats, removable rear seats and an improved tailgate design allowing better loadability. Current models have a new 4-cylinder 1700cc engine. Spare parts, like many vehicles in this class, are only readily available in major urban centres.

Models available include the Standard, Safari, Cub, 5-door s/wagon, single cab and double cab bakkies. Advanced option packs include alloy wheels and sunroofs.

LAND ROVER FREELANDER

Land Rover's new toy is a fun car and, unlike other Land Rovers, cannot be regarded as an off-road vehicle. Drive to all four wheels is not enough to make an off-roader and the Freelander lacks the two ingredients that are needed to be effective off-road, namely

LADA NIVA

	Old model	Current model
ENGINE		
Fuel	petrol	petrol
Cylinders/Configuration/cm^3	4 in-line/1557	4 in-line/1690
Max. power (DIN) kW at RPM	56 @ 5400	59 @ 5200
Max. torque (DIN) N.m at RPM	135 @ 3000	127 @ 3200
TRANSMISSION		
Type: Manual 5-speed permanent four-wheel drive with lockable centre differential and two-ratio transfer gearbox.		
Differential lock/s	centre	centre
SUSPENSION		
Front: Independent dual wishbone and coil springs. Anti-roll bar.		
Rear: Live axle, coil springs four longitudinal and one transverse link.		
DIMENSIONS		
Wheelbase (mm)	2200	2200
Ground clearance (mm)	220	220
Approach angle (degrees)	40	40
Departure angle (degrees)	32	32
Ramp over angle	29	29
Fuel tank capacity	100	100
GVM (kg)	1150	1210
Payload (kg)	400	400
Tyres:	6.95 X 16	175/80/R16
Std body suitable for high lift jack	yes	yes

LAND ROVER FREELANDER

	petrol	diesel
ENGINE		
Fuel		
Cylinders/Configuration/cm^3	4 in-line/1796	4 in-line/1994
Max. power (DIN) kW at RPM	88 @ 5550	71.6 @ 4200
Max. torque (DIN) N.m at RPM	165 @ 2750	210 @ 2000
TRANSMISSION		
Type: 5-Speed manual full time four-wheel drive with centre viscous coupling. No transfer gearing. Electronic hill decent control.		
Differential locks:	none	
SUSPENSION		
Front: Independent MacPherson strut, lower arms, coil springs and stabiliser.		
Rear: Independent MacPherson strut, trapezoidal link and coil springs.		
DIMENSIONS		
Wheelbase (mm)	2557	2557
Ground clearance (mm)	186	186
Approach angle (degrees)	30	30
Departure angle (degrees)	34	34
Break-over angle (degrees)	156	156
Fuel tank capacity (litres)	59	59
Mass Tare	1380	1480
Tyres	195/75 R15	195/75 R15
Internal tie-down rings	yes	yes
Std body suitable for high lift jack	no	no

high clearance and extra low gearing. To compensate for the absence of low gearing, electronic hill descent control acts on the ABS brakes to slow the vehicle on steep descents. The system works well, but what about climbs? An absence of low gearing means that the vehicle runs out of power on even moderate hill climbs and it is difficult to drive over very rough ground in a gentle and controlled manner, which is essential if the vehicle is not to be damaged. What is more serious is the Freelander's lack of ground clearance - it is this element of the design that is a serious disappointment, and turns it into what I would discribe as the first saloon car Land Rover has ever made. The one environment where the Freelander performs well is on the beach but still falls behind its closest rival, the RAV4 here. On road it is a pleasure to drive and the engine choices suit the vehicle well. Handling on corrugations is excellent, and during the week I had the Freelander on test, a speedy run on some twisty gravel roads was hard to resist. In this environment it feels like a four-wheel drive rally car. Interior appointments are typical Land Rover and exude style and the driving position and feel of the vehicle is the best part of the Freelander. There are also a few annoying features too, like a powered rear window that sucks in exhaust fumes when it is dropped and an opaque sunroof which permits the sun to roast the top of ones head on a sunny day.

MAHINDRA

Based on the CJ3 Jeep, it is built in India from Willys body panels and transmission parts mated to a Peugeot diesel or petrol engine. Some of the good points of the last true CJ3 Jeep remain, such as grease nipples on points of high stress axle and suspension areas. Bucket seats and a few niceties have been added. The Mahindra gives birth to intense boredom on the open road, managing a noisy 120kph downhill.

Challenge it to a head wind and you're down into third at 80kph. Off-road it behaves like a Jeep CJ3 and that means that it is agile and very capable.

MITSUBISHI PAJERO - SWB

Many Pajero buyers, no doubt due to excellent marketing, believe that they are buying a vehicle that has competed in and won several Paris-Dakar rallies. The fact is that what is available to the public shares no more than technology with the "rally proven' space-age machine that has been so successful in this event, and only in the very early events were production Pajeros entered.

MAHINDRA

	CL 340 SWB	MM 775 LWB
Type	XDP 4.90	P-2150
Fuel	diesel	petrol
Cylinders/Configuration/cm^3	4in-line/2112	4in-line/2150
Max. power kW at RPM	46 @ 4500	71 @ 4500
Max. torque N.m at RPM	120 @ 2000	175 @ 2750

TRANSMISSION

Type: 4 or 5-speed manual; part-time four-wheel drive and two-ratio transfer gearbox. No free-wheel hubs.

Differential lock/s	none	none

SUSPENSION

Front & rear: Rigid axle on leaf springs and shock absorbers.

DIMENSIONS

Ground clearance (mm)	200
Fuel tank capacity (litres)	60
Tyres sizes front & rear	7.50/16
Std body suitable for high lift jack	yes

MITSUBISHI PAJERO SHORT-WHEELBASE

ENGINE

Fuel	petrol	diesel
Cylinders/Configuration/cm^3	3497/V6	2835/4 in-line
Max. power (DIN) kW at RPM	153 @ 5000	92 @ 4000
Max. torque (DIN) N.m at RPM	300 @ 3000	292 @ 2000

TRANSMISSION

Type: 5-speed manual or 4-speed auto 'super-select'(part-time and/or full time) four-wheel drive and two-ratio transfer gearbox. See text in chapter one for details.

Differential locks:	central	central

SUSPENSION

Front: Independent double wishbone and coil springs.

Rear: Live axle, coil springs four bar link.

DIMENSIONS

Wheelbase (mm)	2695	2695
Ground clearance (mm)	205	205
Approach angle (degrees)	40.5	40.5
Departure angle (degrees)	n/a	n/a
Break-over angle (degrees)	n/a	n/a
Fuel tank capacity (litres)	75	75
GVM	2350	2510
Tyres	265/70 R15	
Std body suitable for high lift jack	no	

I mention this because I have had Pajero buyers read my criticisms of the vehicle and react alarmingly at my conclusions.

The Pajero SWB has few serious competitors in the pocket-sized four-wheel drive market because while it is an excellent town car it is also excellent off-road and has, through its evolution, retained the vital ingredients of a true off-roader, namely low-range gearing and generous ground clearance.

The short wheelbase Pajero is not as good as its long wheelbase brother either on-road or off. On-road it is not quite as smooth and effortless but, in this sphere, is superior to anything in its class. One thing that struck me when driving the SWB well over the speed limit on a film shoot was its outstanding stability at high speed, not something normally associated with short-wheelbase vehicles. Off-road its ride is bouncy and quite choppy and its severe lack of wheel travel on the front wheels soon becomes apparent when traversing uneven terrain. Despite this, this short-coming can easily be overcome by driving technique and the Pajero has gained a vast and devoted following. Interior, the SWB version is similar to the LWB but, with four adults, expect complaints about a severe lack of leg-room and packing space.

For further technical information read the section on the LWB versions later in this chapter.

NISSAN TERRANO

On first seeing the Terrano, particularly the short wheelbase version, one can be excused for making comparisons with the Freelander or RAV4. But this is wrong, because the Terrano is a true off-roader, not just an all-wheel drive plaything. So, comparisons should be made with the Suzuki Vitara, Kia Sportage and the Pajero SWB and the long wheelbase Terrano should be compared with the Isuzu Frontier. The Terrano matches the best of these in many respects.

The second surprise to me was the 2,7-litre turbo-diesel engine. In the Sani or Hardbody it proved sluggish, suffering from severe turbo lag. In the Terrano it is willing, punchy and easy to drive off-road. The turbo lag is just about undetectable and cruising well above the speed limit is easy, even up the steepest climbs. Noise levels are reasonable and the diesel's presence is only obtrusive when idling.

Off-road the Terrano is terrific. It has part-time four-wheel drive without axle diff lock and approach, break-over and departure angles which are excellent, particularly with the short wheelbase version. Clearance under the diff is average. Wheel travel is fair and the suspension is on the stiff side. I pushed the suspension by driving over an axle twister a little too fast and it didn't complain a bit.

The interior is pleasant without the flashy gimmicks often associated with Nissan 4x4s, and the high driving position is just right. Packing space is generous, even in the SWB version.

NISSAN TERRANO

ENGINE		
Fuel	diesel	
Cylinders / Configuration / cm^3	4 in-line / 2664	
Max. power (DIN) kW at RPM	92 @ 3600	
Max. torque (DIN) N.m at RPM	278 @ 2000	
TRANSMISSION		
Type: 5-speed manual part-time four-wheel drive and two-ratio transfer gearbox.		
Differential locks:	none	
SUSPENSION		
Front: Independent double wishbone, torsion bars and stabiliser.		
Rear: Live axle, coil springs, five bar link and stabiliser.		
DIMENSIONS	**SWB**	**LWB**
Wheelbase (mm)	n/a	n/a
Ground clearance (mm)	n/a	n/a
Approach angle (degrees)	n/a	n/a
Departure angle (degrees)	n/a	n/a
Fuel tank capacity (litres)	70	80
Mass Tare	1753	1907
Tyres	235/75 R15	235/75 R15
Std body suitable for high lift jack	no	no

SSANGYONG KORANDO

ENGINE	230EL	320EL	602EL TDI
Fuel	petrol	petrol	diesel
Cylinders / Configuration / cm^3	4 in-line / 2295	6 in-line / 3199	5 in-line / 2874
Max. power kW at RPM	112 @ 5300	162 @ 5500	105 @ 4000
Max. torque N.m at RPM	225 @ 4000	310 @ 3750	300 @ 2800
TRANSMISSION			
Type: 5-speed manual part-time four-wheel drive and two-ratio transfer gearbox.			
Differential locks:	none	none	none
SUSPENSION			
Front: Independent double wishbone and coil springs.			
Rear: Live axle, coil springs, four bar link.			
DIMENSIONS			
Wheelbase (mm)	2480	2480	2480
Ground clearance (mm)	195	195	195
Approach angle (degrees)	28.5	28.5	28.5
Departure angle (degrees)	35	35	35
Break-over angle (degrees)	n/a	n/a	n/a
Fuel tank capacity (litres)	72	72	72
Mass tare	1788	1830	1928
Tyres	245/75 R15	245/75 R15	245/75 R15
Std body suitable for high lift jack		no	no

SSANGYONG KORANDO

The Korando has never appealed to me because of its looks, and I rate it as the ugliest 4x4 by far.

The Korando is based on a shortened Musso chassis and, performance wise, the Korando is below average in most respects. Off-road it is not a good performer and when driven in the company of other vehicles the slightest driver misjudgment is shown up. Wheel travel is fair but clearance, especially between the front wheels is poor. The Korando petrol versions are not underpowered but its road feel is heavy and ponderous for such a small vehicle. Overall the Korando doesn't shine in any aspect.

SUZUKI SJ 410 and SJ 413 SAMURAI

The diminutive Suzuki Jeep is not considered a serious off-roader because of its small size and inability to carry the kinds of loads needed for extended trips. It is also slow and uncomfortable on the road. However, off-road it is excellent due mainly to its small size and light weight. On the beach and over dunes it will keep up with almost all 4x4s but its limitations show when asked to climb hills on uneven terrain where its lack of weight and stiff suspension hamper its ability. Early models roll over very easily, so a novice driver should be very careful as obstacles taken too fast frequently result in rolling over. When bogging down, even in the worst case, the Suzuki can be easily dug out.

Left: SJ410.
Right: Samurai

Suspension is by solid beam axles on leaf springs on older models and coil springs on the new. The current model is enlarged marginally and is called Samurai. It offers improved comfort and

SUZUKI SJ410 AND SAMURAI

	SJ410	SAMURAI
ENGINE		
Fuel	petrol	petrol
Cylinders/Configuration/cm^3	4 in-line /970	4 in-line /1298
Max. power kW at RPM	33.5 @ 5500	47 @ 6000
Max. torque N.m at RPM	73.5 @ 3500	100 @ 3500
TRANSMISSION		
Type: 4-speed manual part time four-wheel drive and two-ratio transfer gearbox.		
Differential lock/s	none	none
SUSPENSION		
Front and rear: (SJ410) Solid axles of leaf springs (Samurai) Solid axles, coil springs, shock and shock absorbers.absorbers and panhard rod. Anti-roll bar at front		
DIMENSIONS		
Wheelbase (mm)	2030	2030
Ground clearance (mm)	205	205
Approach angle (degrees)	42	42
Departure angle (degrees)	38°	38°
Fuel tank capacity (litres)	40	40
Mass Tare	840	950
Mass payload (kg)	350	350
Tyres sizes front and rear	n/a	205/70 R15
Std body suitable for high lift jack	yes	yes

SUZUKI VITARA

ENGINE			
Fuel	old petrol 1,6	new petrol 2.0	new petrol V6
Cylinders/Configuration/cm^3	4 in-line/1590	4 in-line /1995	4 in-line /2493
Max. power kW at RPM	69 @ 5200	94 @ 6000	106 @ 6200
Max. torque N.m at RPM	138 @ 4000	174 @ 2900	208 @ 3500
TRANSMISSION			
Type: Manual 4-speed part-time four-wheel drive and two-ratio transfer gearbox.			
Differential lock/s	none	none	none
SUSPENSION			
Front: Independent MacPherson struts and coil springs. Rear: Solid axles, 5-links, coil springs and shock absorbers.			
DIMENSIONS			
Wheelbase (mm)	2030	2480	2480
Ground clearance (mm)	205	195	195
Approach angle (degrees)	40	34	34
Departure angle (degrees)	33	31	31
Fuel tank capacity (litres)	55	66	66
Mass Tare	840	1355	1405
Mass payload (kg)	350	500	500
Tyres sizes front and rear	195/80 R15	235/60 R16	235/60 R16
Std body suitable for high lift jack		no	no

better features with its coil spring suspension and a wider track, making it more stable. The long wheelbase models are better working machines and are popular with aid organisations operating in Central Africa but are unfortunately not readily available in Southern Africa.

SUZUKI VITARA AND GRAND VITARA

Suzuki's other, more upmarket lightweight is the Vitara. Unlike many vehicles often compared to it, the Vitara has a low-range gearbox and thus equips the vehicle with one of the two chief ingredients for an off-roader. It does, however, suffer from a lack of clearance and this is the design's downfall. Despite this, and its road tyres and feminine looks, it is surprisingly agile off-road and has even been used for difficult long distance trips into Botswana by some who are more daring than I. Its on-road comfort is similar to a small saloon but its off-road ability is paid for by its high speed handling which is vague at speeds over 100kph and scary in a cross wind. The new Grand Vitara's ride is improved over the early models. It comes with features such as air conditioning and electrical adjustment for the exterior mirrors and with a choice of engines; a 2-litre V6 and a multivalve 1,6-litre four-cylinder.

SVM MOHICAN

The SVM (Special Vehicle Manufacturers) Mohican is a 2-seater Jeep CJ style vehicle which is fairly crude in design but nevertheless, tough and an outstanding off-roader. The SVM is a little overpowered and controlling this power takes some getting used to off-road. There are no frills or gimmicks and the entire package is about as basic as you can get in terms of comfort. Consequently it is not a vehicle in which I would enjoy an extended overland trip. The SVM is designed and built in South Africa, it is light, very manoeuvrable and has performed very well in competitive off-road events.

Suspension is by leaf springs that allow better-than-average vertical movement on a galvanised box section chassis. The body is glass fibre with steel reinforcing. The engine is a Ford 3-litre V6, and the 5-speed dual-transfer gearbox is a Borg Warner and the rear diff is lockable. While researching this book I was unable to locate a single dealer so may only be available secondhand.

FRANCOIS ROSSOUW

TOYOTA RAV4

Although the RAV4 does not have low gearing, it has reasonable clearance, excellent wheel travel and is a brilliant off-roader in the hands of an experienced driver. However it is not designed for serious off-road work and, as a result, there are a small number of RAV4 owners who are disappointed with their vehicles because they have loaded them heavily and taken long distance, arduous off-road excursions. The designers never intended the RAV4 to be used in

SVM 3000 MOHICAN

ENGINE	
Fuel	petrol
Cylinders/Configuration/cm^3	V 6/2993
Max. power kW at RPM	110 @ 5000
Max. torque N.m at RPM	237 @ 3000
TRANSMISSION	
Type:: manual 5-speed part-time four-wheel drive and two-ratio transfer gearbox.	
Differential lock/s	rear axle
SUSPENSION	
Front and rear: Leaf springs, adjustable shock absorbers and solid axle.	
DIMENSIONS	
Wheelbase (mm)	2030
Approach angle	55°
Departure angle	50°
Ground clearance (flat) (mm)	260
Fuel tank capacity (litres)	65
GVM (kg)	1240
Tyres sizes front and rear	31 X 10.5 or 15 LT
Std body suitable for high lift jack	yes

TOYOTA RAV4

ENGINE		
Fuel	petrol	
Cylinders/Configuration/cm^3	4 in-line/19988	
Max. power (DIN) kW at RPM	94 @ 5400	
Max. torque (DIN) N.m at RPM	179 @ 4400	
TRANSMISSION		
Type: 5-spd manual full time four-wheel drive with centre differential, limited rear diff . No transfer gearing.		
Differential locks:	centre.	
DIMENSIONS	3-DOOR	5-DOOR
Wheelbase (mm)	2200	2410
Ground clearance (flat) (mm)	205	205
Approach angle	36°	36°
Departure angle	42°	30°
Fuel tank capacity (litres)	58	58
Mass Tare	1565	1710
Tyres	215/70R16	215/70R16
Std. body suitable for high lift jack	no	no

this way, as it has relatively light-duty suspension and transmission. The RAV4 is perfectly suited to beach and dune driving where driving is done in the normal range of gear ratios. If you are looking for a vehicle for pure dune driving, the RAV4 beats just about every vehicle listed in this book! The RAV4 comes in two body styles - three and five door versions. The only changes to the original design was a cosmetic upgrade which took place in mid-1998.

2. WORKHORSES AND PICK-UPS

In this section: Ford Courier, Isuzu KB, Land Rover Defender, Madza B-series, Mitsubishi Colt, Nissan Hardbody, Toyota Hilux, Toyota Land Cruiser Pickup.

FORD COURIER

Although many vehicles in this class were once engineering transformations from two-wheel drive pick-ups to four-wheel drive off-roaders, these vehicles have progressed beyond just a 2x4 conversion. Engines have improved, comfort options increased and suspension systems have been refined to cope with the dual lifestyle of leisure vehicles. The Ford Courier range is not a particularly popular 4x4 when compared to its closest rivals the Isuzu and Nissan pick-ups. Typical of this class of vehicle, ground clearance is limited, especially with regard to the departure angle with additional equipment such as bull bars and towing apparatus often making things worse.

The V6 engine has been refined over the years but I imagine Ford has had just about as much life as they are going to get out of this old design. The new generation diesel engine is brilliant, easy to drive in rough conditions and excellent on the open road. For technical specifications see Mazda B-series.

ISUZU KB

Isuzu's initial foray into the South African 4x4 world was in March 1972 with a 2-litre petrol bakkie badged 'Chev LUV'. The 4x4 derivative came seven years later together with the name change to Isuzu KB series. By now a 1,9-litre diesel engine had been

Above: The previous KB double-cab was for a time called the Reef and Frontier.

included in the range which was available in the 4x4 chassis by July 1979. In March 1984 engine evolution placed a 2,3-litre engine in the 4x4. The range was still going strong until March 1987 when the entire range was given a face-lift and the 4x4 KB was available in 2,3-litre petrol and 2,5-litre diesel engine, both models beingsingle cab layouts. In March 1993 the trend-setting 2,8-litre direct injection turbo-diesel and 2,6-litre petrol engines were introduced together with a double-cab body. At last the Isuzu KB was suitable for the leisure market. For a while the top-spec model was called Reef and Frontier, (before the Frontier station wagon was introduced in 1998) a double-cab offered with both engine options. A third 4x4 variant is the 250D, a 2,5-litre normally-aspirated diesel engine in a single cab.

The Isuzu KB has evolved into a respectable off-roader against stiff competition from Nissan, Samcor and Mercedes Benz (Colt), manufacturers of competing front independent and rear leaf spring suspension pick-ups. Now it must compete directly with the new

ISUZU KB

	KB 230	LE KB260	KB280 DT
ENGINE			
Fuel	petrol	petrol	diesel
Cylinders/Configuration/cm^3	4 in-line/2109	4 in-line/2559	4 in-line/2771
Max. power (DIN) Kw at RPM	70 @ 4600	80 @ 4600	74 @ 3600
Max. torque (DIN) N.m at RPM	170 @ 2600	205 @ 3000	230 @ 2200
for specs on V6 engine see Isuzu Frontier			
TRANSMISSION			
Type: Manual 5-speed part time four-wheel drive with free-wheel hubs and two-ratio transfer gearbox.			
Differential lock/s	none	rear	rear
SUSPENSION			
Front: Independent double wish bones, torsion bars, stabiliser and gas shock absorbers.			
Rear: Rigid axle, leaf springs and gas shock absorbers.			
DIMENSIONS			
	single cab	double cab	double cab
Wheelbase (mm)	1425	3025	3025
Ground clearance (mm)	200	210	210
Fuel tank capacity (litres)	92	83	83
Mass payload (kg)	680	1114	1725
Tyres	215 SR 15	245/75 R15C	245/75 R15C
Std. body suitable for h-lift jack	no	no	no

Toyota Hilux. If you are looking for a diesel-engined double cab then the Isuzu KB280 turbo-diesel is still the best in its class.

A rear differential locking mechanism, now becoming standard on many pick-ups, upgrades the Isuzu to an effective off-roader. The petrol 2,6-litre engine is a good engine but nothing special, and some report thirstier than some of the competition. However, the turbo-diesel engine is superb - it gives ample power on the open road when carrying a load, excellent low-down torque and a free-revving nature, making it an excellent performer off-road. Lack of ground clearance is the Isuzu's biggest drawback and the standard towing attachment snags on obstacles. Late Frontier models, released before the rounded body shape was introduced, feature an aluminium bull bar, sump guard and a rear diff lock. The changes in the new models are largely cosmetic, excluding the V6, which is quieter, more powerful and a better cruise vehicle. The diesel-turbo-engine is still my favourite, and for a working 4x4 it is the better choice.

LAND ROVER

The concept of a light, dual purpose workhorse crossed the Atlantic in 1946 when the British Rover Company developed the Land Rover. Its designer, Maurice Wilks, then chairman of the Rover Company, was using an ex-military Jeep for work on his farm. He conceived the idea of a British equivalent - so the imperishable story of the "Landy" was born. The original Land Rover was announced in April 1948 and was remarkably like the Jeep. Fifty years later Land Rover Ltd is the world's only vehicle manufacturer building nothing but four-wheel drive vehicles.

What made the Land Rover unique among its competitors was its ability to accept power take-offs for driving agricultural equipment such as pumps, saws and winches, and it was marketed as a light-weight tractor that could also carry passengers. Its body was made of Birmabright (developed in Birmingham England) aluminium as a means of overcoming the government's steel rationing and as an aid in production as it could be hand-shaped, obviating the need for new machine presses. To save time the prototype was built on a Jeep chassis and had its steering wheel located in the

middle. The idea of this was that farmers familiar with tractors would immediately be at home behind the wheel and there would be no need for right-hand-drive and left-hand-drive versions.

This idea was soon dropped and the production vehicle had a standard layout and an all-new welded box section steel chassis was made for it. Listed among the first model's optional extras were doors, side screens, weather protection, a passenger seat, cushions, a heater, a starting handle and the tyre for the standard spare wheel.

Land Rover's design, being simple and easy to maintain, gave it the potential for world-wide use, and complied with the British government's post-war stipulation that new projects should be geared for export. It is ironic that the Land Rover idea was originally a stop gap to keep the Rover company busy until steel was available to produce more of the luxury sedans for which it was famous. Thirty years later it was the only part of British Leyland that was turning a profit.

By the end of 1949, 8000 Land Rovers had been delivered. After exports had begun, in parts of Southern Africa it was named the 'Gary' and steadily grew in popularity. These vehicles, known as the 'Series One', continued to be manufactured until 1958, with the only changes being to the engine and transmission. In 1950 the transmission was changed from its original permanent 4WD system which had a free-wheel inserted between the front propeller shaft and the transfer box to overcome the windup when driven on a

COMPARISON CHART

1948 - 1953; THE FIRST JEEP, LAND ROVER & TOYOTA LAND CRUISER

	US JEEP	LAND ROVER	TOYOTA
ENGINE			
Capacity	2199cc	1595 cc	3386 cc
Cylinders	4	4	6
Configuration	in-line	in-line	in-line
Bhp	60 @ 3600 rpm	50 @ 4000 rpm	85 @ 2300 rpm
TRANSMISSION			
Main gearbox	3 speed manual	3 speed manual	4 speed manual
Four-wheel drive	Selectable	Permanent	Selectable
Transfer box ratio	1.97:1	2.52:1	No transfer gearing
Final drive	4.88:1	4.88:1	Figure not available
CHASSIS			
	Pressed steel channel	Steel box section	Pressed steel channel
SUSPENSION			
Axles	Live	Live	Live
Springs	Semi elliptic	Semi elliptic	Semi elliptic
Shock absorbers	Telescopic	Telescopic	Telescopic
DIMENSIONS			
Wheelbase	80 inches	80 inches	90 inches
Track front	48 inches	50 inches	54 inches
Track rear	48 inches	50 inches	53 inches
Length	133 inches	132 inches	151 inches
Width	62 inches	60 inches	65 inches
Weight	2315 lbs	2520 lbs	Figure not available

sealed surface. The new system was truly selectable, allowing the driver to engage the front propshaft at will. This system continued until 1983 with the release of the full-time 4WD system in the newly developed Land Rover 110.

In 1954 the first change was made to the chassis. Still designated the Series-1, the new wheelbase was 86 inches (increased from the original 80 inches). The overall length increased from 11ft to 11ft 8.7 inches and the vehicle was 2.6 inches wider. The unladen weight had increased by over 200 lbs. 1954 also saw the introduction of the first long wheelbase version, its wheelbase measuring 107 inches. With 41 inches of additional load space and vastly increased payload it would keep the peace with the sales department. In less than four years this wheelbase was extended by 2 inches, from 107 to 109 inches, in order to allow the fitting of the first engine alternative - a diesel unit producing 51 bhp at 3500 rpm and a torque of 87lb/ft at 2000 rpm.

This option added 195lbs to the curb weight. The short wheelbase vehicles also undertook a chassis change for the same reason - the 86 inch wheelbase became 88 inches.

In 1957, nine years after it was launched, management decided that the Land Rover should be thoroughly reappraised and, owing to increasing pressure from the sales force, major improvements be made. The results appeared in April of 1958 and came in the form of the Series-2. Still very much a Land Rover, the changes in appearance were obvious. The front wings and body sides were slightly curved and the bonnet had a somewhat subtle shape change. The chassis frame and exhaust, once visible from the side, were hidden by adding additional bodywork below the side panels and doors.

For the first time, concessions were made to driver comfort: easier operating pendant pedals, sprung seats, glass side door windows instead of perspex and, on the 109 inch version, an adjustable driver's seat. Even a carpet covering the transmission hump between the two front seats was offered as an optional extra.

At this time the chassis layouts stabilised with the long wheelbases measuring 109 inches and the short 88 inches, which stayed

this way until 1984. With the Series Two the track was increased by 1.5 inches and the rear springs were hung from the side of the chassis rail instead of directly beneath it. This gave an extra two inches of vertical wheel travel. Perhaps the most important mechanical improvement was to the engine line up. A new overhead valve 2.286 cc petrol engine was offered, although a few early Series Two 109" machines still had the older 1.997 cc engine fitted.

During 10 years of Land Rover production the engine power had risen by 40% and engine torque, so important to a working four-wheel drive, had increased by 50%. The price had increased too - by 40%. In the first year of production, 28 000 Series-2 machines were produced. Just 17 years after it was first produced the half millionth Land Rover was built. Only two years after the Series-2 was announced, vehicles with minor suspension refinements, known as the Series-2A were in the showrooms.

After the Land Rover 109-inch Forward Control came a military derivative in the form of the 101-inch wheelbase Forward Control light troop carrier. These vehicles have become collectors' items and are outstanding in off-road terrain. They are powered by the Rover 3500 V8 with Range Rover transmission components and solid axles on leaf springs. They are noisy and uncomfortable on the road but very versatile for the serious outback adventurer as the chassis layout offers enormous versatility for the fitting of additional fuel and water tanks, spare wheels, stoves, beds and all manner of other safari equipment.

LAND ROVER SERIES-3 AND POST -1966 FORWARD CONTROL

	88" SWB 4 -cyl.	109" LWB	6 -cyl F/Control
ENGINE			
Fuel	diesel	petrol	petrol
Cylinders/Configuration/cm^3	4 in-line/2286	6 in-line/2625	6 in-line/2625
Max. power (DIN) kW at RPM	26.8 @ 3000	64 @ 4200	64 @ 4200
Max. torque (DIN) N.m at RPM	n/a	179 @ 2000	179 @ 2000
TRANSMISSION			
Type: manual 4-speed part time four-wheel drive with two-ratio transfer gearbox.			
Free-wheel front hubs not standard.			
Overdrive unit available to improve top-end gearing. Fairy and Superwinch make them.			
Differential lock/s	none	none	none
SUSPENSION			
Front and Rear: Solid axle leaf springs and shock absorbers. Anti-roll bar on F/Control			
DIMENSIONS			
Wheelbase (mm)	2235.2 (88")	2768.6 (109")	2794 (110")
Ground clearance (mm)	209	209	254
Fuel tank capacity (litres)	45	45	200
Vehicle weight	1402.8	1626	2900
Mass payload (kg)	680	1114	1725
Tyres	7.50 X 16	7.50 X 16	9.0 X 16
Std body suitable for hi-lift jack	yes	yes	yes

Old Land Rovers are still being used as workhorses all over the Third World. This is a 1957 Series-2a in a bit of trouble. Two Range Rovers, both also over twenty years old, help it get off a sand track in Southern Botswana.

In 1967 a six cylinder engine, originally fitted to the Rover 95 passenger car, was squeezed into the Land Rover's engine bay. The 2625 cc unit's output was reduced from that of the saloon car version. Camshaft timings were adjusted and the compression ratio was reduced to, in some cases, as low as 7:1 for Third World use. The engine was rated at 83 bhp at 4 500 rpm and a torque of 128 lbs/ft at 1 500 rpm. A high capacity oil bath air filter was also fitted and the engine produced the smooth pulling power famous in Rover's saloon cars. Owing to handling considerations it was only offered with the long wheelbase version.

In the Land Rover Series-3, the most noticeable change was a new look front end with the headlamps being moved outwards (although this modification appeared during the last months of Series-2a production) and a brand new radiator grille. In Australia many outback travellers complained about the new grille - they couldn't use it for cooking over a fire as they could with the old steel mesh grille.

With the new design, however, water cans could now be fitted in the recesses next to the grille without blocking the headlamps. In the cockpit the instruments were shifted from the centre of the dashboard to directly in front of the driver. It also featured a brand new gearbox with revised ratios, synchromesh on 1st and 2nd, bigger and better brakes and improvements to the seat cushions and ventilation system.

In June 1976 the one millionth Land Rover, a specially painted Series-3 short wheelbase version, was driven off the production line by the Mayor of Birmingham during a grand ceremony at the Solihull plant in the English Midlands. Production of the Series-3 ended in 1984 following the introduction in 1970 of the Range Rover and in 1983 of the One-Ten.

LAND ROVER SERIES 1, 2, 2a AND 3

Many of these workhorses are bought and sold second-hand. If they have been well maintained they are a good purchase and are sure to last almost indefinitely.

Although the body is aluminium, the chassis does corrode and must be inspected closely before purchase. Areas prone to rust on the chassis are in the area surrounding the spring shackles and the chassis cross member at the rear. By modern standards, they are unsophisticated vehicles and Series 1 versions have become collectors' items. Series 2 versions are prone to axle half-shaft breakages and spares should be carried to remote areas. Clean Series 3 versions can make an excellent second-hand purchase.

A South African version of the Series 3 appeared in the form of the R6 - a 109-inch wheelbase chassis and a 12-seat station wagon body. Behind the very attractive flush grille was a 2.6-litre six-cylinder car engine and Spanish-assembled gearbox. It was a troublesome vehicle from the start and no matter how much redesigning work was done the overheating problems could not be overcome.

LAND ROVER DEFENDER

	Tdi 110 s/w	BMW 90s/w	Tdi5 130
ENGINE			
	diesel	petrol	diesel
Cylinders/Configuration/cm^3	4 in-line/2495	6 in-line/2793	5 in-line/2495
Max. power (DIN) Kw at RPM	83 @ 4000	141 @ 4000	90 @ 4200
Max. torque (DIN) N.m at RPM	265 @ 2500	280 @ 2000	300 @ 1950
TRANSMISSION			
Type: 5-Speed manual permanent four-wheel drive with two-speed transfer gearbox			
Differential locks: Centre. Axle differential locks available from Gearmax			
SUSPENSION			
Front: Rigid axle with fully floating shafts on coil springs, panhard rod, radius arms and shock absorbers.			
Rear: Rigid axle with fully floating shafts on coil springs, A frame, radius arms, shock absorbers. Rear anti-roll bar from 1988.			
DIMENSIONS			
Wheelbase (mm)	2794	2360	3226
Ground clearance (mm)	215	215	215
Approach angle	50°	51°	50°
Departure angle	34°	53°	34°
Ramp break over angle	152°	141°	155°
Fuel tank capacity	80	55	80
Kerb weight	2055	1795	2086
Mass payload (kg)	1188	1326	1650
Tyre sizes front and rear	7.50 X 16	7J X 16	7.50 X 16
Wading depth (mm)	500	600	500
Towing with brake (Kg)	3500	3500	3500
Load tie-down rings	no	no	no
Std body suitable for h-lift jack	yes	yes	yes

They are common second-hand purchases and most continue to plague their owners with overheating.

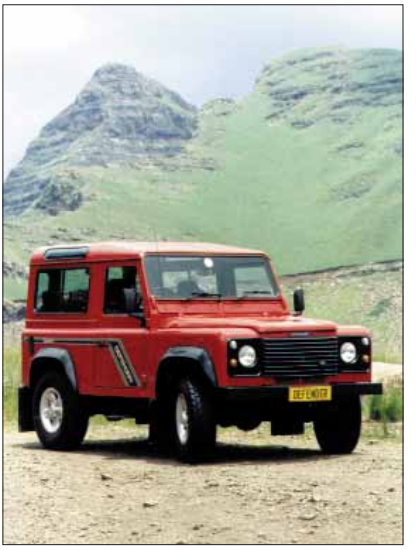
Another South African Land Rover sharing the flush grille of the R6 was the diesel or petrol Series-3 pick-ups launched in 1984 which had ADE 4-cylinder engines. They was discontinued in 1986.

Owing to the variations in Land Rover design during the last 46 years of production, it would take an entire volume to list the specifications of all of the different vehicles. For this reason only the specifications of the most common of the old Land Rovers are given - the short wheelbase 88" and long wheelbase 109" vehicles with the 6-cylinder petrol and 4-cylinder diesel engine and the Land Rover Forward Control modified by Gulf Industries and once sold in South Africa as the Over-Lander motorhome.

LAND ROVER DEFENDER 90/110/130

In 1982, with the success of the Series-3 and the Range Rover behind them, Land Rover decided to combine the two designs. Having made no significant change to the traditional Land Rover design for so long, this was a giant leap forward. The result was the Land Rover 110 (One Ten) and 90 (Ninety). The new vehicle was faster, better on the road and better off it. It was smoother, stronger, more comfort with less noise and a better choice of engines. It took Land Rover from a position falling fast behind the

ABOVE: Defender 110. BELOW: Defender 90.



Japanese to a place back out in front.

Although the vehicle appeared to be a Range Rover-Land Rover hybrid, it did not share as many components with its forefathers as one might think. The chassis design was Range Rover but, unlike the Range Rover, it was built to be strong enough for military use. Like the Range Rover coil springs, panhard rods and radius arms located the axles but the gearbox was new, although it also had full-time four-wheel drive. Much of the

body was common to the Series 3 but, because the new axles had a wider track, wheel arch eyebrows were added.

This gave the the vehicle a particularly aggressive look and despite the fact that they were added to solve the problem of a wide axle on a narrow body, other manufacturers began designing similar wheel arch flares on their vehicles. Engine options were a 4-cylinder 2.1/4-litre and 3.5-litre V8 petrol, although by far the most common in South Africa was the V8.

In 1990 the One Ten and Ninety was named 'Defender' and now comes in three wheelbases: 92,9, 110 and 130 inches, called the Defender Ninety, One Ten and One Thirty respectively.

Prospective Defender buyers beware - the Defender is a truck and not a car. Its close cousins, the Discovery and Range Rover, are off-road cars. The Defender can best be described as an off-roader with good road manners. It is not altogether suited to everyday suburban motoring and, although not uncomfortable, is big and turns like a school bus. Luxury packages are called County or Hi-Line and include cloth seats, carpeting and air-conditioning. One Tens have been built with a 3500cc V8, a 2500cc 4-cylinder petrol and during the past eight years, three versions of a 2600cc 4-cylinder turbo-charged diesel engine. The first of these was the '100' engine and was plagued with reliability problems. The second version, the '200' engine was a vast improvement, offering reliability combined with excellent economy. The latest version, predictably called the '300', is again a vast improvement on its predecessor. The 3500 V8 petrol engine has been discontinued.

Between 1988 and 1991, V8 Defenders were fitted with a Spanish-assembled LT85 5-speed gearbox. 90% of these gearboxes were faulty due to under-sized bearings being fitted in the factory. These gearboxes are good for only about 80 000kms, though many have failed much sooner. Once the bearings wear, the gearbox becomes noisy in all ratios other than fourth. At one stage AAD were contributing towards replacing the bearings with the correct parts, but that appears to be a thing of the past and Land Rover SA are no longer honouring guarantee claims. Purchasing a second-hand vehicle fitted with an untouched LT85 gearbox could be risky. Together with the '300' engine, the current gearbox is smoother and quieter but not as strong. This five-speed manual gearbox is now common to Defenders and Discoveries.

South African manufactured Defenders had galvanised chassis until BMW took over ownership, but now have standard UK spec chassis with rust-proofing applied. Virtually all Defenders manufactured in South Africa up to about 1997 have or have had water-proofing problems.

Current engine choices are the Tdi 5-cylinder diesel and the BMW 6-cylinder 2.8-litre petrol.When there was a choice between the 300Tdi engine and the BMW 2.8, Land Rover had difficulties convincing buyers to take the 2.8. With the new 5-cylinder their task is made even more difficult because the differences in performance have narrowed further. Gone is the tractor-like thump of the older diesel and gone is the severe turbo lag. The new engine is sweet, smooth and powerful. Lots of low down torque and improved cruising has made a great vehicle greater. One blot remains on the horizon to buying, what I consider to be an

outstanding vehicle, is the poor build quality and the notorious unreliability of Land Rover gearboxes.

MAZDA B-SERIES

Introduced in November 1990 as a single cab version, Samcor soon began development of a double-cab variant that is still with us today. The B-series has got better and better. Two engines are now offered: a 4-cylinder 2.5-litre intercooled turbo-diesel and a similar normally-aspirated diesel. The ubiquitous 3-litre V6 Essex engine has been discontinued.

Suspension is independent double wishbone with coils springs at the front and leaf springs at the rear and manual free-wheel hubs are standard. Also see Ford Courier page 49.

MITSUBISHI COLT

Introduced in November 1994, the Mitsubishi Colt is a twin-cab 4X4 based on a two-wheel drive bakkie modified to compete with the wide range of double-cab vehicles. The Colt is built by Mercedes Benz South Africa with 2.6-litre and 3-litre engines in two and four-door body styles but although it originates from the same manufacturer in Japan, it shares very little with the Mitsubishi Pajero or Shogun. It has part-time four-wheel drive with automatic free-wheel hubs. The first Colt 4x4s gained a fair market share by keen pricing and looks. Some early Colts had transfer gearbox failures, a problem which was sorted out fairly early in the vehicle's production run, so buying second-hand should be fairly safe.

The new Colt is happily not an old Colt with some fancy body panels and interior - it is all new. From the moment I sat in the driver's seat this was obvious. And what's better, off-road the improvement is outstanding. Gone is the harsh ride and lack of wheel travel. The new Colt is an accomplished off-roader and can take its place with the best of Toyota, Isuzu and Nissan. The new

MAZDA B-SERIES 4X4

ENGINE		
Fuel	old petrol	turbo-diesel
Cylinders/Configuration/cm^3	V6/2994	4 in-line/2499
Max. power (DIN) kW at RPM	104 @ 5700	80 @ 3500
Max. torque (DIN) N.m at RPM	232 @ 3250	257 @ 2000

TRANSMISSION	
Type: Manual 5-speed part time four-wheel drive with free-wheel hubs and two-ratio transfer gearbox.	
Differential lock/s: none standard. Rear axle lock and Detroit Locker available from Gearmax.	

SUSPENSION	
Front:	Independent double wishbones with torsion bars and shock absorbers.
Rear:	Rigid axle, leaf springs and shock absorbers.

DIMENSIONS		
Wheelbase (mm)	3000	3000
Ground clearance (mm)	230	210
Fuel tank capacity (litres)	66	82
Mass (kg)	1594	1696
Payload	1000	1059
Tyres sizes front and rear	245/75 SR15	215 R15
Std body suitable for high lift jack	rear only	rear only

MITSUBISHI COLT RODEO

	old 3000 V6 D/cab	new 3000i V6 D/cab
ENGINE		
Fuel	petrol	petrol
Cylinders/Configuration/cm^3	V 6/2972	V 6/2972
Max. power (DIN) kW at RPM	109 @ 5000	133 @ 5250
Max. torque (DIN) N.m at RPM	234 @ 4000	255 @ 4500

TRANSMISSION		
Type: 5-speed manual or 4-speed automatic part time four-wheel drive, auto free-wheel hubs and two-ratio transfer gearbox.		
Differential lock/s	rear optional	rear

SUSPENSION
Front: Independent double wishbones and torsion bars, stabiliser and shock absorbers.
Rear: Solid axle on semi-elliptical leaf springs and shock absorbers.

DIMENSIONS		
Wheelbase (mm)	2960	2960
Ground clearance (mm)	210	215
Approach angle (degrees)	33.9	n/a
Departure angle (degrees)	24	n/a
Fuel tank - capacity (litres)	75	95
Mass	1615	1880
Payload (kg)	700	1000
Tyres front and rear	245/75 R15	265/75 R15
Std body suitable for high lift jack	rear only	rear only

V6 engine is also remarkable off-road. Driving up steep banks I deliberately maintained revs at below 1000 and it still pulled strongly. There are not many V6 engines that can match its flexibility. Comfort and engonomics are also modernised and improved. Looks wise its striking appearance turns heads. It is also the first double-cab to be available with automatic transmission.

NISSAN HARDBODY

Nissan's pick-up range shares many technical details with the Sani station wagon. See page 85.

The new Hardbody was released early 1999. At the time of printing I had not yet driven the new vehicles. Specifications of the new model appear on the opposite page.

TOYOTA HILUX

The Hilux is one of the most capable wilderness exploration vehicles ever and can easily compete with any lightweight 4x4 that challenges it. It has been called 'The Workhorse of Africa' and any traveller into Third World Africa can testify to the Hilux's abundance. The reason for this is simple - the Hilux is a simple workhorse.

It first made its appearance with four-wheel drive in 1979, 10 years after the first 2x4 Hilux was introduced. This first vehicle shared many body components with the one-ton Stout. In 1984 the body was redesigned and with it South Africa's first double-cab configuration met with immediate success. It appeared as if the country's 4x4 leisure market got what it wanted - a loadable workhorse that could carry passengers too.

In 1989 the Hilux became the first diesel 4x4 bakkie on the market and in 1991 the well known Raider models were introduced. In 1998 the Hilux changed what I believe to be fundamental in its success in Africa - the suspension layout. The old model Hilux has simple and very robust leaf spring axle mountings. The solid axles and massive ground clearance are what make it such a formidable off-roader. If you are considering purchasing a vehicle in this class and expect it to work hard in difficult conditions then you cannot do better than the old Hilux. Renowned for reliability, it was built with a 2.2 or 2.4-litre 4-cylinder petrol and a 2.4-litre diesel engines.

The gearbox is an all synchromesh 5-speed unit with a low-ratio transfer box and part time four-wheel drive. Manual free-wheel hubs are standard and ground clearance is the best in its class.

FRANCOIS ROSSOUW

The original Hilux was developed on an all-new chassis under a modified Stout body.

Toyota's 1997 engine upgrade, with the 2,4-litre 4-cylinder 22R engine replacing the 4Y 2,2-litre, improved on-road performance. Although the 4Y engine is smoother, it is less effective off-road and although the torque specs would disprove this, low-end torque seems to be diminished. At this time cosmetic changes to the new

1999 NISSAN HARDBODY

ENGINE	2400i s/cab	3200 d/cab	3000i d/cab
Fuel	petrol	diesel	petrol
Cylinders/Configuration/cm^3	4 in-line/2389	4 in-line/3153	V6/2663
Max. power kW at RPM	88 @ 5200	76 @ 3600	110 @ 4800
Max. torque N.m at RPM	189 @ 3600	216 @ 2000	237 @ 4000
TRANSMISSION			
Type: Manual 5-speed part time four-wheel drive with two-ratio transfer gearbox.			
Differential lock/s	limited-slip rear	limited-slip rear	limited-slip rear
SUSPENSION			
Front: Independent double wishbones, torsion bars, stabiliser bar and shock absorbers.			
Rear: Semi-floating rigid axle, leaf springs and shock absorbers.			
DIMENSIONS			
Wheelbase (mm)	2950	2950	2950
Ground clearance (mm)	220	220	220
Fuel tank capacity (litres)	90	90	84
Tare (kg)	1610	1858	1822
Tyres sizes front and rear	215/R15	245/75R15	245/75R15
Std body suitable for hi-lift jack	no	no	no

OLD TOYOTA HILUX

ENGINE	2200 petrol	2400 diesel	2400 petrol
Fuel	petrol	diesel	petrol
Cylinders/Configuration/cm^3	4 in-line/2237	4 in-line/2446	4 in-line/2366
Max. power (DIN) kW at RPM	75 @ 5200	55 @ 4000	80 @ 4800
Max. torque (DIN) N.m at RPM	182 @ 2400	158 @ 2200	186 @ 3200
TRANSMISSION			
Type: 5-speed manual part time (selectable) four-wheel drive with two-ratio transfer gearbox and free-wheel front hubs.			
Differential lock/s	None. Gearmax rear differential lock is available to vehicles with locally built axles.		
SUSPENSION			
Front and Rear: Rigid axle, leaf springs and shock absorbers			
DIMENSIONS			
	Pick up	Double Cab	
Wheelbase (mm)	2840	2840	
Ground clearance (mm)	220	220	
Fuel tank capacity	100	80	
Mass payload (kg)	750	500	
Tyres; old models	7.00 x 15 - 6 ply	205 SR 16	
Tyres; new models	215 R15C	215 R15C	
Suitable for high lift jack; Std.	rear only	rear only	
4X4 Raider	yes	yes	

vehicle can be identified by Toyota's new badging on the grille.

The general criticism that the Hilux's suspension has always been too harsh can be put down to the fact that the vehicle was designed to carry a load under adverse conditions, and, as with all vehicles suited to off-road conditions, the suspension is a compromise. In the case of the old Hilux the suspension was not compromised to a great extent and the vehicle is well suited to a hard life. As a result spare parts can even be found in remote villages. Although the Hilux is tough it does not like to be overloaded and can be broken if this is done.

The Toyota Hilux, probably the most universally respected off-roader in all of Africa.

In pre-1985 versions the battery support bracket is prone to failure and, although this has been improved with later models, it often fails in vehicles used in rough off-road conditions and should be modified and strengthened if this is the case.

The most worthwhile modification to the old Hilux is the Old Man Emu suspension. See page 101.

The first major mechanical and styling change came with the launch of the all new Hilux in 1998. Its introduction brought fear and dread to die-hard Hilux lovers because real off-roaders know that nothing compares to solid axles when you're off-road. It is true that solid axles offer many advantages off-road and a few disadvantages on-road but the new Hilux is clear proof that only in the most difficult conditions is independent front suspension a disadvantage worth noting.

Rumours that the new model would have a revised front suspension began about a year before the SA launch, undoubtedly due to the release of the vehicle in the US and Australia. At this time the fact that it was fitted with a modern independent torsion bar system instead of the archaic leaf spring and solid axle, overshadowed the fact that it was very likely that the new vehicle would have improved seating, ergonomics, ride, safety... the list goes on.

Now, for the first time, the Toyota Hilux can be compared with vehicles such as the Nissan and Isuzu 4x4 pickups and should not be compared with its predessesor. Why? Because the old Hilux could be forgiven for its hard ride, poor brakes and uncomfortable seating because it was such a robust off-roader. This attitude of forgiveness was evident with the old Land Rovers and early Range Rovers which all have on-road idiosyncrasies that drivers learned to live with while doting on the vehicle's brilliance off-road.

I admit that I prefer solid axle suspension and am in harmony with the vast majority of serious off-roaders around the world. There will be many Hilux owners who will be reluctant to change to independent front suspension and there may even be some who move to the Land Rover Defender. My conclusion is that 95% of

existing Hilux owners will find that the new model more than meets their off-road requirements in terms of performance and ability and will exceed their expectations as a long distance cruiser and town vehicle. Some less experienced drivers will even find the new model easier to drive and therefore more effective off-road.

There is a hint of sadness with the passing of the old Hilux. Unfortunately for Toyota, the legacy of the Hilux 4x4 is so good

NEW TOYOTA HILUX

ENGINE

	2700i petrol	3000 diesel
Cylinders/Configuration/cm^3	4 in-line/2694	4 in-line/2986
Max. power (DIN) kW at RPM	108 @ 5200	67 @ 4000
Max. torque (DIN) N.m at RPM	235 @ 2400	192 @ 2200

TRANSMISSION

Type: 5-speed manual part time (selectable) four-wheel drive with two-ratio transfer gearbox and manual free-wheel front hubs.

Differential lock/s	rear	rear

SUSPENSION

Front: Independent double wishbone, torsion bar, stabiliser bar, gas shock absorbers.

Rear: Rigid axle, leaf springs and gas shock absorbers.

DIMENSIONS

	pick-up	double cab
Wheelbase (mm)	2860	2860
Ground clearance (mm)	225	225
Fuel tank capacity	92	81
GVM (kg)	2590	2590
Mass payload (kg)	1020	850
Tyres; old models	245/75 R15	245/75 R15
Std body suitable for high lift jack	rear only	rear only

that it is almost impossible to better. There are very few working vehicles that enjoy the unquestioned loyalty and admiration of so many. I have yet to be convinced of the new vehicle's ability to generate that kind of following. Only time will tell.

The new engine line-up improves the Hilux's appeal, especially the 2,7-litre fuel injected petrol which has good acceleration and is easy to drive off-road. The engine however is only suited to unleaded petrol. I drove it on dunes and it displayed ample power and torque and most of the climbs were tackled in high-range first for the short climbs and second for the longer, momentum climbs. The 3-litre diesel is not unlike the old model 2400 petrol in these conditions and often needed several attempts at each obstacle. As a cruising vehicle the 3-litre diesel is underpowered, so a turbo modification is needed to satisfy most users although, even with a turbo, it is still not powerful enough to match the willingness of the 2,7 petrol models or many of the Hilux diesel competitors such as the Ford, Mazda or Isuzu. A Hilux with the Prado's 3-litre turbo-diesel engine is under consideration.

TOYOTA LAND CRUISER

In 1933 the automotive division of Toyota Automatic Loom Works was established. The origins of the Toyota Land Cruiser began some five years after the Second World War, when US Army Jeeps were a common sight in Japan. These were the only 4x4s available and at the time there was a need for a vehicle a little larger than the Jeep and one that could be built locally as part of the reconstruction programme meant to revitalise Japan's economy. The US Army and the Police Reserve approached Toyota Motor Corporation with a request to design and produce such a vehicle. Toyota used its experience gained during the war when it produced the light scout car, the AK10. In only five months a Jeep-like prototype called the Toyota Jeep was built. Willys quickly pointed out that this name would be an infringement on its trademark, and in the following year it was given a new name - the Toyota Model B-85. Production commenced in 1953 and a year later, after 298 Model B-85s had been produced, so the name Land Cruiser made its mark on the world.

Not surprisingly, it looked very much like an American Jeep. (see page 52) It had a split front windscreen, the only Toyota ever to have one, and was driven by a 6-cylinder 63kW engine and a gearbox which initially had no synchromesh whatsoever, but later was given syncros on the two top ratios only. The 1963 FJ25 model was a short wheelbase machine with a 6-cylinder 236 cubic-inch engine and part time four-wheel drive which could be engaged without stopping. This powerplant remained the only engine available until 1968.

Exported from Japan in 1967, the 40 series FJ40 (SWB) and the FJ45 (LWB) and their replacements the FJ42 and FJ47, maintained the strictly military appearance of the earlier Land Cruisers while the 40 series maintained the looks of the earlier machines but came with a choice of hard and soft tops. The hard-top version featured a two-piece tailgate and small windows on the side at the rear. The LWB versions were offered with a pick-up, a soft-top, a canvas top and a cab-chassis options. The early 4-speed transmission was

replaced by a 3-speed column shift with a 2-speed transfer gearbox. Between 1960 and 1968 few visual changes appeared, but ongoing mechanical improvements took place. The gear change was moved from the column to the floor and the rear axle diff, which had occupied a position in the middle of the axle, was moved to the position it occupies today. The 15-inch wheel rims were replaced with those measuring 16 inches.

In 1968, the old "135" petrol engine was replaced by a 3 873cc 6-cylinder unit that produced increased power and torque. In 1969 a station wagon version appeared in the form of the FJ55, the predecessor to the modern 60 series station wagons. This machine was the first four-door Cruiser, and was equipped with improved seating, better ventilation and heating and was far more modern in appearance than its predecessors. This vehicle introduced modern materials to the Land Cruiser such as plastic brake and clutch fluid reservoirs and disposable oil filters.

The 1971 range was improved when the engine was fitted with a twin barrel carburettor and the drive train was given Burfield

TOYOTA LAND CRUISER PICK-UP

	FJ 40 Petrol (old)	FJ 40 Diesel	FJ 40 Petrol
ENGINE			
Fuel	petrol	diesel	petrol
Cylinders/Configuration/(cm3)	6 in-line/3956	6 in-line/4164	6 in-line/4477
Max. power (DIN) kW at RPM	101@ 4200	96 @ 4000	145 @ 4400
Max. torque (DIN) N.m at RPM	275 @ 2200	280 @ 2000	363 @ 2800
TRANSMISSION			
Type: Manual 5-speed part time four-wheel drive with free-wheel hubs and two-ratio transfer gearbox.			
Differential lock/s	none	none	none
	Gearmax limited-slip rear diff available		
SUSPENSION			
Front and Rear: Rigid axle with semi-elliptic leaf springs and shock absorbers			
DIMENSIONS			
Wheelbase (mm)	2980	2980	2980
Ground clearance (mm)	185	230	230
Fuel tank capacity (litres)	90	90	90
GVM (kg)	3035	3035	3035
Mass payload (kg)	1000	1000	1000
Tyres	7.00 X 16	7.50 X 16	7.50 X 16
Std body suitable for high-lift jack	yes	yes	yes

constant velocity joints. Split wheel rims also made their debut. Tyre sizes went from 7.00 X 16 to 7.50 X 16. In 1972 the 3-speed box was replaced by a 4-speed unit and a heater/demister was fitted.

In 1975 perhaps the most significant range of improvements to the already very popular and top selling Land Cruisers were made. A brand new 6-cylinder powerplant, the "2F" was introduced. It was a greatly improved 4230cc that produced 96 kW at 3600 rpm and a torque of 274 Nm at 1800 rpm. This was the year that the first diesel powerplant was available to the Land cruiser. The 'H' engine produced 70 kW at 3600 rpm and torque of 216 Nm at 2200 rpm. Diesel equipped vehicles were designated the 'H' series, and so the vehicle was known as the HJ45. Hazard warning flashers and inertia reel seatbelts were added, and some anti-pollution equipment was plumbed into the engines. Brake lining area was increased and fully floating axles were introduced to all models. During the remainder of the 1970s, ongoing modifications appeared. A tubular spare wheel carrier, revised mirrors, a canvas top option for the LWB model, an 84-litre fuel tank, the 'B' series diesel engine, quarter vents and improved seating kept the Land Cruiser up with the times.

The current Land Cruiser pick-up is the FJ75, only available in a long wheelbase version in South Africa. Like those before it, it remains an outstanding heavy-duty 4x4. Its design is old fashioned and rugged, it's very reliable and spare parts are readily available throughout Africa. Suspension is by solid axles and leaf springs. Criticisms still include the long rear overhang that causes heavy loads in the pick-up load box to make the front ride up and cause handling difficulties. There are a few station wagon variants of the FJ40 and FJ75 but these are rare and make excellent safari vehicles. Current Land Cruiser pick-ups are now fitted with an uprated 4200 cc 6-cylinder diesel powerplant.

3.LEISURE STATION WAGONS

In this section: Isuzu Frontier and Trooper, Jeep Cherokee and Grand Cherokee, Land Rover Discovery and Range Rover, Mercedes Gelandewagen and M-class, Mitsubishi Pajero LWB, Nissan Sani and Patrol, SsangYong Musso, Toyota Land Cruiser Prado, GX and VX, Volkswagen Syncro Bus.

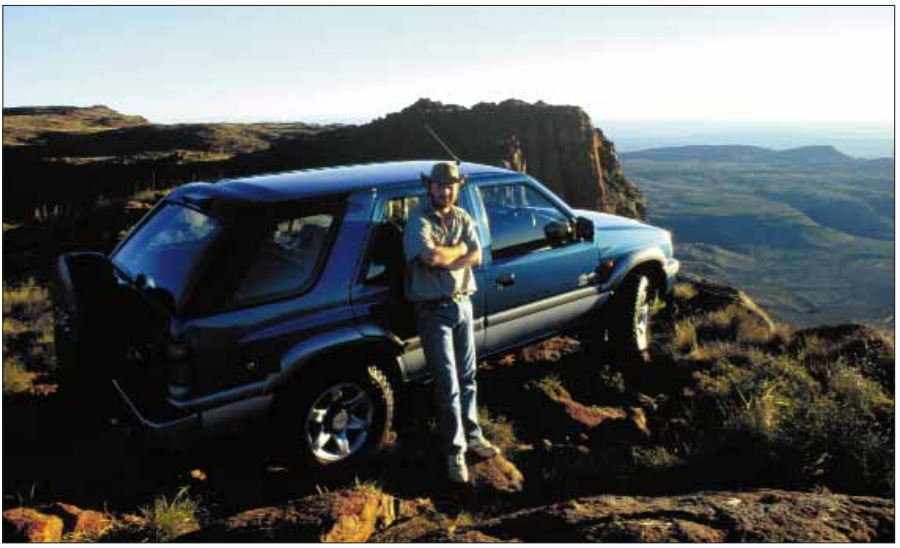
ISUZU FRONTIER

The Isuzu Frontier was introduced to South Africa in early 1998 competing in the budget priced station wagon market. Its main competitors are the Nissan Sani and SangYong Musso. Being a pick-up based station-wagon, it is very similar to the Sani but a fair bit smaller. In terms of comfort, driveability and loadability it is very similar. It is a little better off-road because of superior clearance and Isuzu's turbo-diesel engine. On the open road they are very much alike, especially when the V6 engines are compared. When compared to the SsangYong it is better suited to off-road use, for the same reasons as above but falls short when on-road cruising. The Isuzu is a good cruiser, quiet and comfortable but the interior is fairly simple without many frills.

Off-road the rear diff lock is a needed feature as the axle travel is fairly small, but I enjoyed it off-road and drove over particularly difficult terrain to position the vehicle for the South African TV commercial. Many have suggested that the final sunset shot with the vehicle perfectly positioned on the edge of a precipitous cliff was done through trick photography or with the help of a helicopter. With the help of two very energetic rock packers and a path finder I drove it to where the director wanted it - and enjoyed every minute of it.

ISUZU FRONTIER

ENGINE	320 V6	280DT
Fuel	petrol	diesel
Cylinders/Configuration/cm^3	V 6/3165	4 in-line/2771
Max. power Kw at RPM	140 @ 5400	74 @ 3600
Max. torque N.m at RPM	260 @ 4200	230 @ 2200
TRANSMISSION		
Type: Part time four-wheel drive with free-wheel hubs and two-ratio transfer gearbox.		
No. of forward gears	5	5
Differential locks:	Rear	Rear
SUSPENSION		
Front: Independent double wishbones, torsion bars, stabiliser bar and shock absorbers.		
Rear: Rigid axle, coil springs, stabiliser bar and shock absorbers.		
DIMENSIONS		
Wheelbase (mm)	2760	2760
Ground clearance (mm)	210	210
Fuel tank capacity (litres)	83	83
Kerb weight (kg)	1794	1805
Payload (kg)	n/a	n/a
Tyres	245/70 R16	245/70 R16
Load tie-down rings	yes	yes



The author with the star of the show - the Frontier as seen in the TV ad, perched on edge of a Karoo cliff after a gruelling but fun drive up the mountain.

Engine choices are the 2,8 turbo-diesel and the 3-litre V6. The diesel is better if you intend taking your Frontier exploring, the V6 if you intend staying close to the cities.

ISUZU TROOPER

The Isuzu Trooper was one of few vehicles to directly compete with the Range Rover when it was released in South Africa in the early eighties, and there are a still a fair number of these older machines around. Suspension was by independent front wishbones and leaf springs and a solid axle at the rear. The current model is an altogether different vehicle. Suspension is now by independent front wishbones and a solid axle at the rear with coil springs. Luxuries such as central locking, electric windows, electric sunroof and all-round disc brakes are standard and it is classed as a top-spec vehicle designed to compete with the Pajero Discovery and Prado. The Trooper is equipped with superb seating and is a very comfortable long distance cruiser. It is also very powerful and accelerating and overtaking manoeuvres are a pleasure. The

Trooper's most serious handicap emerges when it is taken off-road. When moving over rough ground in low ratio first or second and trying to keep speed down, it is very difficult to control the vehicle as delicate power applications are awkward due to an oversensitive accelerator. For the same reason, driving in slippery stuff at low speeds becomes difficult and the Trooper tends to display a lot of unnecessary wheelspin.

Previous page: Third generation Trooper
Top: 2nd generation Trooper.
Above: 1999 Trooper.

Steering is light with good feel and the brakes are superb. The manual gearbox is car-like and engaging four-wheel drive is effortless and can be done on the move. Troopers are fitted with automatic freewheel hubs and part-time four wheel drive. Despite recent exterior and interior styling changes the Trooper's looks remain dated.

ISUZU TROOPER

ENGINE	OLD MODEL	1999 MODEL
Fuel	petrol	petrol
Cylinders/Configuration/cm^3	V 6/3165	V 6/3165
Max. power kW at RPM	130 @ 5200	151 @ 5400
Max. torque N.m at RPM	260 @ 3750	284 @ 3000

TRANSMISSION

Type: 5-speed manual, part-time four-wheel drive with two-ratio transfer gearbox. Old model has auto hubs, new model has manual or auto hubs.

Differential locks: None standard. After sales rear axle limited-slip differential available from Gearmax.

SUSPENSION

Front: Independent double wishbones, torsion bars, stabiliser bar and shock absorbers.
Rear: Rigid axle, coil springs, stabiliser bar and shock absorbers.

DIMENSIONS		
Wheelbase (mm)	2760	2760
Ground clearance (mm)	230	230
Approach angle (degrees)	40	40
Departure angle (degrees)	31	31
Fuel tank capacity (litres)	85	83
Mass tare (kg)	1865	1865
Payload (kg)	535	535
Tyres	245/60 R16	275/70 R16
Load tie-down rings	yes	yes
Std body suitable for high lift jack	no	

JEEP CHEROKEE and GRAND CHEROKEE

The Jeep Cherokee is a competitively priced five-door station wagon and, although the design is over twenty years old, remains a best-seller in the USA. It is old-fashioned, basic and a good all-rounder. It is a vehicle which excels at nothing, but manages to do everything with a degree of competence which attracts third and fourth time customers year after year. New models are offered with an excellent turbo-charged diesel engine which is worth serious consideration for a vehicle operating in Africa.

The Grand Cherokee is the flagship of the Jeep range and is a top-spec 4x4 crammed with creature comforts. The new Grand Cherokee V8 is also fitted with an extraordinary traction system. Instead of the ABS brake-managed traction control system found in the Range Rover and M-Class Mercedes, the Cherokee uses hydraulics to prevent wheel slip. The result is superb traction and excellent off-road performance. The soft suspension is still solid axles back and front. Like Land Rover, Jeep seem to be adamant that to loose the off-road advantage of solid axles is not on the card. With the Grand Cherokee the standard spare tyre is a compact type and must not be relied on during back country travel. Spare parts availability is improving as more dealers are established, many soon to be shared with Mercedes Benz due to the merger of Chrysler and Daimler. Petrol models can only run on unleaded fuel which is not available in many parts of the sub-continent, rendering petrol vehicles unsuitable for adventurous travel.

Top: Cherokee. Above: 1999 Grand Cherokee.

JEEP CHEROKEE AND GRAND CHEROKEE

	Cherokee 2.5TDI	Grand Cherokee 4.7 V8
ENGINE		
Fuel	diesel	petrol
Cylinders/Configuration/cm^3	4 in-line/2499	V8/4701
Max. power kW at RPM	85 @ 3900	172 @ 4600
Max. torque N.m at RPM	300 @ 2000	300 @ 3200
TRANSMISSION		
Cherokee: 5-speed manual part time 4wd (TDI) or full-time 4wd 5-speed manual or 4-speed automatic with 4.0 petrol.		
old Grand Cherokee : 5-speed manual or 3-speed automatic permanent 'Quadra Trac' 4wd with centre viscous couple unit and limited-slip rear differential .		
new V8 Grand Cherokee: 4-speed automatic with Quara-trac hydraulic anti-slip system		
Differential locks	rear	limited-slip rear differential
SUSPENSION		
Cherokee	Front: Solid axle, coil springs and shock absorbers	
	Rear: Solid axle, leaf springs and shock absorbers	
Grand Cherokee	Front: Solid axle, coil springs stabiliser and gas shock absorbers	
	Rear: Solid axle, coil springs stabiliser and gas shock absorbers	
DIMENSIONS		
Wheelbase (mm)	2575.5	2691
Approach angle	38°	36.7°
Departure angle	32°	28.6°
Ramp break-over angle	158°	157.4°
Ground clearance (mm)	211	210
Fuel tank capacity (litres)	76	78
Kerb weight	1706	1818
Tyres	225/75 R15	215 or 225/75 R15
Payload (kg)	518	520
Std body suitable for high lift jack	no	no

LAND ROVER DISCOVERY

In 1989 Land Rover - competing directly with many Japanese, who by now were producing excellent vehicles fitting into a category lying between the Land Rover and the now very luxurious Range Rover - launched the Land Rover Discovery by fitting a brand new two and four door estate car body on a Range Rover chassis. It was offered with either the 3500cc V8 or a 2500cc four-cylinder direct injection turbo-charged diesel engine.

The Discovery is classed as a top-spec 4WD leisure vehicle and is grouped with the Mitsubishi Pajero, Isuzu Trooper and Toyota Land Cruiser GX. Like all these vehicles, off-road ability and on-road comfort trade-offs have taken place. Compared with the opposition, the Discovery is better suited to off-road use than its competitors, with the associated on-road performance penalties.

Its superior axle articulation gives it outstanding ability in the rough which is paid for by more-than-average body roll. On-road comfort is still excellent and far superior to the early Range Rover.

The 1994 face-lift introduced an all-new interior, uprated 3,9 litre V8 engine and improved on-road manners with the fitting of anti-roll bars to the suspension. Land Rover claim that these fittings, long withheld from the Discovery and Range Rover because of the

detrimental effect on the vehicle's phenomenal vertical wheel travel, do not affect off-road performance to any great extent. They also improve safety and will only be felt when the going gets really difficult.

The two engine options are ideal for such a vehicle - the V8-petrol for the city slicker with off-road aspirations and the Tdi for the long-distance cruiser and explorer. If you want a Discovery to perform well off-road the standard tow bar must be removed or modified as in standard form it is so low that it even catches when climbing off the pavement! Side steps are also not a sensible option for the Discovery if any off-road use is intended.

The launch of the Discovery Series 2 in early 1999 introduced not only a longer and wider vehicle but some new technologies. In addition to HDC (Hill Decent Control) there are new engine management systems called HPI, EUI, ECM and FTC, the details of which go beyond the scope of this book. Even without ACE (Active Cornering Enhancement), Land Rover's new stabilising system, it is better than ever on-road. Off-road, however, it is a different story.

ETC (Electronic Traction Control) combined with a centre differential that cannot be locked makes for an off-roader which is difficult to drive and which, when coerced into traversing wheel-lifting terrain, spins its wheels and digs holes into the earth before moving over it, normally in a huge cloud of dust. This is because, without a locked centre diff, traction is quickly lost, and before ETC can compensate the vehicle slows. Should the driver make the mistake of easing the throttle, a common technique to regain traction, the vehicle stops. If the throttle is opened, as this system demands, ETC will lock any spinning wheel, transfering power to those with traction. However, it reacts so slowly that terrain negotiated with ease by lesser 4x4s finds the Discovery struggling. What is worse, when hill climbing over uneven ground, should the driver reduce the throttle opening at a stage when ETC is engaging, the vehicle stops and slides a short distance backwards before regaining traction. Should this occur on a slippery slope, serious loss of control could result.

Landowners may one day dread seeing one of these vehicles driving over their lands because it is now impossible to 'tread lightly', as wheelspin is now part of driver technique needed to traverse uneven terrain.

Why is ETC behind Land Rover's newest creation? I believe that in an effort to simplify off-road driving, ETC eases the demands made on the driver by removing the question of when to lock the centre differential. But when conditions are more than just a slippery surface, instead of doing this, the opposite has occurred. Normal off-road driving techniques must be discarded in favour of a difficult, aggressive and environmentally unfriendly driving style. Add to this the extended body and reduced departure angle, which with a tow bar is very poor, and the Discovery Series 2 should be compared to vehicles like the Mercedes M-Class. Engine choice has been made easier with the splendid Tdi5 (see Defender for more details) which is a great improvement over the Tdi300, although turbo-lag is still there.

RANGE ROVER

In four-wheel drive terms the Range Rover represented a departure from the norm when it was introduced in 1970. It was a completely new vehicle in both design and concept. The idea first came to light as early as 1952 when a truly civilian version of the Land Rover, called the Road Rover, was built but never released. Rover intended to produce a vehicle that would combine the off-road abilities of a Land Rover with saloon-like cruising ability.

Development of the Range Rover began in earnest in 1965 and in less than five years the showrooms were bursting with

LAND ROVER DISCOVERY

ENGINE	NEW V8I AUTO	TDI300	TDI5
Fuel	petrol	diesel	diesel
Cylinders/Config./cm^3	V 8/3950	4 in-line/2500	5 in-line/2500
Max. power kW at RPM	132 @ 4750	83 @ 4000	101 @ 4200
Max. torque N.m at RPM	320 @ 2600	265 @ 1800	315 @ 1950

TRANSMISSION

Type: 5-speed manual or 4-speed auto permanent four-wheel drive with lockable centre differential and two-ratio transfer gearbox. Electronic traction control on some models

Differential lock/s	viscous couple	centre	centre

SUSPENSION

Front: Rigid axle with fully floating shafts on coil springs, panhard rod, radius arms, stabiliser and shock absorbers. Air springs in some new models.

Rear: Rigid axle with fully floating shafts on coil springs, A-frame, radius arms, shock absorbers and stabiliser. Air springs in some new models.

DIMENSIONS

Wheelbase (mm)	2540	2540	2540
Ground clearance (mm)	200	200	200
Approach angle (degrees)	34.3	34.3	34.3
Departure angle (degrees)	n/a	28.9	28.9
Ramp Breakover angle	151	149	n/a
Fuel tank capacity (litres)	95	88,6	95
Kerb wieght	2020	2053	2205
Payload (kg)	655	667	600
Tyres sizes front and rear	255 R18	225 SR16	225 SR16
Std. body for h-lift jack	no	no	no

customers. Range Rovers were displayed with pride at motor shows all over the world and the motoring press announced a triumph for British engineering. In fact, a Range Rover was the first vehicle to appear in the Louvre Museum in Paris as “an outstanding example of modern sculpture” - praise indeed.

The Range Rover was a combination of a lightweight 3500cc V8 engine, permanent four-wheel drive transmission incorporating three differentials, and long-travel coil spring suspension. It was concluded that coil springs would not only produce a more acceptable ride on bitumen but also offer greater axle articulation to greatly improve its ability over rough ground. The V8 engine, first built by Rover and fitted to their saloon cars, was a unit bought from General Motors in 1965. It was light and produced its power at low revs - ideal for an off-road machine.

Unfortunately, owing to the high torque produced by the V8, no existing Land Rover gearbox was suitable, so a totally new transmission had to be designed and built. Permanent four-wheel drive would give the new vehicle the advantage of improved traction, cornering and wet weather handling. In the rough a driver could decide at any time to lock the centre differential and prevent slip between the front and rear axles. This made it an extremely easy vehicle to drive in the rough. Land Rover made sure that no one was in doubt as to the Range Rover’s pedigree - the early models

The author’s 1971 Range Rover Mark One.

The Range Rover’s interior in 1971.

displayed a badge on the tailgate: “Range Rover by Land Rover”. The brilliance of the design did not go unnoticed. The RAC awarded the Dewar Trophy ‘for outstanding technical achievement in the automobile field’ together with the Don Safety Trophy which was awarded to the Range Rover in 1970. And as we have seen, its beauty was even honoured by the Louvre.

Early advertisers made the claim that there are four types of car - “a luxury car, a performance car, an estate car

and an off-road car" and that the Range Rover was all of these. The press responded by asking: what about economy cars? The V8 was thirsty, far more so than the four cylinder Land Rovers in production. The early Range Rover interior was spartan - there was no carpet, vinyl seats and owing to pressures for an early release date, three plastic plugs in the centre facia where additional instrumentation could be fitted. In 1973 when the Mark 2 version was released the interior design was completed.

Range Rover 'Classic' Vogue.

RANGE ROVER		
	old Range Rover 3.5	new Range Rover 4.6 HSE
ENGINE		
Fuel	petrol	petrol
Cylinders/Configuration/cm^3	V 8/3528	V 8/3950
Max. power kW @ RPM	97 @ 5000	164 @ 4750
Max. torque N.m @ RPM	250 @ 2500	376 @ 3000
TRANSMISSION		
Type:	5-speed manual; full-time four-wheel drive with lockable centre diff and two-ratio transfer gearbox.	4-speed automatic, full-time four-wheel drive with viscous coupled centre transmission and two-ratio transfer gearbox.
Fairy overdrive (optional) step up ratio 0,728:1 for old 4-speed manual gearboxes		
Differential lock/s	centre	centre
New RR has electronic traction control. Auto versions have centre viscous coupling.		
SUSPENSION		
Range Rover 3.5		
Front	Rigid axle on coil springs, panhard rod, radius arms and shock absorbers.	
Rear	Rigid axle on coil springs, A- frame, radius arms, 'Boge' self levelling strut and shock absorbers.	
SUSPENSION		
New Range Rover		
Front: 5 ride-height settings controlled inside the cab. Rigid axle on pneumatic cylinders (air springs),panhard rod, radius arms and gas shock absorbers. Anti-roll bar.		
Rear: 5 ride-height settings controlled inside the cab. Rigid axle on pneumatic cylinders (air springs), A-frame, self-levelling strut and gas shock absorbers. Passive rear wheel steering and anti-roll bar by composite glass fibre axle location struts.		
DIMENSIONS		
Wheelbase (mm)	2540	2745
Ground clearance (mm)	191	214
Approach angle (degrees)	37	34
Departure angle (degrees)	32	25
Ramp breakover angle	150	151
Fuel tank capacity (litres)	81	100
Kerb weight	1725 - 1892	2090
Mass payload (kg)	680	603
Tyres sizes	205 SR 16	255/65 R16
body suitable for high-lift jack:	no	no

In 1972 the British Army's Trans-Americas Expedition drove two specially equipped Range Rovers down the entire length of the American continents, from Alaska to Cape Horn to open the way for the Pan Americas Highway. Between the two continents lay the notorious Darien Gap, a 350-mile stretch of swamps, mountains and forests. These were not the first vehicles to drive through the Darien Gap, but they were the first to drive the entire length of North and South America. The journey was not without its problems. Mile wide rivers, deep ravines and repeated differential failures that at one stage had both vehicles immobile were among the many obstacles that had to be overcome by the expedition.

The Range Rover remained unchallenged for so long that improvements to the design came very slowly. It soon became apparent that this vehicle was very much a status symbol and for almost a decade the changes made were largely cosmetic. The fact that Range Rovers were being used for many tasks originally done by Land Rovers seemed less important to the designers than making the vehicle more comfortable and more up-market. The main criticism levelled against the Range Rover was its overly heavy gear change which remained unchanged until the introduction of the 5-speed gearbox in 1983.

The Range Rover came to South Africa in 1979 and was assembled from CKD kits in Leyland's Blackheath plant. Quality control was poor and sadly the local vehicles earned a reputation for unreliability. Soon after this a series of fatal accidents were documented as a result of catastrophic tyre failures occurring on the now discontinued Michelin 205/16 M+S radials (see chapter 4)

Payload is 680kgs and the roof requires supporting if a heavily loaded roof-rack is to be carried. To increase the Range Rover's payload, fit Discovery rear springs, and if that is not enough, an OME suspension kit.

The last Classic Range Rover which came off the Solihull production line in 1996 has been replaced with a vehicle so sophisticated that I would not dare put it to the same tasks that I put my first 4x4 - a 1971 Mark I Range Rover pictured on page 75, the 2834th Range Rover to roll out of the factory.

In 1994, for the first time in its 24-year history, the Range Rover underwent a major styling change. The brief given to the new vehicle's designers was simple: create a vehicle that matches if not exceeds its predecessor's off-road ability, improves its driveability, comfort and loadability, while making sure that what is created is unmistakably Range Rover.

The result is a very beautiful, highly complex machine that cost £300-million to develop, once again setting the standard in 4x4 luxury vehicles.

Current models come with 4-speed automatic or 5-speed manual transmission, and pneumatic cylinder ride-height controllable suspension and three engine variants which include 4.6 and 4.0-litre V8 petrol and a BMW 2.5-litre turbo diesel. Unfortunately the diesel engine will not be sold in South Africa in the near future.

The new Range Rover has undeservedly earned a reputation in South Africa for regular breakdowns, caused by off-road obstacles such as deep water, which render the vehicle almost undriveable. These cases are rare and in most, the computer which controls the gearbox and suspension, has failed. Usually, this means that the vehicle suspension drops and gear selection can become a problem. Because the result of computer breakdowns is so dramatic stories have made the press. In reality, the Range Rover is no more suseptable than many other sophisticated vehicles, eg. Trooper, Pajero, Grand Cherokee, Mercedes M-Class etc. whose engines are computer-controlled and failure means that the engine does not run. During the first year of production reliability problems surfaced but are now much improved.

To take the idea of a luxury 4x4 one step further, the Range Rover Autobiography is available. Here, the buyer can select not only from a wide range of standard options, but even the type of glass can be selected as well as leather trim colour combinations, in-flight entertainment (for example VCR and TV scenes in the head restraints for rear passengers) and an almost infinite range of body colour options.

MERCEDES BENZ G-WAGEN

The Mercedes G is one of the most impressive off-road station wagons ever made and whenever I see them in action they never fail to impress. Their secret is a long-travel coil spring suspension that gives good articulation while not suffering the body lean that tends to lift weight off opposite wheels on side-slopes. Off-road this translates into easy going over rocks and boulders while at the same time, wheels don't lift when the vehicle is negotiating steep turns on slopes. In addition, the vehicle is so beautifully engineered and built for serious work. For example, the front is fitted with a pulling bar normally seen on military trucks. Clearance is generous and the front and rear differentials can be locked. All G-wagens are underpowered, which often means low first when the ideal gear should be low second, although the vehicle is so good off-road it rarely seems to matter!

Among its few weaknesses are its rear springs which should be replaced after 100 000 kilometres as they are prone to breakage after this. The older versions (461 series) have part-time 4WD, the newer ones (463 series) a permanent 4WD system. All have three

lockable differentials, and the newer models also have ABS braking, air conditioning, manual or automatic transmission in both short and long wheelbase. The 463 series is also more refined refined for long distance road work.

461 series short wheelbase

In 1998 the Gelandewagen was reintroduced to South Africa without out much media attention and it still does not appear to be a serious marketing venture. The model is the 290GD turbo-diesel auto in long and short wheelbase but surprisingly it is the 461 series which is absent of any frills. It is unlikely to find many buyers as it sells for more than a Land Cruiser 100 GX. The Gelandewagen is superb for the serious off-roader and in pure on/off-road performance it is as good as there is.

The author's 461 series 290GD Turbo-diesel in northern Namibia

MERCEDES BENZ M-CLASS

This highly sophisticated city 4x4, taking the Cruiser VX and Range Rover market head on, will without doubt attract the rich and famous. But I am not sure if it will attract the rich and famous who want to go off-roading and I imagine that with the Range Rover and Cruiser's off-road reputations and the M-class's 'softer' appearance, it will go no further than becoming the king of the urban jungle. The design is striking, the interior typical Mercedes and the on-road manners without fault. In this department it is as good as its competitors but when it's time to leave the road it trails in their dust. Not that the M-class is a bad off-roader, it's just that the RR and Cruiser do both so well. Lack of ground clearance is a fault and the limited wheel travel is only a minor hindrance as the ingenious traction control takes care of that - even when three

wheels are off the ground it keeps power to the driving wheel. Off-road the M-Class takes a little practice and a more aggressive approach than one would normally use works well. Easing the accelerator as a wheel spins as is normal procedure results in the vehicle slowing down instead of gaining traction and speeding up.

MERCEDES BENZ (STYRE PUCH) GELANDEWAGEN

ENGINE	280 GE	230 G	290 GD
Fuel	petrol	petrol	turbo-diesel
Cylinders/Configuration/cm^3	2746/6 in-line	2300/4 in-line	5 in-line
Max. power (DIN) kW at RPM	115 @ 5250	66 @ 4400	90 @ 3800
Max. torque (DIN) N.m at RPM	226 @ 4250	167 @ 2500	280 @ 2000

TRANSMISSION

Type: All have two-ratio transfer gearbox. 461 series: 4 or 5-Speed manual part time fwd with two-ratio transfer gearbox. 463 series: 5-speed manual full-time fwd with two-ratio transfer gearbox. 465 series: 5-speed manual or 4-speed auto full-time fwd with two-ratio transfer gearbox.

Differential locks: Front and rear axle locks on all models. Centre lock on models with full-time 4wd.

SUSPENSION

Front: Rigid axle on coil springs, panhard rod, two control arms, torsion stabiliser bar shock absorbers.

Rear: Rigid axle on coil springs, rubber helper springs, 2 control arms, shock absorbers.

DIMENSIONS	LWB	SWB
Wheelbase (mm)	2850	2400
Ground clearance (mm)	225	225
Approach angle	37°	37°
Departure angle	32°	32°
Fuel tank capacity (litres)	75	75
Gross weight	2800	2500
Payload (kg)	865	655 - 735
Tyres front and rear	215 R 16	215 R 16
Standard body suitable for high lift jack	no	no

MERCEDES BENZ M-CLASS

ENGINE	
Fuel	petrol
Cylinders/Configuration/cm^3	3199/6 in-line
Max. power (DIN) kW at RPM	160 @ 5600
Max. torque (DIN) N.m at RPM	310 @ 3000

TRANSMISSION

Type: 5-Speed auto with lock-up clutch. Full-time four-wheel drive torque converter and electronic traction control.

Differential locks: none

SUSPENSION

Front: Double wishbone, torsion bar, gas shock absorbers, stabiliser.

Rear: Double wishbone, coil springs, gas shock absorbers, stabiliser.

DIMENSIONS	
Wheelbase (mm)	2820
Fuel tank capacity (litres)	70
Gross weight	2010
Payload (kg)	540
Tyres front and rear	255/65 R16
Standard body suitable for high lift jack	no

A gentle push on the accelerator here does the trick. It likes slippery surfaces but doesn't enjoy rocky terrain, where from a driver's point of view, one is scared of pushing it in case it crashes down and damages expensive machinery. The chrome spare wheel carrier and protection bars lower the clearance further and look like an after-thought, as if the designers forgot about the location of the spare wheel until the last minute and were forced to quickly come up with a solution. The result spoils an otherwise elegant design. Add the optional chrome protection bars, which are so close to the ground that off-road travel is just about out of the question, the result looks like a mixture of 90's taste and 70's kitch.

MITSUBISHI PAJERO LWB

I thought that of all the followers of a 4x4 marque, Land Rover owners were the most passionate about their product. This was until I came into contact with die-hard Pajero owners. Controversy about vehicles will be stirred more often by Pajero owners than by anyone else. In my numerous radio talk shows or discussions, whether in the press or on my website, Pajero owners are the most outspoken and critical of other vehicles. I am not sure why but it is clear that the Pajero has a large and jingoistic following.

The Pajero is built by Samcor from imported SKD (Semi Knocked Down) kits, is available with 2,8-litre turbo-diesel and 3,5-litre V6 petrol engines and is a dual-purpose vehicle at home in the city and bush. To make comparisons with other

vehicles and to arrive at worthwhile conclusions it should be compared with the Land Rover Discovery, Isuzu Trooper and Toyota Land Cruiser Prado. On-road it is level pegging with the Toyota and Isuzu and may even better these for cornering ability and stability. The petrol and diesel engine options closely match the Prado's in performance, bettering the old Discovery diesel while similar to the Isuzu's petrol.

Off-road the Pajero is a good performer and is easy to drive but is inferior, if by a small margin, to the Toyota. It is without doubt better than the Isuzu but, for off-road ability, it cannot match the Discovery which is the best in its class. Rear axle articulation is good but at front, where it counts the most, it is very poor. This is why the Pajero is so stable on-road. Even mild off-road obstacles will find the front wheels lifting and spinning. This, in most cases, can be overcome with appropriate driver technique.

One of the Pajero's selling points is that it is neither a part-time nor full-time four-wheel drive vehicle - the driver may choose. This is Mitsubishi's 'Super-Select' transmission allowing a choice of two or four-wheel drive for use on-road and four-wheel drive for use off-road including low range gears. Front hubs are automatic and engage as the four-wheel drive lever is used. According to the

MITSUBISHI PAJERO

	old 2.6 petrol	2.8 turbo diesel	3.5 V6 ECI.
ENGINE			
Fuel	petrol	diesel	petrol
Cylinders/Configuration/cm^3	4 in-line/2555	4 in-line/2835	V 6/3497
Max. power (DIN) kW at RPM	79 @ 5000	92 @ 4000	153 @ 5000
Max. torque (DIN) N.m at RPM	147 @ 3000	292 @ 2000	300 @ 3000
TRANSMISSION			
Type: 5-Speed manual or 4-speed automatic. Depending on model, part time or "Super Select" allowing part-time or permanent four-wheel drive with lockable centre differential. Automatic free-wheel hubs on current models. All with two speed transfer gearbox.			
Differential lock/s:	none	centre. new models also at rear	
SUSPENSION			
Front: Independent double wishbone, torsion bar, stabiliser and shock absorbers			
Rear (old models): Live axle, elliptic leaf springs and shock absorbers			
Rear (new models): Live axle, 3 link location, coil springs and shock absorbers			
DIMENSIONS			
Wheelbase (mm)	2695	2725	2725
Ground clearance (mm)	205	205	205
Approach angle (degrees)	N/A	40.5	40.5
Departure angle (degrees)	N/A	26.5	26.5
Fuel tank capacity (litres)	92	92	92
Gross vehicle weight (kg)	1700	2720	2720
Tyres sizes front and rear	215 R16	265/70 R15	265/70 R15
Std body suitable for high lift jack	no	no	no

handbook, disengaging them requires that two-wheel drive be selected and the vehicle reversed a short distance. In reality this is not so as they unlock on their own within a few kilometres after two-wheel drive has been reselected.
The 1998 cosmetic changes have not helped the Pajero in any way. The additions look like after-sales add-ons and what is worse, the side steps, which every Pajero owner knows are ripped off the moment the vehicle is taken off-road, are now permanent fixtures. The new mouldings without side-steps look very odd but with them, the Pajero must stay on a flat surface.
A brand new Pajero is due for release early 2000. Information on Pajero's short wheelbase model appears on page 43.

NISSAN PATROL (SAFARI)

During the eighties a version of the Patrol known as the 'Safari' was available in South Africa - the pick-up being built locally while the station wagon was imported. The Safari was the third in a trio of heavy-duty four-wheel drive pickups, sharing its load with the Toyota Land Cruiser FJ40 and the Land Rover 110 and it posed a serious challenge as it gained an excellent reputation for durability and reliability. Its off-road performance is excellent although it suffers a little through lack of ground clearance between front and rear axles. All have part-time four-wheel drive and the suspension is basic leaf springs all round with live axles.

The second generation Patrol, introduced in 1994, was the biggest vehicle in its class, bigger even than the Land Cruiser FJ80. Coil springs were introduced while the live axles were maintained together with part-time four-wheel drive. A lockable rear axle differential was introduced.

The current all-coil sprung Patrol is a refinement in every respect - particularly cosmetically - and now the vehicle has broad appeal. The previous model's over abundance of chrome and almost grotesque styling found it few friends in Southern Africa and the vehicle was never very popular. However, in Australia

FRANCOIS ROSSOUW

The third generation Patrol is distinctive in that it has even more chrome than most of it's American competitors. It was the first Patrol with coil springs.

it attracts a huge following. To evaluate its performance it should be compared to the Land Cruiser GX. Performance is closely matched off-road but on-road it falls short in a number of ways, the most significant being the ride. The suspension has the tendency to feel a little brittle as if the tyres are over-inflated and

NISSAN PATROL

	Safari	Patrol
ENGINE		
Fuel	petrol	petrol
Cylinders/Configuration/cm^3	6 in-line/2753	6 in-line/4169
Max. power kW at RPM	92 @ 5000	125 @ 4200
Max. torque N.m at RPM	195 @ 3000	325 @ 2800
TRANSMISSION		
Type: 4-Speed (early models) or 5-Speed manual part time four-wheel drive with two-ratio transfer gearbox and free wheel front hubs.		
Differential lock/s	no	rear axle
SUSPENSION		
Front and rear old model	solid axle, leaf springs, anti-roll bar, dampers.	
Front and rear new model	solid axles on coil springs, torsion bar type stabilisers.	
DIMENSIONS		
Wheelbase (mm)	2950	2970
Ground clearance (mm)	220	240
Departure angle	n/a	31°
Break-over angle	n/a	30°
Fuel tank capacity (litres)	82	95
Mass Tare (kg)	2859	2900
Tyres sizes front and rear	7.00 X 16	7.50 X 16
Std body suitable for high lift jack	no	no

NISSAN SANI

	3 litre petrol	2700 Tdi
ENGINE		
Fuel	petrol	diesel
Cylinders/Configuration	V 6	4 in-line
Capacity (cm3)	2960	2663
Max. power kW at RPM	110 kW @ 4800	69 kW @ 4100
Max. torque N.M. at RPM	237 Nm @ 4000	204 Nm @ 2400
TRANSMISSION		
Type: Manual 5-speed part time four-wheel drive with two-ratio transfer gearbox.		
Differential lock/s	none	none
SUSPENSION		
Front: Independent double wishbones with torsion bars, stabiliser bar and shock absorbers.		
Rear: Semi-floating rigid axle, leaf springs and shock absorbers.		
DIMENSIONS		
Wheelbase (mm)	2950	2950
Ground clearance (mm)	220	220
Fuel tank capacity (litres)	84	84
GVM (kg)	2749	2769
Tyres sizes front and rear	245/75 R15	245/75 R15
Std body suitable for high lift jack	no	no

on corrugations the ride can get quite unpleasant. On-road the big petrol engine has plenty of power and hauls this large vehicle along at respectable cruising speeds, performing about half way between the Land Cruiser's 4,5 petrol and 4,2 diesel engines. Seating, ergonomics and space utilisation are an improvement over its predessesor and in terms of extras it is good value when compared to its competitors.

NISSAN SANI

The Nissan Sani originated in 1983 and came as a result of Chris Holden's dream to build a locally produced affordable four-wheel drive station wagon. The first vehicles were rather rudimentary in comparison with the current production models and the prototype was built in a 3x6-metre garage. In 1986 James Bently joined Holden and together they created what is now a well known marque and a large group of contented followers. The Sani is built by Sani Industries in Pietermaritzburg where initially production stood at about five units per month. By the late eighties it had soared to 25 per month at which time Nissan, on whose chassis the Sani is built, bought a large shareholding in the company and then invested in an entirely new factory.

In 1989 the Sani's shape began to change and a new three-door model based on the Hardbody made its debut. Two years later a five-door version was released, powered by Nissan's 3-litre V6 engine. The increased power available to the Sani boosted its sales further. Soon after that, further body styles were introduced, including a double-cab, double-cab Executive and the familiar 5-door Executive.

What makes the Sani unusual is that the body is part fibreglass. The fibreglass components consist of traditional GRP (Glass Reinforced Plastic) exterior and interior panels built with the aid of RTM (Resin Transfer Moulding) bound together in what they call a 'Double Shell' system. Photographs of Sanis in roll-over accidents attest to the structural strength of the design. Added to the structure is a steel sub-frame and carbon fibre is placed in high-stress areas such as the door pillars.

The original Sani chassis was based on the Nissan Tracker, Nissan's first bakkie-based four-wheel drive. Likewise, current Sanis are based on Nissan's long-running four-wheel drive bakkie, called Hardbody. These were also once called Patrol.

FRANCOIS ROSSOUW

COURTESY NISSAN

COURTESY NISSAN

From the top down: The original Sani, the Nissan Tracker, the forerunner of the Sani, The first five-door, with the second generation the Sani tackled the luxury station wagon market.

All these vehicles have a solid rear axle on leaf springs at the back and independent front double wishbone torsion bar suspension. Nissan have shown consistent improvements to their Sani range and in late 1995 the front suspension was given a major revision with the addition of dual front coil springs and shock absorbers and revised towing apparatus designed primarily to improve performance in rough conditions. One result of this refinement was a significant improvement, especially off-road.

All have part-time four-wheel drive and manual free-wheel front hubs and are offered with a range of engines including their top-of-the range 3-litre V6. Body options are numerous and include single-cab, extended single-cab and steel-body double-cab pickups as well as the Sani Executive package which includes a 5-door station wagon body and an interior fitted out for luxury travel. The suspension gives a fairly comfortable ride on sealed surfaces, but shows limitations of restricted vertical wheel movements when off-road. On earlier suspension systems the vehicle felt front-heavy and bottoming the front suspension was done without difficulty. Older vehicles also had inappropriately designed towing equipment and bull-bars, creating poor approach and departure angles, degrading off-road performance.

The current model is the third generation Sani. It is better than earlier models in almost all respects except for off-road performance. The problems are caused by the styling department. When I see vehicles such as this arrive on the off-road scene I ask myself, “don’t the styling people talk to anyone?”. The side-steps, good looking and stylish as they may be, are far too low and are easily damaged off-road. They cannot be easily removed without removing plastic body styling panels.

SSANGYONG MUSSO

Riding heavily on the Mercedes engines installed, the Korean-built SsangYong Musso arrived to challenge the luxury leisure 4x4 market in 1995 and the model, due largely to its very competitive price tag, has done quite well in South Africa. The Musso is a road vehicle with fair off-road ability. Engine options begin with a normally-aspirated diesel version which is grossly underpowered developing 74kW at 4000 rpm. Add the South African turbo conversion and the Musso's power, although not abundant, develops 105kW at 4000 rpm, turning the vehicle into a comfortable cruiser. New petrol engined versions offer even more power and the local agents claim that the E320 is quicker off the mark than all the Musso's competitors, including those that sell for twice as much. The petrol Musso's drawback as a tourer is that it must be fed unleaded fuel unavailable in remote areas.

Off-road the Musso is a fair performer but is not as good as most of the competition. It should be compared to vehicles with similar price tags such as the Sani which has similar performance. Against top-spec station wagons, it falls well short of vehicles like the Discovery, Prado and Pajero. Ground clearance is its biggest problem but can be improved by adjustment of the torsion bars. In fact, the major-

SSANGYONG MUSSO

ENGINE	230EL	320EL	602EL TDI
Fuel	petrol	petrol	diesel
Cylinders/Configuration/cm^3	4 in-line/2295	6 in-line/3199	5 in-line/2874
Max. power kW at RPM	112 @ 5300	162 @ 5500	105 @ 4000
Max. torque N.m at RPM	225 @ 4000	310 @ 3750	300 @ 2800
TRANSMISSION			
Type: 5-speed manual or 4-speed auto part time four-wheel drive with two-ratio transfer gearbox and automatic free-wheel hubs. 320EL has full-time 4wdrive			
Differential lock/s	none	none	none
SUSPENSION			
Front: Independent double wishbone, torsion bar and telescopic shock absorbers.			
Rear: Live axle, coil springs, shock absorbers.			
DIMENSIONS			
Wheelbase (mm)	2630	2630	2630
Ground clearance (mm)	205	205	205
Approach angle (degrees)	27.4	27.4	27.4
Departure angle (degrees)	27	27	27
Fuel tank capacity (litres)	72	72	72
Kerb weight (kg)	1876	1931	1876
Tyres size: front and rear	235/75 R15 or 255/70 (320ES0)		
Std body suitable for high lift jack	no	no	no

ity of Mussos have badly set front suspension due to the months they spend in containers in transit when their suspensions are fully compressed by the tie-downs. As a result most Mussos, even brand new ones, have lower-than-spec ground clearance at the front.

As with so many vehicles in this class the standard tyres are light-duty and should be changed if adventurous travel is intended. Transmission is part-time four-wheel drive Borg Warner 5-speed manual gearbox and automatic free-wheel front hubs. With its growing popularity, spare parts are becoming more readily available throughout the sub-continent.

TOYOTA CONDOR

Toyota's true 4x4 stationwagon at the price of the average 4x4 double-cab fits into a cosy gap in the market and the new product is perfect for its position. The uninspired design and style of the Condor belies its performance; enjoyable and compitent in all theatres of operation, and while far from exhilarating, ideally suited to its role as light duty family off-roader. The Condor has front independent torsion bar suspension with a solid axle on leaf springs at the back. Engine options are a 2,4-litre petrol engine or a 3-litre diesel. As clear proof that the Condor has been developed to handle high-stress motoring the chassis is a seperate ladder frame which ensures strength off-road. As with all Toyotas, its build quality is excellent. Off-Road performance is fair, but ground clearance is lacking both between the front wheels and between the axles, which are its most serious handicaps. Another is the inability to engage centre diff lock in high range as the system auto locks when low range is selected, which means that high speed gravel cannot be done with the added security of locked 4-wheel drive. Axle ariculation is limited and not unlike that found in many 4x4 pick-ups while approach and departure angles are average. Considerng the Condor's size and weight, fuel consumption is heavy in both diesel and petrol models, The Condor concept is the answer for the adventurous traveller wanting a station-wagon while working on a tight budget.

TOYOTA LAND CRUISER PRADO

Introduced to South Africa in 1997 the Prado is the first Toyota 4x4 station wagon that has broken their tradition of solid axle suspension all-round. The Prado has independent front coil spring suspension and a solid rear axle on coils. The Prado is a luxury station wagon, smaller than the Cruiser 100, with permanent four-wheel drive transmission with lockable centre and rear differentials. The Prado comes with two engine options, a 3,4-litre V6 petrol and 3-litre 4-cylinder diesel. If you are looking for a vehicle that will spend 99% of its time on-road then choose the petrol. If you plan to be a little adventurous, go for the diesel. The diesel engine is a beauty, offering good cruising and town driving power but also enough low down torque, where the turbo is inoperative, to allow really low engine speeds when moving over rough ground.

Having driven one for over a year the Prado continues to impress. Off-road it is as able as any luxury 4x4 on the market and in this department I would place it behind the Discovery but superior to the Pajero, if by small margins. RareIy have I ever driven a vehicle more able on dunes than the diesel Prado - put it into low-range fourth and it feels unstoppable and very easy to drive. Apart from more body roll, on the road it is equal to the Pajero but superior to the Discovery. Its interior is unexciting and its competitors beat it for seating and appointments. The Prado is not well suited to heavy loads and vehicles built before about May 1998 had rear suspension problems which result in easy bottoming of the rear axle, even without a load. This has been corrected to some degree on current models. Heavy-duty springs and shocks do well on the Prado and if you intend to use a Prado for heavy loads put them on your 'must have' list. The Prado has passed the highest passenger car safety regulations available and is probably the safest 4x4 in the world. One of the remarkable attributes of the Prado which is superior to any four-wheel drive vehicle I have ever driven is its manners on rough gravel. Nothing provokes the Prado into an unpleasant slide and never does it feel as if it will take you by surprise on loose, uneven surfaces. Lock the centre differential in these conditions and it displays almost uncanny stability.

I ran a diesel Prado for 36 000kms before returning it to a sponsor. I have to say that it was the most effortless, trouble-free 40 000 kms I have done in my life. The vehicle performed brilliantly without a single fault emerging. Tyres were Conti Trac AT 235/85 R16.

TOYOTA LAND CRUISER - 50, 60, 80 and 100 series

I am unable to establish when the first Land Cruiser station wagon was released but it may have been in 1965. The vehicle shared the chassis of the pick-up but the body was completely different, designed to carry people instead of heavy loads. This was the FJ55. Few of these early station wagons found there way to South Africa. In 1980 the FJ55 was replaced by the series 60. In tune with the growing leisure market in 4x4s, the FJ60 came equipped with luxuries like power steering, cloth seat trim and air

TOYOTA CONDOR

ENGINE

Fuel	diesel	petrol
Cylinders/Configuration/cm^3	4 in-line/2986	4 in-line/2438
Max. power (DIN) kW at RPM	66 @ 4000	85@ 4800
Max. torque (DIN) N.m at RPM	192 @ 2400	195 @ 2800

TRANSMISSION

Full-time four-wheel drive with two-ratio transfer gearbox with a lockable centre differential.

Differential lock/s:	centre	centre

SUSPENSION

Front: Independent wishbone, stabiliser bar, torsion bars and shock absorbers.
Rear: Rigid axle, leaf springs and shock absorbers.

DIMENSIONS

Wheelbase (mm)	2650	2650
Ground clearance (mm)	205	205
Approach angle (degrees)	37	37
Departure angle (degrees)	30	30
Fuel tank capacity (litres)	70	70
GVM	2195	2130
Tyres	205/70 R15	205/70 R15
Load tie-down rings	no	no
Fuel tank capacity (litres)		

TOYOTA LAND CRUISER PRADO

ENGINE

Fuel	diesel turbo	petrol
Cylinders/Configuration/cm^3	4 in-line/2982	V6/3378
Max. power (DIN) kW at RPM	92 @ 3600	132 @ 4800
Max. torque (DIN) N.m at RPM	295 @ 2400	298 @ 3600

TRANSMISSION

GX: 5-speed manual or 4-speed full-time four-wheel drive with two-ratio transfer gearbox.
VX: 4-speed auto full-time four-wheel drive with a lockable centre differential. All models have two-ratio transfer gearbox.

Differential lock/s:	centre and rear	centre and rear

SUSPENSION

Front: Independent double wishbone, coil spring and shock absorbers.
Rear: 4-link, rigid axle, coil springs, stabiliser bar and shock absorbers..

DIMENSIONS

Wheelbase (mm)	2675	2675
Ground clearance (mm)	245	245
Approach angle (degrees)	36	36
Departure angle (degrees)	30	30
Fuel tank capacity (litres)	90	90
GVM	2750	2710
Tyres	265/70 R16	265/70 R16
Load tie-down rings	yes	yes
Std body suitable for high lift jack	no	no

conditioning. The buyer could also choose between petrol and diesel engines.

The FJ60 is found working for its keep all over the Third World and have for many years been the most popular choice of many

aid organisations. The leaf springs are softer than those found on pick-ups so passengers get a spongier ride when the going gets rough, but these springs give a superior ride on the tarmac. Heavy steering is power assisted and luxury items such as air conditioning are fitted to many models. Criticisms include heavy fuel consumption and the location of the spare wheel behind the rear axle under the vehicle which is an obvious disadvantage off-road.

Top: The Land Cruiser station wagon FJ55. This one is still operating in Maun Botswana. Middle: 80 Series with series 60 behind. Above: 100 Series.
Following page top: FJ80
Following page bottom: 100 Series GX on Cape West coast dunes

In 1990 a totally new station wagon entered the market - The FJ80 - with the coil spring suspension and a redesigned body that so many 4x4 enthusiasts admire today. The 80-series was a major improvement in every sense - a fast and comfortable vehicle with improved off-road ability and an outstanding towing vehicle superior to almost anything on the road. The coil spring suspension is an excellent balance for cruising comfort and off-road ability. In the rough the FJ80 is supremely confident, although when things get very rough it can be hard on occupants. At speed it is exceptionally stable with steering feel superior to the competition. Fuel consumption of the petrol version is quite acceptable up to 120kph from which point it soars rapidly. (At 150kph I measured a staggering 22 litres per 100 kilometres). On the down side there are no jacking points for a high-lift jack and the spare wheel stowage under the load bay is a pain and can create difficulties in the rough. The FJ80 is built with various types of transmission, from the more familiar part-time four-wheel drive on the GX to full-time four-wheel drive with a lockable centre differential on the VX. With some VX models the spare wheel is stowed on the back door.

The 100-series, launched mid 1998, is a development of the 80 retaining the solid axles on coil springs on the GX but going to independent front suspension on the VX. The GX is now aimed at the user, the off-roader who may demand the very best in off-road performance. To this end the GX is fitted with front and rear axle diff locks coupled to a full-time four-wheel drive system and a lockable centre diff. A spare auxiliary fuel tank is also fitted. The

TOYOTA LAND CRUISER STATION WAGON 60 AND 80 SERIES

	FJ 60 Petrol	FJ 80 Diesel	FJ 80 Petrol
ENGINE			
Fuel	petrol	diesel	petrol
Cylinders/Configuration/cm^3	6 in-line/4230	6 in-line/4164	6 in-line/4477
Max. power (DIN) kW at RPM	n/a	96 @ 4000	145 @ 4400
Max. torque (DIN) N.m at RPM	n/a	280 @ 2000	363 @ 2800
TRANSMISSION			
FJ 60 and FJ80GX: 5-speed manual or 4-speed auto part time four-wheel drive with manual free-wheel hubs. FJ80 VX : 5-speed manual full-time four-wheel drive with a lockable centre differential. All models have two-ratio transfer gearbox.			
Differential lock/s	none	none	centre
SUSPENSION			
FJ 60 Front and Rear: Rigid axle with semi-elliptic leaf springs, shock absorbers.			
FJ 80 Front and Rear: Rigid axle with coil springs, shock absorbers, stabiliser bar.			
DIMENSIONS			
Wheelbase (mm)	2980	2850	2850
Ground clearance (mm)	185	235	235
Fuel tank capacity (litres)	90	95	95
GVM	2070	2960	2960
Tyres	7.00 X 16	275/70 R16	275/70 R16
Load tie-down rings	no	no	no
Std body suitable for high lift jack	yes	no	no

TOYOTA LAND CRUISER STATION WAGON 100 SERIES

	FJ100 GX	FJ 100GX	FJ100 VX
ENGINE			
Fuel	petrol	diesel	diesel turbo
Cylinders/Configuration/cm^3	6 in-line/4477	6 in-line/4164	6 in-line/4164
Max. power (DIN) kW at RPM	165 @ 4600	96 @ 3800	150 @ 3400
Max. torque (DIN) N.m at RPM	387 @ 3600	285 @ 2000	430 @ 1400
TRANSMISSION			
GX: 5-speed manual or 4-speed full-time four-wheel drive with two-ratio transfer gearbox. VX: 4-speed auto full-time four-wheel drive with a lockable centre differential. All models have two-ratio transfer gearbox.			
Differential lock/s: GX has centre, front and rear locks. VX has centre and rear locks.			
SUSPENSION			
GX Front and rear: Rigid axle with coil springs and shock absorbers.			
VX Front: Double independent wish bones, torsion bar and shock absorbers.			
VX Rear: Rigid axle with coil springs and shock absorbers. Self-levelling air-suspension on some imported models.			
DIMENSIONS			
Wheelbase (mm)	2850	2850	2850
Ground clearance (mm)	215	215	215
Approach angle (degrees)	34	34	34
Departure angle (degrees)	26	26	26
Fuel tank capacity (litres)	96+45	96+45	96
GVM	3160	3160	3260
Tyres	275/70 R16	275/70 R16	275/70 R16
Load tie-down rings	yes	yes	yes
Std body suitable for high lift jack	no	no	no

GX is a masterpiece. It's big, very big, but the balance of on-road comfort and speed coupled with loadability, good range and off-road performance is superb. Its drawback off-road is clearance between the axles and a spare wheel stowage under the loadbay. Models to be launched in 1999 will correct the spare wheel position but the clearance shortcoming can only be corrected by a heavy-duty suspension system, the Old Man Emu system working particularly well. Engine options with the GX are the familiar 4,5-litre 6-cylinder but now with fuel injection and a 4,2-litre normally aspirated diesel. The diesel is a little underpowered but not to a point where the vehicle is unpleasant to drive. Those considering fitting an after-market turbo, be aware that although this is a worthwhile modification, gearing falls short and performance does not match that of the VX.

The VX challenges the 4x4 limousine market and tackles the Range Rover and Mercedes M-class head-on. In South Africa the VX comes with 4,2-litre turbo-diesel engine and automatic transmission. The engine is the smoothest and quietest diesel I have ever driven and produces massive torque well under 2000 rpm. Off-road this engine is beyond compare for flexibility. Interior equipment ranges from electric seats to an electric sunroof. If you are considering a grey-import Land Cruiser, I recommend you read the pros and cons of such imports in chapter one.

The best part about the 100-series which is a personal observation - this is a very good looking machine.

VOLKSWAGEN SYNCRO BUS

A four-wheel drive adaptation of the very popular rear-wheel drive minibus is no longer made but second-hand units are available. There are two versions: the standard 'Microbus ' and the Caravelle luxury version. Both have a 2.1-litre fuel-injected 4-cylinder engine. Advanced 4WD is permanent using a hydraulic viscous coupling between the front and rear propshafts. Suspension is by independent coil springs on all four wheels. Modifications for off-road use include protective plates, a single low gear ratio for off-road work and raised suspension. The Syncro's performance over uneven ground is impressive because of excellent vertical wheel travel and axle differential locks which can be engaged on the move.

The Syncro is seriously disadvantaged when conditions get muddy, because of its small wheels, road tyres which clog very quickly and low ground clearance. The engine is low slung and this is a problem both when wading and when the vehicle is being driven over uneven terrain. The levels of exterior finish and interior comfort are very high.

FRANCOIS ROSSOUW

VOLKSWAGEN SYNCRO BUS 4X4 2.1 LITRE

ENGINE

Fuel	petrol
Cylinders / Configuration / cm^3	4 horizontally opposed / 2109
Max. power (DIN) kW at RPM	82 @ 4800
Max. torque (DIN) N.m at RPM	174 @ 2800

TRANSMISSION

Type: 5-speed manual full-time four-wheel drive with hydraulic viscous coupling. Single speed low gear for off-road work.

SUSPENSION

Front: Independent wishbones and coil springs and shock absorbers.

Rear: Independent diagonal arms and coil springs and shock absorbers.

DIMENSIONS

Wheelbase (mm)	2455
Ground clearance (mm)	193
Fuel tank - capacity (litres)	70
Mass Tare	2500
Mass payload (kg)	848
Tyres sizes front and rear	205 SR14
Std body suitable for high lift jack	no

4. SPECIALISED AND UNUSUAL VEHICLES

In this section: Bejing Jeep, Land Rover Forward Control, AMC Hummer, Uaz, Toyota Mega Cruiser. Mercedes Benz Unimog.

BEJING JEEP

If you want to see a crude vehicle, take a look at the Bejing Jeep! It makes the Lada Niva look highly sophisticated. A small number were imported into South Africa and nowhere on earth are they worse suited. They are unreliable and spare parts are not available. No longer available, they are an excellent example of a vehicle imported into the country by someone looking to make a fast buck.

LAND ROVER FORWARD CONTROL

In 1962, a very different Land Rover was introduced - the Land Rover Forward Control. The original wheelbase was 109 inches and this was increased to 110 inches in 1966. It was born of the need for more space and higher payload. Unless a totally new vehicle was to be produced, forward control was the only way to increase load bay length without drastically changing the chassis. The vehicle has a curb weight of 1 973 kgs and a maximum permissible vehicle weight of 3636 kgs, 568 kgs more than a conventional Land Rover. Combined with massive ground clearance and huge 9.00/16 inch tyres, the vehicle had superb off-road performance. Never as versatile as a standard Land Rover, the Forward Control had limited popularity and production ceased in 1977. Many examples of the Forward Control found their way to Southern Africa, most through the South African and Rhodesian armed services and a few through aid organisations. They were used as troop carriers, ambulances and communications vehicles throughout the border conflicts from the '60s through much of the 80's.

HUMMER

In late 1979 a subsidiary of American Motors Corporation, AM General began development of a High Mobility Multi-purpose Wheeled Vehicle, or HMMWV (pronounced humvee). The US Army awarded AM General a prototype contract in 1981 which was followed by development and testing lasting four years. Since then over 150 000 HMMWV's have been produced for the US armed forces. The vehicle gained international recognition in the Gulf War when it won the hearts of the infantry men that drove it. For South Africa the

Hummer is a showpiece and not a workhorse. This is because it is too wide for sand tracks and trying to drive in sandy conditions in heavy bush is very frustrating. It is powered by a 6.5-litre V8 turbo-diesel engine couple to a four-speed auto transmission. The one pictured is a five door station wagon model imported by Safari Centre in 1998.

UAZ

Visitors to Mozambique may be familiar with these vehicles - Russia's "working man's 4x4". These vehicles are as basic as you can get. The Uaz 31512 is the all-purpose workhorse, seven seats with a payload of only 100kgs while the 33035 is the load carrier, with a payload of only 800kgs! They are both powered by a 2,4-litre 4-cylinder petrol engine producing 66,9 kW and have all-round drum brakes. There are seven derivatives of the 33035.

Top: Uaz31512
Bottom: Uaz 33035

TOYOTA MEGA CRUISER

Similar in appearance to the American Hummer, the Mega Cruiser is a mammoth 5-metre long, 2.1-metre wide, 10-seater station wagon. Its off-road abilities are extraordinary as it floats over obstacles that would stop the average off-roader. Suspension is independent torsion bars on all four wheels, portal axles, an immensely torquey 4-cylinder, 4.2-litre turbo-diesel engine, automatic transmission and a system which deflates and inflates the rear tyres while on the move. The only criticism that can be fairly levelled at it is that if you are going to be so extravagant when designing a 4x4, why not go all the way with tyre inflation systems on all four wheels like the Hummer? Launched in mid-1996 the Mega Cruiser is available in South Africa for about R800 000.

MERCEDES BENZ UNIMOG

Often referred to a the ultimate expedition vehicle, the Unimog has earned this reputation through years of service not just impressive looks. The second series of Unimog is a marked improvement over the old, with better seating, interior comforts, lower noise levels and easier serviceability. The Unimog is nothing short of phenomenal off-road but it will get stuck in mud. Its portal axles mean that ground clearance is so good that the wheels will sink very deep before it gets stuck. When it does, extraction can be impossible with regular winch gear. In these cases, another Unimog or a bulldozer may have to be called to the rescue.


3.
AUXILIARY
EQUIPMENT
Bankfin
HBS689 GP
sorting the needs
from the wants

Don't be fooled into thinking that without a fully-equipped vehicle you'll not be able to make trips into the wilderness. This chapter will act as a guide through what has become an often confusing shopping experience. Which items are essential and which are simply nice to have? From this point of view, read on.

BODY-MOUNTED ACCESSORIES

BULL BARS

Bush or bull or roo-bars are now commonplace on vehicles from minibus taxis to four-wheelers. They are made of aluminium, mild steel or stainless tubing and are fitted either because the driver wants genuine protection from the possibility of hitting an animal at speed or to look macho around town. Either way, they are useful items when it comes to fitting winches, spotlights and grille guards. In the past it was fashionable to fit overly heavy steel wrap-around tubes designed by retired civil engineers who, during their working lives, designed suspension bridges. Today things are more sensible and most bull-bars sold are lighter in weight and look better too.

Here are some points to consider when selecting a bull-bar:

- *Is your vehicle equipped with air bags? If so, only a manufacturer-approved bull-bar is acceptable. Non-approved bull-bars may prevent the correct deployment of an air bag during an accident. In this case claims made against a manufacturer due to this will be nul-and-void.*
- *Bull-bars designed to ward off serious impact are broad, tall and lean forward, causing whatever it meets to be pushed downward, protecting the windscreen and passengers. This type of bull bar is not necessarily made from very large diameter piping - the strength of its design is its heavy mountings.*

This lightweight bull bar weighs less than 15 kgs, complete with headlight protection and grille net.

- *Check that the design does not affect the vehicle's approach angle.*
- *Should the upper bar of a bull bar be higher than the bonnet, light from the headlamps will strike the bar and shine back at the driver. This can be very annoying.*
- *If you intend to fit a winch at a later date select a bull bar with an integral winch mount. If you intend to fit spot-lamps ask your supplier for fittings for these.*
- *Take a close look at the mounting points - these are going to absorb any impact, and not the tubing. Thick heavy piping with light mounts make matters worse - if the steel piping has no 'give' or the mounts are weak, a light impact at one end of the bar can push it back along its entire length, and damage the body-work on the other side of the vehicle. Wrap-around bars are more prone to this.*
- *Painted bull-bars require periodic repainting.*
- *Alloy A-bars are light and protect the radiator and nothing else. They make good mounts for driving lights.*
- *A galvanised bull-bar may look less attractive but is a good and cheaper option for vehicles operating in coastal areas.*
- *Brand new aluminium bull-bars look great but dull over time.*
- *Powder coating is corrosion and scratch resistant and surfaces also look great. Powder coating differs greatly so shop around for the best quality.*
- *When adding equipment to a bull-bar avoid interfering with the airflow to the radiator, oil cooler and air conditioner radiator.*

ARB of Austrailia make some of the best looking and practical bull bars around. They are more expensive than local varieties but worth the expense if you want the best.

Locally-made, powder coated and well made bull-bar by Front Runner

SIDE-STEPS/RUNNING BOARDS

Side-steps are the first items to get damaged on an off-road vehicle.

Most side-steps do not assist access into a vehicle because they are positioned too close to the under-door sill to get a decent foothold.

Fitted to vehicles such as the Discovery, Pajero or Trooper they become a source of frustration the moment the vehicle is asked to do even a simple off-road manoeuvre.

Fitted to high vehicles such as the Hilux, they are high enough off the ground to prevent damage, but are often too high to assist access - therefore they are a pointless annoyance. They jut out from the vehicle's side at knee height, smearing trousers with mud or dust when accessing or leaving the vehicle. In the case of the Hilux they do protect the bodywork.

The standard Land Rover Defender side-steps are effective and well placed but even they, in their folded position, get bent out of place very easily. They can, however, be easily kicked back into shape. With the Pajero and Nissan Sani the low side-steps are designed as part of the body styling. In both cases they cannot easily be removed without making the vehicle look odd. The Prado and Discovery designs are more adaptable. They are better positioned than most and can be removed easily which is advisable if off-road work is intended.

Even fold-away side-steps get damaged off-road and often cause damage to the vehicle, as can be seen to the left of the step

BUMPERS AND TOWING EQUIPMENT

Tow-bars, bull bars and bumpers frequently adversely affect a vehicle's ability to traverse uneven ground. Fitment centres, enthusiasts and even the manufacturers themselves make this mistake. The Land Rover Discovery is a typical example. Keep all such modifications as close to the bodywork and as high as possible to prevent degrading the departure and approach angles.

When debogging a vehicle, use the vehicle's towing eyes to attach cables and ropes in preference to towing apparatus which is not designed to withstand the loads that can be created by snatch straps or winches. More information in this regard is in the chapter, 'Recovery'.

Front tow-bars

To make launching a boat easier, fit towing apparatus to the front of your vehicle. Position the tow-bar off-centre to the left. This will allow the driver to see alongside the trailer which will improve directional control.

Do not fit the tow bar close to the ground because if it is low, the stern of the boat will be higher, which means the vehicle will have to push the trailer further into the water than would be necessary if the tow hitch was higher and the stern lower. In other words, the boat will float off the trailer in shallower water. And, a low-slung front towing apparatus renders the vehicle useless for off-road use.

SUSPENSION MODIFICATIONS

With many modern 4x4s equipped with suspension systems better suited to road conditions than off-road work, modifications may be necessary to increase ground clearance and improve payload. Also, vehicles that excel off-road may be in need of softening up for more road use. There are various ways to tackle this.

Specialist suspension modification manufacturers

One of the best manufacturers of matched suspension mods is Old Man Emu (OME). It comes from Australia, the world's leader in off-road gear. A broad outline of the results that can be expected from common suspension modifications is as follows:

Heavy-duty springs

When coil springs are exchanged for higher rated units make your selection carefully. Light-duty units will feel similar to those that the manufacturer has fitted but will ensure longer life of the shock absorbers, especially if they are the gas type. Medium rate springs will improve road holding, reduce body roll and improve payload by a small amount. Hard springs will improve off-road handling, on-road adhesion, reduce body roll and are recommended for vehicles with loaded roof-racks. They improve heavy payload handling, stability and safety but may feel harsh on-road.

Professional safari operators fit these systems to Land Rover Defenders with good results. The ride is quite a bit better than the standard springs and the axle travel, when combined with gas shocks, is improved.

With leaf spring vehicles such as the old Hilux, the change is even more impressive. The new springs smoothe the on-road ride and at the same time vastly increases the axle articulation due to spring lubrication between the leaves.

Spring assisters

Coil sping assisters come in the form of helper coil springs that fit inside the existing coils, rubber blocks squeezed between the coils of a spring to restrict its collapse, or Roadmaster's new invention as illustrated. I not tested this new system but the concept looks promising. The product will be released late 1999.

Air shocks and inflatable coil inserts that are inflated to suit load and conditions are another option. Although I do not have first hand experience of these, I have heard that they do not cope well with excessive off-road punishment. For leaf springs the only assister I know of is the Roadmaster active suspension unit (right) which is very effective in improving payload while ing vehicle stability when loaded. (Roadmaster 043 743 5283)

Possible problems caused by suspension modifications

While heavy-duty springs increase ride height the angle at which the propshaft universal joints operate is increased, often resulting in accelerated wear or vibrations. Other items to check are the brake hoses. There must be ample length to cope with full axle travel without the risk of stretching the hose.

Gas shock absorbers

Few vehicles have gas shock absorbers fitted as standard equipment and for a vehicle expected to work long hours off-road they are essential. In the past, few four-wheel drive vehicle manufacturers pay enough attention to shock absorbers. Here, Toyota deserve a thumbs up as the new Hilux is the first 4x4 I know of where gas shocks are standard equipment. Other manufacturers are following their lead.

Working 4x4s need gas shocks. For example, my own Land Rover 110 went through two sets of standard shock absorbers within 30 000 kilometres. Once the second set had worn out, the first being replaced under guarantee, I replaced them with Bilstein gas shocks. When selling the vehicle after clocking up 130 000 kilometres the shocks were as firm as when I fitted them. Gas shocks often make the ride a little firmer but the real advantage comes when cornering or carrying a load. The difference in my case was a significant improvement in ride even when compared with brand new standard shock absorbers.

When fitting gas shocks it is essential that the suspension setup is checked and adjusted if necessary. Not centralising the suspension before fitting gas shocks can cause rapid destruction of the shock absorbers. The reason for this is that when a suspension system, particularly independent wishbone types, are not set in the 'central' position when the vehicle is at rest, the shock absorbers act as bump-stops instead of the rubber bumps designed for the job. The internal components are literally hammered to pieces.

Do not assume that if your vehicle is brand new that the suspension is correctly set up. Many imported vehicles stay lashed down to the bump-stops in crates for months and when they are delivered the suspension has 'sagged' and must be reset. Vehicle importers and manufacturers should make this a vital part of the pre-delivery check list.

Why gas?

A shock absorber, simply described, is a metal tube filled with oil through which a piston moves. On the piston is a valve which permits oil to pass through at a limited rate. The tube is connected to the chassis and the piston is connected to the axle. The oil's limited travel damps the movement of the piston and therefore the axle to which it is attached. This prevents oscillation that the springs would create if left undamped. As the piston moves in the cylinder heat is generated. Heat thins the oil and makes the shock less effective. What is worse, the oil in a hard working shock mixes with air and bubbles are formed. The mixture of hot air and hot oil passes through the valve with ease which eventually causes the shock to soften until the ride is uncomfortable and unpredictable.

Gas shocks are different in that they are pumped with a small quantity of inert gas. This gas cannot mix with the oil and the main reason why shock-absorbers become soft when they get hot is eliminated. Shock-absorbers in a heavily loaded 4x4 on a rough sand track work almost as hard as shocks on a competition rally car. I know of one Range Rover which after being called to rescue the survivors of an accident in Northern Botswana, 'cooked' a gas shock by racing to get to the accident scene. The shock was blackened by heat and was destroyed. The driver admitted that he had the vehicle airborne a few times. The accident victim was me.

Polyester Bushes

Bushes made from hard rubber are fitted in various locations in suspension systems to soften the vibrations generated by the wheels, engine and transmission. In off-road vehicles these bushes are stressed more than in a normal road vehicle and as a result wear out and need periodic replacement. Bushes are located in various places, namely leaf spring shackles, steering dampers, control arms locating the axles, radius arms and panhard rods (steering control arms).

The effects of worn bushes can be vague steering, instability, uncomfortable ride on corrugations, clunks and bangs on rough terrain and clunks when reversing or braking.

A worthwhile option when replacing bushes is to fit polyester units. Polyester is replacing rubber in bushes in industry from shipping to heavy machinery and vehicles are reaping the benefits of the reseach into new age plastics. The advantages of polyester are long life and a stiffer suspension which aid stability and safety. Little more vibration or noise is sometimes transmitted to the driver but this is rarely noticeable and they often cost less than genuine parts.

AUXILIARY TANKS

Fuel tanks

Easily fitted to some vehicles, these are an effective way of increasing

Here are some pointers to consider when designing and building your own fuel tanks:

- *Ideal material from which to build fuel tanks is mild steel with a minimum thickness of 2mm.*
- *Include gusset plates to prevent the fuel from sloshing around and to strengthen the tank.*
- *Attach the drain pipe in a protected position protruding from the side of the tank and not from the bottom.*
- *Tanks must be galvanised, inside and out, before fitting.*

The position of tanks will vary from vehicle to vehicle. Possible locations are under the front wings, under the seats, in the loading bay as far forward as possible (bakkies), headers above the existing tank, alongside the chassis rails between chassis and outer body near the doors and on the floor of the loading area. Never install a fuel tank in front of the engine - spillage or leakage can cause a disastrous fire. Switching from one tank to another can be made using either electric solenoid valves or taps, (the former being more expensive), or individual fuel pumps. It is important to use proper fuel hose when fitting tanks as ordinary hose will soon become brittle and crack. Industrial hose suppliers will sell fuel hose considerably cheaper than auto spares retailers.

Top: Some vehicles are better suited to the fitting of long-range tanks than others. This is a 72-litre tank on a Prado.
Bottom: Front Runner builds tank kits and supplies 4x4 outlets throughout the country. This complete kit is a Toyota-approved long-range tank for the new Hilux.

Carrying fuel

Never use ordinary plastic containers to carry fuel, as they are unreliable and after time the plastic can become brittle and slightly porous, causing fuel to seep out and create a fire risk. Bumping and jolting over rough terrain stresses plastic containers carrying liquid, and the risk of breakage when filled with fuel cannot be over stressed. Steel jerrycans are therefore advised. When purchasing jerrycans look closely at the seal clamp. Some cheap types leak and become a never-ending frustration, so spend a little more and get good ones. Ex-Army jerrycans, if in good condition, are cheaper and can have new rubber seals fitted and be repainted. (do not cross the border if they are painted military drab)

Diesel is less hazardous to transport than petrol, but if you are carrying diesel in jerrycans once used for petrol, remember that as little as a 2% mix will render it as volatile as pure petrol, so empty the cans completely.

Water tanks

Water tanks can be fitted to your vehicle by most safari vehicle supply workshops or can be installed by anyone with some DIY ability and welding skills. Water tanks must be very strong so they don't crack under the vibrations and flexing created when a vehicle moves over rough ground. Steel tanks should be no less than 2mm thick and should be strengthened by baffles inside the tank. Baffles also prevent water sloshing around when the vehicle is moving. To prevent rust, steel tanks should be galvanised inside and out. Water from this type of tank can taste metallic, and the tanks should be flushed several times before use. The ideal material from which to build a water tank is stainless steel. It is strong, corrosion resistant and does not give the water an unpleasant taste. Storing water in aluminium is a health risk as it oxidises and has been associated with Alzheimer's disease. Opaque plastic is the best material for storing water although most home workshops cannot fabricate tanks from it.

The selection of a position in which to fit a water tank will depend on your particular vehicle. The same positions recommended for fitting additional fuel tanks apply to water tanks - with this important addition: while fuel should never be carried in front of the engine because of the fire risk, water carried here aids weight distribution and is safe. If a large quantity of water is carried in the front, it is advisable to strengthen the front springs.

Tanks under the seats in Land Rovers, a position often used to fit fuel tanks, tend to get quite hot and make the water less pleasant to drink, but convenient for washing dishes. The tunnel behind the rear wheel arches in Land Rovers is an ideal position to fit a tank. For easy access, the tap can protrude out of the back of the vehicle and in this position the water remains delightfully cool. In pickups, an obvious position is inside the loading bay as far forward as possible, with the tap protruding either from the body panel at the side of the vehicle (prone to damage) or underneath the body panels. Carrying water on the roof is not advised for a number of reasons. The tanks get warm, require some effort to fill if a running hose pipe is not available and severely compromise a vehicle's centre of gravity.

A few considerations when piping from water tanks:

- *Because water is a very poor lubricant, most electric fuel pumps cannot be used to pump water as these are lubricated by the fuel running through them.*
- *Secure all exterior water taps with small padlocks to prevent theft. Wrap rubber bands around the locks to prevent them being damaged*
- *If you have a steel water tank fitted to your vehicle, attach a vehicle tyre valve to the top of the tank, in a position where access is easy. On the output pipe attach a tap and a long hose with a fitting to allow a shower rose to be attached. Now pump in air. The pressure will force water out of the pipe - the more you pump the higher the water pressure. Do not over-pump or you may split the tank. Test a new system by pumping and monitoring the water pressure. This shower system could also be used to pump fuel to an engine in the event of a fuel pump failure.*

AUXILIARY LIGHTING

Original equipment headlights are good for a lot of conditions and masters of none.

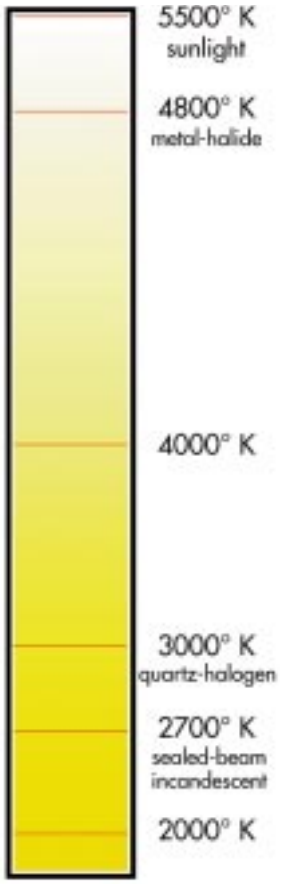
If you intend to travel at night in Third World Africa, where dogs, chickens, cattle and goats are a constant danger, fit good quality auxiliary lighting to your vehicle.

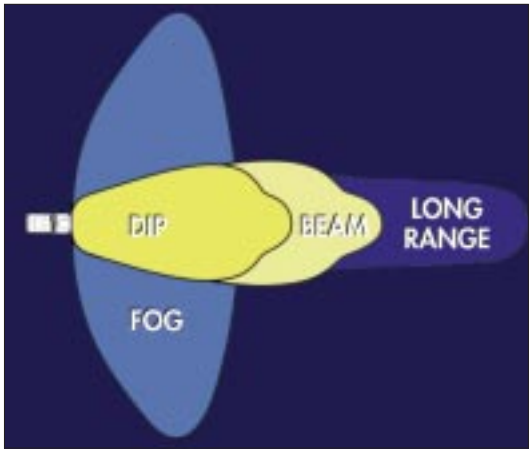
Driving lights

Driving lights supplement the vehicle's own lighting, giving a mod- visibility broad spread illuminating the road sides and providing penetration ahead.

Fog lamps

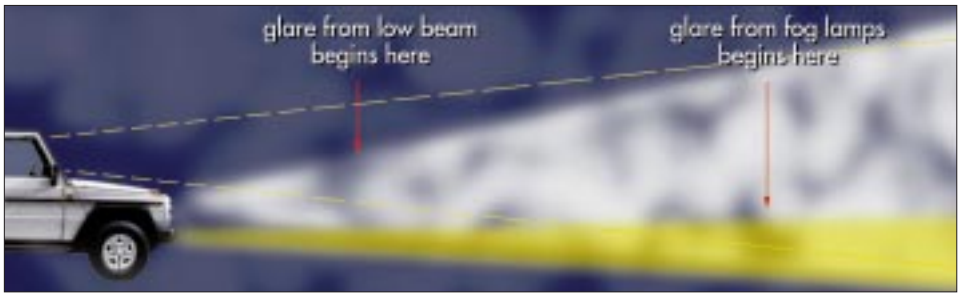
Fog lamps are not simply driving lights with an amber filter. What is crucial about a fog light is its spread, not its colour. Genuine fog lamps throw a very broad flat beam that stays low. This prevents glare as the light bounces off the airborne particles and is thrown back into the face of the driver. Amber permits further penetration through the fog, but its primary function is not to increase the driver's





Long range

Long Range lights penetrate ahead, the range of a typical quartz-halogen light being three kilometres. Specialist lighting such as the metal-halide 900 000 candle-power units made by KC Hilites are rated at



over 18 kilometres. Long range lights are characterised by a prism-less lens. Another excellent example is the Cibie Oscar which is my first choice in long range lighting.

THE COLOUR OF LIGHT

Clear light is used for seeing and red and amber light is used to be seen. It is for this reason that tail lights are red and driving lights are white or as close to white as possible. The chart above represents the light temperature spectrum in degrees Kelvin.

Metal halide

Metal halide is new technology where a special bulb runs at very high voltage. A ballast powers each lamp and these lamps, made in the USA by KC Hilites, throw light brighter and whiter than all the competition. They are so pricey as to be out of the reach of most 4x4 enthusiasts.

Quartz halogen

Quartz Halogen became standard equipment in most motor vehicles by the end of the seventies, before which incandescent sealed beams were used. Normal wattage ratings range from 50/65 (50 watts dim/65 watts high beam) to 100/150. The difference in efficiency between these two extremes is cast and if you are dissatisfied with your vehicle's lights, simply changing the bulb rating may be an economical and effective answer. If you do this make sure that the vehicle's relays and switches can cope with the extra current, otherwise expensive burnout will occur.

Sealed beam

Incandescent sealed beams are not as bright as quartz-halogen. Their advantage is that they are totally waterproof and very robust. Apart from being less efficient their other disadvantage is that when the filament fails or the lens is damaged, the entire reflector and lens units must be replaced.

FITTING AUXILIARY LIGHTS

Auxiliary lights are easily fitted by anyone knowing basic electrics. They must be fitted in conjunction with a relay directly linked to the high/low beam switch, so that they automatically switch off when the headlamps are switched to low beam. This is enforced by law. Poor performance and unreliability can be avoided by high quality connectors and relays and the use of multi-core copper wire with a core diameter of at least 3mm.

Light guards

When fitted too close to the light lens they make cleaning difficult. Some are purely cosmetic - the design should protect the lens from flying stones, as this is how most damage occurs. Steel mesh types that hinge open for cleaning are best. Broadly spread slats are not very effective against flying stones.

Rear lighting

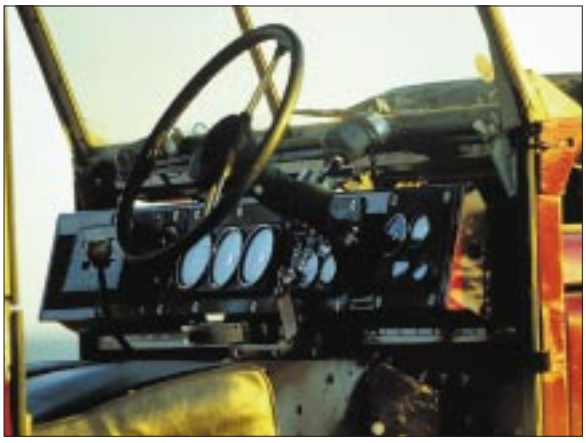
It is also a good idea to have a small floodlight permanently attached to the rear of the vehicle. They are invaluable if you need to do the following after sunset:

- *Arrive at a camp-site.*
- *Hitch up or unhitch a trailer.*
- *Perform a tricky reversing manoeuvre.*
- *Undertake repairs to a second vehicle.*

I also recommend the use of a 12-volt fluorescent tube with a long cable. They are robust, consume little current and are ideal for working on a vehicle thanks to their broad, even spread of light.

GAUGES

Monitoring engine performance while travelling far from home is a good idea. I learnt the hard way when my oil pump failed in central Botswana on our return leg after a wonderful two weeks in the bush. I had suffered a blowout on a rear tyre and stopped to change the wheel. On restarting the engine the oil pressure light failed to go out. The oil pressure gauge was not working because it was a cheap Taiwanese model and had always been unreliable. The first item that I checked was the sender switch that triggers the warning. I swapped it for the one fitted to the other Range Rover travelling with me. This did not solve the problem and we then concluded that it was a failure in the engine itself. After removing the sump to check the oil strainer which we suspected had cracked, we dismantled the oil pump. We discovered the fault and made a temporary repair.



This 40-year old Land Rover Series One with a Rover 2,6 straight 6-cylinder engine has gauges monitoring just about everything.

After priming the pump with vaseline the engine started and the oil light went out. We were soon back on the road but less than 10 kilometres later the oil light came on again. By now we had spent over 10 hours repairing the vehicle and decided to tow it home - over 700 kilometres. When we arrived home we swapped the sender switches back. Then it

dawned on me that I should try and start the engine. It started and the light went out - the sender switch from the other vehicle had failed due to a bit of dirt it collected when we fitted it. I drove my vehicle in that state for two weeks until I found the spare part that I needed. If I had had a decent gauge fitted to my vehicle all the towing would have been unnecessary and much of the guess work while trying to work out the problem would have been avoided.

TempAlert is an engine protection device that sounds when engine oil or water temperature exceeds recommended maximum.

Sadly, manufacturers spend money fitting unnecessary gimmicks such as altimeters and inclinometers while omitting essential items such as oil temperature and pressure gauges.

Oil pressure gauge

The signal is transmitted to the gauge via either an electrical sender unit or thin copper tubing that carries the oil to the gauge. In general, the latter type is more accurate and reacts faster to pressure changes. The electrical type gauge is more common in newer vehicles.

Oil temperature gauge

The signal is transmitted to the gauge via an electrical sender unit. This gauge is an essential item when traversing heavy sand or towing. Know the safe maximum oil temperature for your vehicle and never exceed it. 120°C is the maximum for most vehicles.

Voltage meter

This gauge monitors the condition of the battery. Voltage measurements must be taken with the engine turned off and some electrical equipment switched on e.g. park lights. The reason for this is that a turning alternator will cause a false reading and when electrical equipment in turned on, the battery is doing some work. Only when the battery is working can the voltmeter indicate how much more work the battery is capable of doing. This is because it is the voltage drop that determines the condition of a battery. For example, a battery on an open circuit (nothing switched on) may indicate 13-volts. If, when lights are turned on the voltage drops to 8-volts, this indicates a battery in a poor state. (It could mean that it is in a poor state of charge or that the battery is old or damaged) If the voltage drops to 12-volts, this can be regarded as normal and the battery in good condition. The higher the load on the battery, the higher the voltage drop will be.

Ammeter

The ammeter measures the flow of current in and out of the battery. Vehicle ammeters have a central indicator that swings to either negative or positive. It is wired to enable a vehicle operator to determine if the load on the battery by electrical equipment is higher or

lower
than the amount of current the alternator is returning to the battery. For example: If the lights are turned on with no engine running, the indicator will swing to the left, or negative. When the engine is started and the alternator engages, the indicator will swing to the right, or positive. If additional equipment is turned on and the current draw matches the maximum output of the alternator, the indicator will indicate zero current flow - the input current matching the output current. If you find that your ammeter tends to run towards the negative when running electrical equipment, then it may be a good idea to fit a heavier duty alternator. Never be tempted to fit heavy current draw equipment such as a winch through an ammeter as the vast amounts of current drawn by even a light winch under load will destroy it.

Guages like these in a Pajero are gimmicks. If the driver is looking at guages when traversing difficult off-road terrain, then I would rather be outside.

Inclinometer

Some Japanese 4x4s are equipped with an inclinometer. It indicates how steeply you are going up or down. They are gimmicks and are more use to the passengers in off-road driving situations. The driver should be concentrating on the terrain, not looking at inclinometers which offer little more than entertainment value.

ELECTRICS

BATTERIES

There are two types of battery applications, 'float' and 'cyclic'. A float application is where the battery's charge current exceeds the current drawn. An example of such an application would be photovoltaic cells charging batteries running radio repeaters, where current drawn is light and frequent, and the solar cells keep the batteries permanently in a high state of charge. A cyclic application is where heavy current drawn from heavy equipment is replaced by slower constant current and at times the batteries could be in a low state of charge.

Normal vehicle battery applications cannot be described as cyclic, because the current drawn by starting a vehicle will be replaced within the first 7 kilometres (assuming the vehicle started on the first crank) by a 50-amp alternator. Nor can they be described as 'float', because the vehicle's electrical system will be drawing current as soon as the engine is stopped. Interior lights, radios and security systems result in the battery never achieving a full state of charge. Therefore a battery could spend all of its life in a partial discharge condition. In addition, most vehicle batteries are placed under the bonnet and are subjected to severe temperature changes. The battery may freeze overnight and then be exposed to very high

temperatures during the period when the engine is running. A rule of thumb for this is as follows: a battery is rated at 25°C; for every degree below 25° the battery will loose one percent of its capacity. Its life however will be increased (before failure). Also for every one degree above 25°C the battery will gain one percent of its capacity but its life will be reduced.

Vehicles operating winches and other heavy duty equipment are cyclic applications, since the heavy current drawn is replaced gradually over a period of time, depending upon how the vehicle has been driven.

Which battery should be used for these differing applications? If a calcium battery (float application) is used in a cyclic application and the battery is not able to be recharged immediately, the battery will 'sulphate', causing irreparable damage to the plates. An apparent loss of capacity would be noticed and after a short while total failure would result. Should a battery designed for a cyclic application be used in a float charge mode you run the risk of 'stratification' of the electrolyte, 'mossing' of the plates and a large amount of active material falling off the plates and becoming sediment. This eventually causes battery malfunction.

I have had personal experience with a single Willards 674 'Farm Power' battery, operating it for two years under arduous off-road conditions: for field use operating powerful HF radio transmitters, powering a personal computer, lights and jump-starting light aircraft followed by five years in my Land Rover - and only then did it show signs of age.

DEEP-CYCLE BATTERIES - MODELS AVAILABLE

	NO.	CAPACITY	LENGTH	WIDTH	HEIGHT	WEIGHT
Willard Batteries:	722	50amps	255	173	182	16kg
Willard Batteries:	774	90amps	345	175	204	27kg

Both models have carry handles and the 722 is particularly suitable for portable applications. Willard Batteries are available from all good vehicle battery outlets.

Delco Voyager, the most popular deep cycle battery in 4x4s.

Willard 774 heavy duty deep cycle battery.

	NO.	CAPACITY	LENGTH	WIDTH	HEIGHT	WEIGHT
Delco Voyager	M24M	76amps	275	173	222.8	19.9kg
Delco Voyager	M27M	105amps	306.2	173	224.6	23.6kg
Delco Voyager	M30HMF	115 amps	344.2	172	226.7	27.5kg

When a freezer or lighting is powered from the vehicle's primary battery, there is a risk that it will be flattened overnight or during an extended stay. Should this happen in the bush the vehicle may have no way of being started. Dual battery split-charge systems solve this problem by enabling a second battery to run the fridge and lighting while the vehicle's primary battery remains unaffected. This second battery must be a deep-cycle type, designed to cope with large discharge and recharge cycles.

The best systems are the auto-relay or manual switch systems. Diode systems (large alloy heat-sinks with electrical connectors) are useless - I have never seen or heard of one that works satisfactorily.

Delco Voyager Deep-Cycle Batteries

Because Delco is the most popular auxiliary deep-cycle battery found in South Africa's 4x4, here are directions for their use.

Features

Delco Voyager are of flooded cell construction, fully sealed and require no topping up. The only maintainance required is cleaning and greasing of the connectors. The built-in hydrometer allows easy check of the state of charge. The battery is designed for use as a regular vehicle battery and can both supply the current necessary for cranking and for general purpose deep-cycle use.

Hydrometer indicator

Green: Above 70% charge. Ready for use.

Black/invisible: Between 50%-70%. Recharge if possible.

Red: Below 50%. Recharge immediately.

Yellow/clear: Electrolite level low. Do not charge.

Storage

Delco Voyager batteries store well but must be fully charged beforehand and must be disconnnected from all loads, however small.

Normal charging requirements

Optimum battery life will be obtained if a green hydrometer condition can be maintained and batteries should never be left in a deeply discharged state. Once the state of charge has reached 100%, charging should only be continued for long peroids at a reduced rate to prevent long-term electrolyte loss. On-charge voltage should be 13,5-13,8 volts.

Charging Deep-Cycle Batteries

Lead-acid batteries, be they float or deep-cycle types, have recharging characteristics which can frustrate the user. Because deep cycle types are used in many off-road applications, I will deal with these alone.

When a deep-cycle battery's charge drops below about 11.8 volts it resists accepting a charge. No matter how much current is fed into such a battery it appears to be lifeless. The reasons are unclear but appear to have something to do with the duration of the charge and less to do with amount of current. When the charge is initalised, only a tiny current is accepted. After about four hours (this time varies with the state of discharge) the current accepted suddenly increases and the battery sucks all the current it can be given. In fact it can absorb current so fast that it can damage itself if allowed too much. It is a bit like a horse - if it is fed enough it will eat until it kills itself.

Some off-road operators have selected float batteries because these accept a charge more readily when deeply discharged. They pay a high price because float application batteries deteriorate rapidly when used in this way.

Take a look at the following scenario: A battery is used cross country all day. It reaches a point when the engine is shut down for the night and the fridge and some lights are turned on. The following day the vehicle remains stationary. By the morning of the second day, two nights and a day have gone by - 36 hours. The daytime temperatures are high and the fridge has been working hard. The operator knows that the battery charge must be getting low but he is not too worried because there is a dual battery split-charge system fitted. He decides to take the vehicle for a short run, principally to charge the auxiliary battery. The battery voltage, although high enough to keep the freezer working had dropped off the 'high current accepting plateau'. The vehicle is driven for a two hour game drive; plenty of time, so the driver thinks, to recover the battery with the special heavy-duty 100-amp alternator fitted. But, during the two hours the deep-cycle battery only accepts 10 amps. The operator is now under the false impression that he has a fully-charged battery and, as night falls, can go the electric lights and the freezer continues to keep its contents frozen. By twelve that night the freezer low-voltage cut-out activates and in the morning everything has thawed. The operator is baffled and swears to sue the battery supplier because he has been sold a dud battery.

The soluton is simple: avoid letting the battery drain below 11.8 volts. One of the best battery maintainance systems is made by National Luna. It can be fitted with any dual battery system. When fitted

coupled with a 'winch isolator', a useful item that ties both batteries in parallel for winch operations.

Charging requirements with a very flat battery

A very low battery will only accept a very low charge current. If the open circuit is below 11-volts it may be necessary to override any reverse polarity protection on the charger. The time required for the battery to accept a measurable charge may be as follows:
If the charge current is not measurable at the end of the charging times indicated, the battery should be considered permanently damaged and should be replaced. If the charge current is measurable during the above charging times, the battery should be

considered good and charging should be completed in the normal manner.

The following table indicates the usable power of two models of the Delco Voyager. For standard use, discharge is from 100% down to 50% charge. In emergency use the table indicates usable power from 100% to 0%. A second battery wired in parallel will double the value (excluding reductions due to mismatch due to battery age etc.)

TIME REQUIRED FOR FLAT BATTERY

TO ACCEPT A MEASURABLE CHARGE

ON-CHARGE VOLTAGE	HOURS
16 volts	up to 4 hours - check every half hour
14 - 15,9 volts	up to 8 hours - check every half hour
13,9 volts or less	up to 16 hours - check every half hour

HOURS OF USABLE POWER

	STANDARD USE			EMERGENCY USE		
MODEL	LOAD			LOAD		
	5 amps	15 amps	125 amps	5 amps	15 amps	125 amps
M24MF	7.2	2.0	1.05	14.4	4.0	4.0
M27MF	9.3	2.5	1.35	18.6	5.0	2.7

Care of batteries:

- *Deep-cycle batteries are suitable for normal vehicle use as well as discharging up to 70% of their capacity.*
- *Keeping a battery cool, keeping it charged and not over draining it are the three most important principles in extending the life of a normal lead-acid or deep-cycle battery.*
- *Overcharging causes grid erosion and can seriously diminish the ability to accept a charge. A current taper with timer or a suitably controlled regulated voltage is the best protection against overcharging.*
- *Do not fast-charge a battery, unless in an emergency, especially if it is a deep-cycle type.*

Storing batteries

Batteries do not store well. When operating a low mileage vehicle or a vehicle that stands for long periods, make sure that the battery is kept in a good state of charge, otherwise it will deteriorate rapidly. Check and top up the electrolyte and recharge every three months - leaving it longer will damage the cells. If necessary store batteries indoors to prevent

Battery Monitor tells the operator the state of both batteries and has an audible warning to alert when batteries are about to fall off the "high current accepting plateau".

the electrolyte from freezing as in most cases this destroys the battery.

Delco batteries are maintenance free and most models include a charge indicator window. Some are also fitted with marine terminals which may require a modification to your vehicle wiring if used in place of the vehicle battery. Marine terminals are however good enough for vehicle operations and in many respects superior.

220-VOLTS

If you want to run 220-volt equipment in the field there are a number of options available:

Unipower mobile welding kit

Unipower Electronics, by fitting a series of specially designed components, convert an ordinary vehicle engine into a potent generator, fit even for heavy-duty arc welding. The kit features a multi-purpose alternator and power control unit and is supplied complete with clamps, welding leads, battery booster clamps and a remote hand-throttle and cable. Unipower boasts solid state circuitry, 220-volt DC 2500 watts regulated power and over-voltage protection. Although Unipower is designed primarily for welding it is suitable for all power tools, heavy-duty lighting installations such as a small film location shoot and fast battery charging up to 175 amps. It is not suitable for TV sets, computers and induction motors or where a square sine wave is required. For these applications an inverter is better suited. Unipower can be contacted on 011 452 2959.

Inverters

Inverting current from 12-volt DC to 220-volt AC is done with an inverter. New technology has made these devices very compact and virtually indestructible. Overload them and they simply shut down or wire them up incorrectly and they simply refuse to work. For one year I used a solar panel to charge a battery which by means of a 200-watt inverter ran an Apple Mac PC and printer in ambient temperatures of over 40°C. Much of the work on the first edition of this book was done at this time. The inverter became so hot that it could not be touched, yet it operated faultlessly. Current draw reached 10-amps at 12-volts (120-watts). Square-wave inverters are suitable for computers, printers, televisions, hi-fis etc.

I currently use an Everpower 330 to charge camera batteries. Although it does not have reverse polarity protection it has proved itself a robust unit and is now a permanent fixure in my camera case.

The Everpower 330 inverter is a handy light-duty unit available from UPS technologies, 021 531 6621.

Portable generators

Despised by those who have to put up with the noise of other campers running generators for their TVs, fridges and shavers! Abundant migrants to the northern Natal and southern

Mozambique coast, they are polluters of the environment. Because alternative power sources are silent, more ecologically friendly and cost no more, I see no place for portable generators in this book - or in fact anywhere where nature-loving people go.

ROOF-RACKS

Roof-racks have evolved from utilitarian galvanised steel frames with wooden slats to alloy silver, grey or black hammer tone powder coating with matching slats. They look better, are lighter and more durable to corrosion. Although alloy racks are lighter they are not as strong as steel and overloading an alloy roof-rack will cause failure long before a similar load would damage a steel rack. The packing and overloading of roof-racks is covered in chapter eight.

If you want the strength of steel and are prepared to pay the price of additional weight, an ideal design is to have a steel rack made and then weld on expanded steel mesh instead of wood. The rack should be galvanised once the entire structure is complete because painted steel requires constant attention to avoid the onset

of rust. The expanded mesh needs no maintenance, as does wood, it is comfortable to sleep on and it provides infinite places to attach tie ropes.

There are some disadvantages with all-metal roof-racks. Metal rubbing against metal, such as roof-rack and jerrycans, causes far more wear than wood rubbing against metal. It is therefore advisable that a piece of ply wood be placed between jerrycans and the metal parts of the roof-rack. No matter how tightly the jerrycans are secured, there will be some movement and with the aid of dust abrasion will be severe.

Roof-rack supports are a good idea if the vehicle's roof pillars are weak such as the Land Rover Defender.

ABOVE: A simple all-steel galvanised roof-rack.

Alloy and wood roof-rack.

With just two of us in the vehicle, a simple lightweight frame onto which two spares were bolted was all that was needed for even the most remote safaris. Even with light roof loads such as this, spread the load on the roof gutters as broadly as possible

One of the most important elements of roof-rack design is the feet. If the feet are too narrow it will cut through the vehicle's roof gutters. The roof-rack must not be wider than the vehicle's roof.

The weight carrying capacity of a roof-rack is usually limited by the capacity of the roof supports themselves, so this aspect should be investigated. Adding supports to the roof to allow heavy loads should also be looked at.

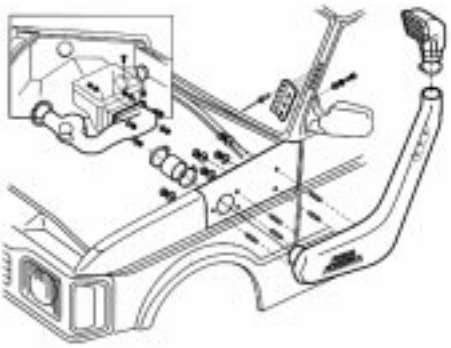
Roof-racks which extend to beyond the windscreen are very useful to set up a roof-top tent, or to carry awkward loads. Some designs have the roof-rack extension supported by the front bumper. However, it is not advisable to drive with loads too far forward as overloading the roof pillars and the front suspension could result in a cracked windscreen, broken springs or even bent axles. If you are struggling between buying a roof-rack or a trailer, read roof-top tents in chapter 8 and trailers in chapter 7.

MISCELLANEOUS

AIR-INTAKE EXTENSIONS/SNORKELS

If you intend to drive through deep water, an extension to the air intake can be fitted, or if desert travel is undertaken and the vehicle does not have a cyclonic air filter then fitting a snorkel air intake doubles the dust ingestion protection. The most well known make is the Australian Safari Snorkel. They are available for almost all 4x4s and can either be fitted at home or by off-road outlets, many of which stock the Safari Snorkel. Benefits are more than just

COURTESY SAFARI SNORKEL



protection from water and dust. The air is cleaner up high and therefore air filters last very much longer. The air is also cooler than inside the engine compartment. This clean cool air will improve engine performance.

Fitting a snorkel does mean drilling holes into the body and this is a deterrent to some who want to ensure the resale value of their vehicle. However, engine damage caused by water ingestion is never cheap. How to recover an engine that has swallowed water is covered in chapter 9. 'Vehicle Preparation and Bush repairs'.

PROTECTION PLATES

The most vulnerable parts of a 4WD vehicle are the fuel tank, sump, and on some vehicles the transfer gearbox where it protrudes below the chassis frame.

Protection plates add weight, tend to collect a lot of mud and grass, and can cause overheating and fires when grass is heated and dried by the exhaust. Universal joint guards also tend to clog up. If you intend to do a lot of driving over rocks or want to go off-road racing, protection plates are a good idea. Otherwise their disadvantages outweigh the advantages.

GRILLE NETS

If you intend travelling over grassland, fit a protective net over the radiator grille. This will prevent grass seeds choking the radiator and the resultant overheating. Of the many materials I have experimented with, aluminium mesh works best. My own aluminium mesh grille net is fixed permanently to my bull-bar without any measurable difference in engine temperature, even under heavy load. The pores are small enough to prevent the passage of seeds while the fine aluminium wire does not greatly restrict air flow. Plastic mesh used to make swimming pool scoops is another alternative, but is less efficient. Shade netting is also used but is only suitable as a temporary measure, because it severely restricts air flow.

FIRE EXTINGUISHERS

Motorists who carry fire extinguishers rarely use them. Rather they use them when helping out fellow motorists who do not have one and suddenly have a need for one. There is no substitute should you have a fire. To the off-roader, when travelling over grasslands, fire is

Above: The result of no radiator protection in tall grass. Left:Cleaning out grass seed can be a painstaking chore.

Fine aluminium mesh is the best material to use for a grille net as it allows good air flow while preventing the passage of seeds and grass.

always a serious risk. Grass tends to get caught around the exhaust, it dries out, smoulders and eventually ignites.

Once the grass ignites, it burns so fiercely that even with an extinguisher, extensive damage can result. Many vehicles have been lost in this way and I know of a brand new Nissan Sani, on its first trip out, that caught alight in the grasslands of the Makgadikgadi Pans in Botswana. After all the precious drinking water had been used in an unsuccesful attempt to put out the blaze, they were left without food, clothes and water with a 70-kilometre walk to the nearest town ahead of them. Although the vehicle was destroyed, the two men escaped with their lives. Many vehicles are prone to this danger. I also know of a Land Rover Series-3, Defender, Mercedes Gelandewagen, and a Nissan Patrol that have been lost in this way. Every vehicle must carry their own extinguisher.

One hot day, also in the Makgadikgadi Pans a convoy of seven vehicles, of which only one was equipped with an extinguisher made a short stop. As the party stood enjoying the solitude someone noticed smoke coming from under a Range Rover. By the time the extinguisher was found in the lead vehicle and brought to the scene the fire had spread and the vehicle's electrics were severely damaged. From then the Range Rover could not shift gears nor lift its suspension. In that state it drove all the way home in second gear.

Dry powder extinguishers are suitable for vehicle fire applications. Carry one of at least 1,5 kg. I carried a rechargeable dry powder extinguisher in my vehicle for five years before I needed it. One day downtown the BMW in front of me burst into flames. I pulled over, grabbed the extinguisher and with the help of the rather shaken driver, managed to open the bonnet. The carburettor and air filter were ablaze. My rechargeable extinguisher required that the valve be opened by turning the extinguisher upside down and

dropping it. This I did and the $C0^2$ cannister pressurised the tank. At that moment the tank exploded in my face. Luckily I was unhurt but had turned a pale blue colour as I was covered in the fine blue extinguisher powder. I was very fortunate that the situation was not me and my family in the middle of the Kalahari with a fire on my hands.

OIL COOLERS

Radiators through which the engine or gearbox oil is pumped and cooled are only necessary for vehicles working very hard in high ambient temperatures and for those using power take-off equipment, where the vehicle is stationary. High speeds sustained for long periods in hot climates will produce oil temperatures close to the maximum tolerance for many engines, and in these cases oil coolers are an added precaution that should be taken. Automatic transmissions will require oil coolers in heavy sand conditions - most four-wheel drives fitted with automatic gearboxes have these fitted as standard equipment. High quality oils, discussed in chapter 9, have better heat dispersing properties and improve cooling.

SEAT COVERS AND INTERIOR VEHICLE PROTECTION

Seat covers and loadbay linings protect your investment from the harsh wear and tear of bush travel. When a vehicle is loaded and moves over rough ground damage is caused when the contents rub against the sides of the loading bay. I have a set of Takla Pro-Covers fitted in my vehicle and they are well worth the expense. Because they do not make me sweat any more than the regular seat, I leave the seat covers on all of the time, protecting the seats from my young children's dirty feet and sticky hands.

SOUND SYSTEMS

The owner of an overland vehicle has an additional responsibility with regard to sound systems. To be out in the bush is a luxury few are fortunate enough to experience. It is a very special place.

To the lover of the great outdoors there are few things more irritating than when some inconsiderate philistine - who obviously does not appreciate his surroundings - insists on playing his music so loud that every living thing for miles around can hear. The whole experience is spoiled, and the din is hardly conducive to attracting wildlife.

WINDSCREEN CLEANING MODIFICATION

Anyone operating a vehicle in Africa, particularly those with flat windscreens like older Land Rovers, Defenders and Toyota FJ40s, will know of the frustration of summer driving as hundreds of insects collide with the windscreen. In my frustration at having to put up with large curved streaks across my windscreen within minutes of having stopped to clean it, I devised a method where insects, no matter how firmly squashed or sticky the residue, can

easily be removed while driving. I attached two wiper blades on each arm and ran a brass pipe from the water outlet, up the arm, to spray the area between the wiper blades.

A brass bolt is used to attach the two wiper blades to the arm and a thin brass tube is glued underneath the arm. Another brass tube is used to run the water from the outlet to the wiper arm. In order to allow the wiper arm to move, a short length of clear plastic hose is used to join the two brass pipes. To create a jet at the end of the brass pipe, crimp the end so as to narrow the aperture. The windscreen is then conditioned with RainX and lastly a tablespoon of window cleaner is poured into the water reservoir. This system remains effective no matter how thick the insects or mud are splattered onto the windscreen. It also explains why many rally cars are fitted with similar systems.

TWO-WAY RADIOS

Radios are covered in Chapter 10, 'Navigation and Communication'.

SECURITY

Water tanks and jerrycans should be locked with small padlocks and chained to the roof-rack if a loaded safari equipped vehicle is to be left unattended - day or night! The padlocks should be removed from the jerrycans when driving to prevent sand and vibration from wearing the paint and damaging the locks. External water taps should also be secured by a padlock, especially in desert regions.

INSURANCE

Vehicle theft in Third World Countries is common and preventative measures must be taken. Your insurance company may insist on having etched windows and an immobiliser or alarm fitted to your vehicle. Ordinary comprehensive vehicle insurance taken out in South Africa is in most cases not valid in countries such as Mozambique and Angola and it is recommended that travellers consult their insurance brokers and obtain written permission to visit such countries.

Be sure to establish if your 4x4 is covered in the event of damage when off-road driving on private land, such as on one of the many privately run 4x4 trails. Many ordinary policies exclude cover in such conditions. I suggest consultation with one of the best insurance brokers specialising in 4x4 vehicle cover, Quadrisure. Call 012 348 8584. Other specialist insurance brokers are Ream (011 394 8235) and Four Sure (0800 119 229)

MORE INFORMATION AND ADVICE

The third video in the 4x4 series by the author (see page 181) is called 'Working in the Wilderness'. It will be available mid 2000. For information call the Continental 4xForum 021 785 5752.

AUXILIARY EQUIPMENT PRODUCERS AND SUPPLIERS

AA Stores
Stores throughout South Africa
Retail stores operated by the Automobile Association retail a range of handy motoring items as well as an excellent range of motoring books, videos and some of the best road maps available.

Alpine Developments
Cape Town, 021 52 3131.
Engine and turbo charger modifications and installations.

ARC
45 Main Road Edenvale, 011 452 5298
ARC is, like many fitment centres, the result of a man's hobby becoming, his business and livelihood. Owned and operated by Cecil Walker, ARC was one of the first to specialise in aluminium. The range of equipment is broad and varied.

ARC 4x4 Centre - Western Cape
45 Kendal Road, Diep River, 021 701 1345, 082 895 3263
ARC in the Western Cape is located next to Cristy Sports in Cape Town's Southern Suburbs. ARC is a 4x4 equipment outlet supplying ARC's alloy racks and packing systems as well as a wide range of items from suspension modifications to roof-top tents.

Baillies Off Road
Cnr Main and Summit Road Blue Hills, Midrand, 011 318 1966
Supplying and fitting the well known Safari Snorkel.

Brakhah 4x4
Pretoria, 021 663 4506
Brakhah began its life building one of the most successful off-road trailers, and has grown into a specialist vehicle equipment centre.

Cape Off Road and Safari
Epping Western Cape, (021 934 3554)
Cape Off-Road and Safari operate a one-stop 4x4 shop, catering for all aspects of off-roading. Their specialties include suspension systems, nav gation, dual battery systems and in their inventory they boast some unique and well tested products.

Continental 4XForum - The Information Hub to the 4x4 Community
http://www.4xforum.co.za, fwdrive@iafrica.com, 021 785 5752

Dover Parts
Selby, Johannesburg, 011 493 6717
If you are looking for Land Rover parts, but do not want to pay the high prices of the dealers, Bill at Dover parts is the man to talk to.

Echo Accessories
Plot 186 Derdeport, Pretoria, 012 808 2786
Echo is a well established manufacturer of off-road trailers and roof-top and trailer tents.

Front Runner
Kyalami, 011 466 0155
Front Runner is a specialist 4x4 engineering works supplying equipment of all kinds to shops and fitment centres throughout the African Continent. The standard of manufacture is high, with clever engineering and smart design being part of the Front Runner identity. Front Runner has been succesful in achieving Toyota and other brand name approval on many items.

Greensport (Cymot)
A collection of off-road and camping retailers in Windhoek, Tsumeb, Swakopmund, Walvis Bay, Rundu and Oshakati in Namibia as well as Montagu Gardens in Cape Town.

LA Sport Outdoor & Adventure
Pretoria, 012 329 4515
4x4 equipment retailer and fitment centre in Pretoria.

Leimer's Land Rovers
011 795 2507
Rebuild specialists of Land Rovers of all ages, particularly series three versions. Also, new Land Rover parts at excellent prices.

Makro
Stores throughout South Africa
The well known super-store chain discounts a wide range of camping gear as well as a limited range of off-road gear.

Neil Woolridge Motors
Pietermaritzburg, 0331 45 3519
4x4 accessories and fitment centre

Nick's Racing
Windhork, Namibia, 061 21 6884, 081 124 0375
4x4 modifications and service in Windhoek, Namibia.

Northern Off-Road Equipment
Strydom Park, Randburg, 011 791 1611
A small general off-road equipment supplier who also specialises in long-range fuel systems, supplying tanks to other 4x4 equipment outlets.

Outdoor Warehouse
Stores throughout South Africa, Outdoor Warehouse retail camping equipment and a few 4x4 accessories.

Proto
Stellenbosch, Western Cape, 021 887 0013
Makers of some very nice alloy accessories for Land Rovers

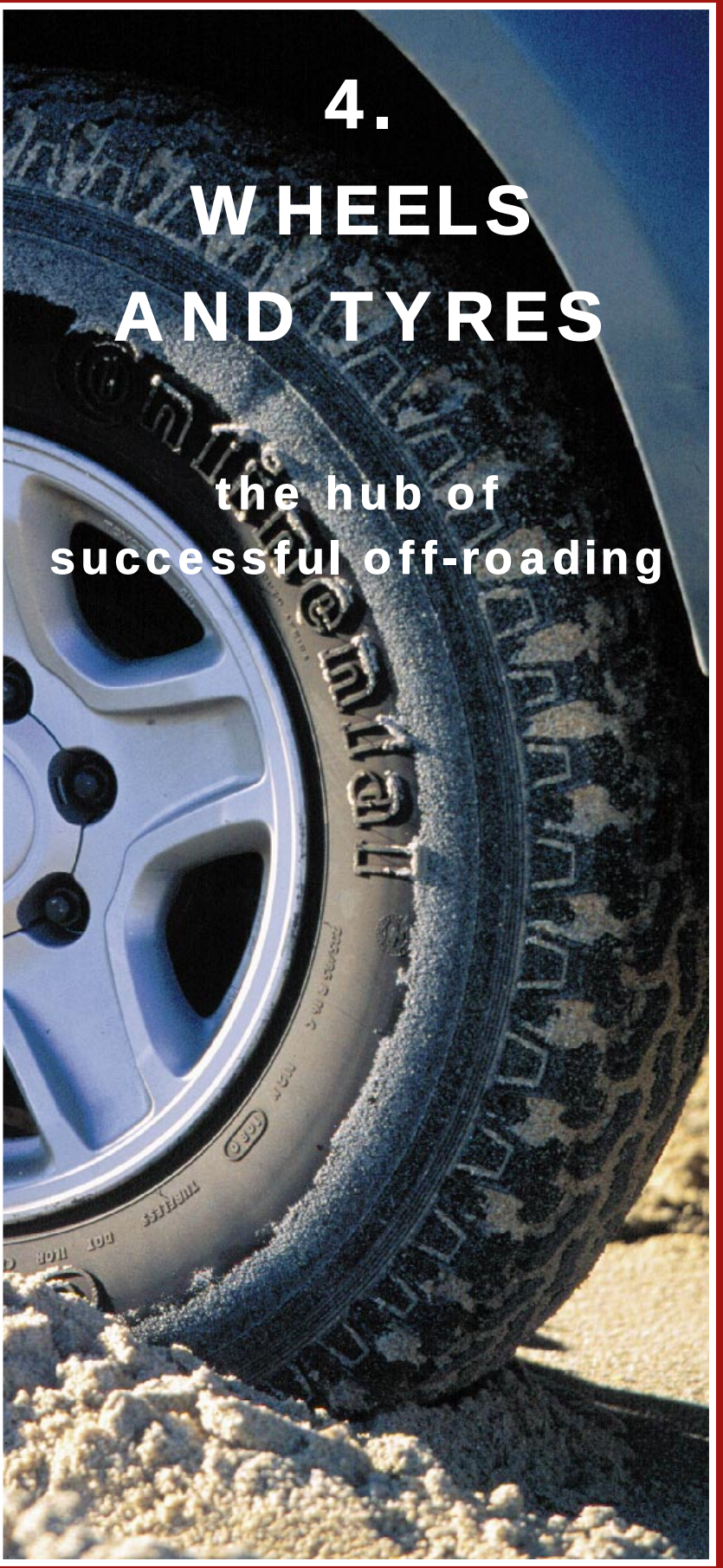
Ruff Stuff
Lauda Road, Killarney Gardens, Cape Town, 021 557 7264.
Manuafacturers and retailers of off-road gear for all 4x4 vehicles.

Safari Centre
Johannesburg (011 465 3817), Pretoria (012 348 3253), Cape Town (021 595 3910), Gabarone Botswana (09267 37 2390)
Safari Centre has grown into South Africa's largest retailer and 4x4 equipment fitment centre. The range of equipment at all outlets is wide and varied, often stocking many versions of similar items giving clients the widest choice possible.

Steves Auto Clinic
Kyalami, 011 466 2050
Turbo-charger and engine development company with an excellent reputation.

Traidcon 4x4 Warehouse
Main Road, Randburg, 011 886 7601
Traidcon 4x4 Warehouse and Fitment Centre stocks a broad range of 4x4 and camping accessories.

4.
WHEELS AND TYRES



the hub of successful off-roading

The pressure a tyre exerts on the ground and the effect the tread pattern has on the surface over which the vehicle is passing will determine the ease and efficiency with which the vehicle will travel. Although motor manufacturers go to a great deal of trouble to research what type of tyre will work best with a particular vehicle, they are normally shod with general purpose tyres or just road tyres with aggressive treads.

For best results when selecting tyres ask these questions:

- *Tyres, like vehicles, are a compromise between on-road performance and off-road ability. How much time will the tyres spend off-road?*
- *What kind of off-road terrain is most likely to be encountered? Sand, mud, snow, rocks, etc.*
- *What kind of load will be carried? Exceeding the tyre's load ratings will cause premature failure, blowouts and accidents.*
- *What is the maximum speed that will be attained by the vehicle? Tyres have maximum speed ratings that must not be exceeded.*
- *What kind of ambient temperatures will be encountered? Some East Bloc manufactured tyres will not withstand the heat of an African desert.*

TYRE SELECTION

Mud tyres

A tyre suited to sand or normal road use clogs rapidly and loses traction in mud. The large gaps and chunky look in the tread of mud tyres facilitates 'self-cleaning'. As the wheels rotate the mud embedded in the tread is released and is thrown out. Heavy treads tend to make more noise than fine treads and this is most noticeable on tar at speed. Purpose built mud tyres do not have good wet road performance, so extra care is needed in these conditions.

Sand tyres

The main feature of a tyre designed for sand is not, as is commonly thought, broad width, but a tread pattern that compresses the sand beneath the tyre instead of penetrating through it – which is what happens when a mud tyre is used on sand. The gaps in the sand tyre tread are narrow and the tread pattern runs longitudinally around the tyre. Good sand tyres flex well when used at low pressures.

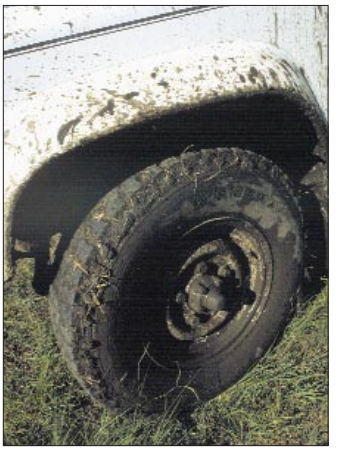
Sand tyres must also be tough enough to withstand rough tracks and sharp stones of semi-desert regions, since rarely do pure sand conditions last for long before being interrupted by sections of sharp stones and gravel.

Broad tyres

Not all vehicles are designed for very broad tyres. On some vehicles the tyres may rub the steering arms, brake hoses or chassis when the steering is on full lock. If your vehicle is blessed with good axle articulation, oversized tyres may rub against the body when the axles are extended in off-road travel. They also put undue stress on transmissions not designed for the use of big tyres.

Broad tyres in sand

It's a mistake to think that very wide tyres will automatically be suitable for sand operations. That's due to the belief that it is the tyre's width that affects its penetration. Although this is to a small degree true, almost all of the advantage gained by a tyre's width is counteracted by the fact that a broad tyre needs to push more sand in front of it than does a narrow tyre, ie. it has a higher rolling resistance. A tyre moving over thick sand builds up a wall of sand in front of it. The greater the penetration, the deeper the tyre sinks into the sand, and the higher the wall becomes. Eventually the vehicle's progress will be halted as the wall becomes higher and higher and the drag overcomes the engine power or traction. Narrow tyres create narrow sand walls, and so have lower rolling resistance.



General SAG general-purpose rough-country tyre works well in just about every environment. High resistance to punctures is also a quality of this tyre - important for a tyre to be effective in the wilderness.

Broad tyres in mud

I have witnessed occasions when broad tyres have had a distinct disadvantage in mud; and other times (albeit less frequently) when they have been an advantage.

One dry winter on Vaal Dam I was asked to assist a Ford F250 fitted with Yokohama Super Diggers, a common broad tyre well suited to sand. The craft which the Ford was attempting to pull out was a lightweight skiboat with a 30hp motor on the back. Once the tyre treads had clogged the vehicle became useless. My vehicle was fitted with 205X16 radial mud and snow tyres at 2,3-bar. Not only did I extricate his vehicle and boat in tandem, but then proceeded to pull a five-ton yacht up the same slipway.

Narrow or general-purpose tyres can be made more effective in sand by lowering the pressure, but a purpose-built sand tyre cannot be improved for mud conditions.

In comparison, consider the case of three Land Rover Defenders fitted with 750X16 Michelin XL mud tyres inflated to 2.5-bar trying to mount a steep muddy slope during a hill-climb. While the Defenders struggled to get up the hill, the Isuzu KB diesel I was driving walked up without so much as the slightest wheel-spin. The Isuzu was fitted with Continental RVT280s, 265/70R15, a broad general-purpose off-road tyre, also inflated to 2.5-bar.

There seems to be no definite conclusion when is comes to mud tyres, pressures and tyre width. What is conclusive though, is that a self-cleaning tyre does make a significant difference to performance in mud, and tyres suited to sand will not have this feature. In conditions when the mud gets deep so that penetration needs to be avoided, broad self-cleaning tyres and very low pressures are desirable.

Broad tyres in rough country

In rough country, broad tyres are more easily damaged by rocks than narrow tyres. This is the most significant and undisputed disadvantage of broad tyres.

Snow tyres

A mud tyre will perform well in virgin snow conditions. On compacted snow, as found on well-used roads, a less knobby tyre will be more effective. Typical effective road/mud and snow tyres are indicated M&S (mud & snow) and have squared shoulder and block tread.

Rough country tyres

Don't mistake a heavy knobby tread for toughness. The thickness of the sidewalls is of as much importance as the thickness of the tread. Tyres of this type have restrictive speed ratings when they become specialised very-heavy-duty types. If your vehicle is operating under constant off-road conditions where resistance to damage is more important than traction, cross-ply tyres may be worth considering.

Damage to a sidewall is a common occurrence in rocky terrain. The thickness of the sidewall is a good indication of a tyre's resistance to damage. Three-ply sidewalls are recommended for off-road conditions

All purpose 4x4 tyres

The vast majority of leisure off-roaders will require a tyre to handle all theatres of operation – sand on the beach or on a safari into Botswana, mud for the occasional rainy spell that turns the tracks into a slippery mess, and rocks on the family weekend 4x4 outing or over the spectacular hills of the Richtersveld.

No single tyre stands out as being the best for all conditions. The best way to choose a tyre suitable for your needs it to talk to experienced enthusiasts who have been there before.

Summary:

- *Heavy tread far apart: good for mud, mediocre in sand.*
- *Medium tread close together: good in sand, mediocre in mud.*
- *Thick tread: good for sharp rocks, often combined with hard compound rubber which will wear well on rough tracks. Will not flex well – a disadvantage in sand.*
- *Thick sidewall: good for sharp rocks. Good load rating. Less ability to flex in sand. More resistant to damage when at lower pressures due to the strength of sidewall.*

OTHER FEATURES

Speed ratings

The maximum permissible speed is printed on the tyre sidewall. Tyre damage will result if this is exceeded. When a tyre is deflated for reduced penetration, the permissible speed rating no longer applies.

Load ratings

The maximum permissible load is printed on the tyre sidewall. Tyre damage will result if this is exceeded, particularly if high speeds are attained.

High ambient temperatures

Tyre damage due to heat occurs when an under-inflated tyre is run at high speeds. Heat blowouts can occur to inner tubes before the tyre is affected. The result is an inner tube that shreds itself and after such a blow-out it is irreparable. Cheap imported tyres are often totally unsuited to the extreme road temperatures.

Imported or local tyres?

Imported tyres generally have softer rubber compound and many do not cope well with local high speed gravel road conditions. Whenever I am consulted as to the best tyre I more often than not recommend a locally manufactured tyre.

RADIALS VERSUS CROSS-PLIES

Cross-plies

These are constructed by laying strips of fabric over each other at 90° angles, forming a wafer effect. These strips are called plies and the more plies a tyre has the higher its load carrying ability will be, while its flexibility is reduced. They were first used in the 1860s and apart from improvements in the materials used they have changed little in design. When the side wall of a cross-ply expands with deflation, the ground pressure in the middle of the tread decreases. At the same time the ground pressure on the outside of the tyre increases. The lower the inflation pressure the more marked the effect.

When the tread bar of a cross-ply meets the ground it bends. This causes the weaker area of casing behind to distort, allowing the tread bar to move backwards. As the tyre rotates and the tread leaves the ground, it flicks back to its original position. This movement, combined with the distortion of the tread described above, causes trauma to the surface over which the tyre is passing. In sandy conditions, this trauma, exaggerated if the cross-ply is under-inflated, will cause the tyre to dig in. Cross-plies are therefore unsuited to heavy sand conditions.

Cross-plies also have a higher rolling resistance than radials and this will affect fuel consumption. Perhaps the only time that cross-ply tyres could be advantageous is when the vehicle spends most of its time carrying heavy loads at low speeds over hard rocky ground that could cause damage to more expensive radials.

Radials

Radials are superior to cross-plies in almost every respect except price. They offer superior traction, safety and comfort, both on a paved surface and off-road.

Radial tyres are made by laying strips from bead to bead (the bead is the point where the tyre meets the rim). The advantage of this design is that flexing of the sidewall does not affect the tread. They flex independently of each other. So, decreasing pressures will flex the sidewall and tread area, while keeping the tread pressure evenly spread and increasing the tyre's contact area with the ground, thereby decreasing the ground pressure and the tyre's penetration.

TUBES VERSUS TUBELESS

The question of tubed or tubeless is much debated in four-wheel driving circles.

These are the facts:

- *If a tubeless tyre is deflated for use in heavy sand and conditions that require excessive throttle, the tyre may move on the rim. The result is total deflation.*

- *A tubed tyre running at reduced pressures generates more heat and is more prone to damage.*
- *A tubed tyre is often easier to repair in the bush than a tubeless one, because they are easier to remove from the rim and are much easier to re-inflate (tubeless tyres often require a bead expander to do this).*
- *A spike type puncture is easier to repair on a tubeless tyre. If the puncture site can be found, the wheel need not even be removed from the rim. With a more serious puncture or tyre damage they are more difficult to repair than tubed tyres.*
- *Tubes do not strengthen the tyre or help prevent punctures.*
- *Blowouts occur less often to tubeless tyres. In tubed tyres, sudden deflation can be caused by excessive heat that is aggravated by friction between the tyre casing and the tube. This is especially serious if the tyre is under-inflated or overloaded where tyre distortion increases this friction tenfold.*
- *Damage to tyres is common in outback travel. If you use tubeless tyres, carry a suitable tube to enable you to effect a repair should the damage be sufficient to render the tyre useless for tubeless operation. It is very unlikely that you will find the tube of the correct size when you need it and even if you do not intend to go into very remote areas, carry a spare tube. You have been warned!*
- *Blowouts can tear a tube to pieces rendering it useless, so if you use tubed tyres, carry a spare tube.*

TYRE SELECTION – SUMMARY

There is no ideal, all-conditions off-road tyre, so all are a compromise in one way or another. When driving in Southern Africa count on encountering heavy sand. If you travel during the rainy season (November to May) you may also be faced with mud. You are only likely to encounter snow if driving in very mountainous areas in winter.

If you have no specific task for your 4WD and it is going to be used as a general leisure vehicle and will be covering all types of terrain, my recommendation is a steel belted, medium width, high profile radial with a fairly chunky tread pattern. Make sure that the tyre's load carrying capacity is sufficient for your purposes.

THE FITTING OF TYRES, TUBES AND VALVES

Tyres and tubes

When fitting tyres with inner tubes it is imperative that once the tyre is inflated it should immediately be deflated and then re-inflated. This will remove twists in the tube. If a twist remains, the tube may split. Evidence of tube failure of this nature can be detected as the tear begins at the point of highest stress, namely the valve. Many tyre fitting workshops do not know this, so you should keep and eye on the fitting operation and make sure that this operation is carried out correctly. I learnt the hard way and suffered one such blow-out on a front wheel on a brand new tyre while doing 110 kph.

Valve stems

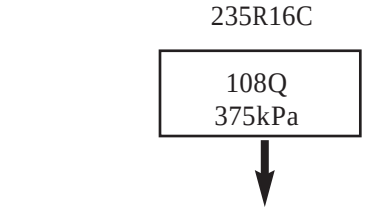
The length of valve stem fitted to tubed heavy duty tyres fitted to a 4x4 must be the short type. Long stems are vulnerable to damage by rocks, grass and undergrowth and are subject to failure, often when the tyre is working hard in a remote location. Tyre fitment centres may assure you that it makes no difference – but it does, so insist on short valve stems. If you use tubeless tyres, carry a few spare valves with you.

TYRE BUYER'S GUIDE

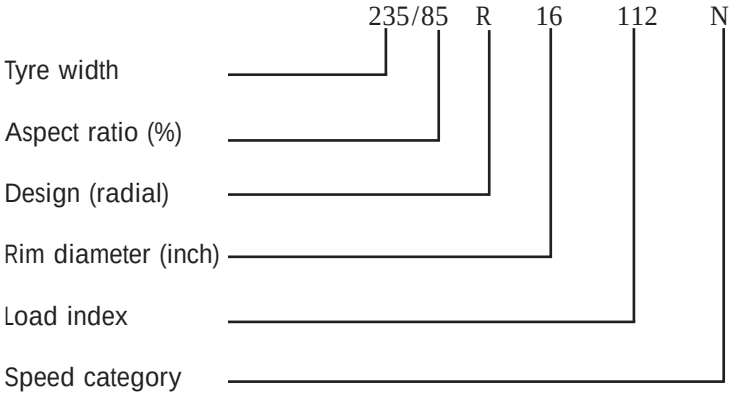
On the sidewall of all tyres is a series of numbers and letters. This gives information about the tyre's construction and size. The example below is for a Continental Conti Trac AT. From this, and the tables which follow, much is learned about this product.

NEW LOAD/SPEED INDICES

Some tyres may display this information in the following way:



At a speed of 160kph (Q)
this tyre can carry a load of 1000kgs (108)
at an inflation pressure of 375 kPa.



SPECIFIC TYRE BRANDS

This summary is based on the opinions of thousands of 4x4 enthusiasts. It has been difficult to compile it because during the research, opinions were at time so diverse that it became difficult to arrive at a conclusion. For example, the Yokohama Super Digger

LOAD INDEX TABLE

LI	kg	LI	kg	LI	kg
96	710	107	975	118	1320
97	730	108	1000	119	1360
98	750	109	1030	120	1400
99	775	110	1060	121	1450
100	800	111	1090	122	1500
101	825	112	1120	123	1550
102	850	113	1150	124	1600
103	875	114	1180	125	1650
104	900	115	1215	126	1700
105	925	116	1250	127	1750
106	950	117	1285	128	1800

SPEED CATEGORY TABLE

Index	max kph	LI	kg	LI	kg
G	90	N	140	T	190
J	100	P	150	U	200
K	110	Q	160	H	210
L	120	R	170	V	240
M	130	S	180	W	270

has a well documented reputation for outstanding tread life and suddenly someone who, when asked about the Super Digger reported only 35000 kms out of a set. I know of a number 4x4s that have covered over 100 000 kms on a single set.

This summary is meant as a guide to the reputation of each tyre and not what the manufacturers claim. Please do not regard it as absolute as differing conditions, vehicle types, load variations and tyre pressures over the life of a tyre can all have a significant effect on a tyre's performance. It also only covers the most popular tyre models found on Southern African 4x4s.

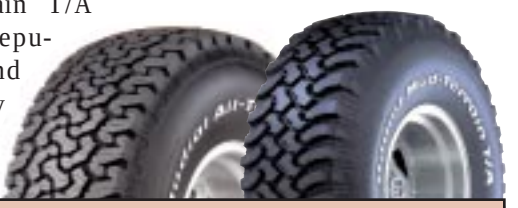
Key to Charts:

- *Mileage: reputation for distance covered before replacement.*
- *S/Wall: number of sidewall plies and resistance to penetration.*
- *Tread: strength of tread and resistance to penetration.*
- *Punct: resistance to punctures. A heavy tread does not necessarily mean high resistance. For example, some tyres are like magnets to nails. Nobody seems to know why.*
- *Mud: performance in mud.*
- *Sand: performance in sand at below normal pressures.*
- *Wet tar: compromises that make a tyre good off-road are often felt on wet tar.*
- *Dry tar: grip and noise levels.*
- *Rocks: performance and resistance to punctures.*
- *Sizes available have been omitted because of the rapid changes made to tyre designs and it would probably take about ten pages to list all of the manufacturers and their products.*
- *Ratings: P=Poor, F=Fair, G=Good, E-Excellent.*

BF Goodrich

This US manufacturer makes a number of off/on-road products and all appear to have a good reputation. Their tyres fit 14, 15 and 16-inch rims. The All-Terrain T/A has a particularly good reputation for robustness and good mud traction. They are more expensive than most.

Left: Mud Terrain T/A
Right: All-Terrain T/A



BF GOODRICH									
Model	mileage	s/wall	tread	punct	mud	sand	wet tar	dry tar	rocks
Long Trail T/A	G	G	F	G	F	F	G	G	G
All-Terrain T/A	F	G	E	E	E	F	G	G	G
Mud Terrain T/A	F	G	G	G	E	F	F	F	F

Continental (Gentyre)

Gentyre and the Continental brand are home-grown products all of which were developed for local needs. The General listed here is the Super All-Grip radial, once supplied as OE (original equipment) on Land Rover Defenders and is an excellent tyre for a working 4x4. The Conti Trac AT is Continental's flagship model and is ideally suited to luxury 4x4s that are also required to tackle off-road conditions and long stretches of unpaved roads. It is currently OE on the Defender.

The second generation Conti Trac AT was available from early 1999. It can be told from the first generation by a serrated seam on the sidewall. This tyre has improved tread life and a tougher sidewall. Conti Trac is available in a range of 15 and 16-inch sizes.

Left: Conti Trac AT
Right: RVT280

CONTINENTAL									
Model	mileage	s/wall	tread	punct	mud	sand	wet tar	dry tar	rocks
Conti 180N	G	F	F	G	P	E	G	G	F
Conti 280	G	G	E	E	G	G	F	G	E
Conti Trac AT (new)	F	G	G	F	G	G	E	E	F
Gen SAG radial	G	G	E	E	G	G	F	F	G

Firestone

The two products that Firestone have built from local needs is the R4S and the ATX. Both are available in 14 and 15-inches, the ATX being the most widely used for off-road work. Its reputation is one of ruggedness and excellent puncture resistance. Their road manners are not as good and they can be a little noisy. They do not work well in mud. The Town and Country is a very old design and

is Firestone's only 16-inch 4x4 tyre. It is a polyester-treaded tyre with poor overall performance, unsuitable for today's high-speed station wagons.

Firestone ATX

FIRESTONE

Model	mileages	wall	tread	punct	mud	sand	wet tar	dry tar	rocks
ATX	G	G	E	E	P	G	F	G	E
Town & Country	P	P	F	F	P	F	F	F	P

Goodyear

The Wrangler is one of the best known multi-purpose tyres and has an excellent all-round reputation. OE on the Hilux for some time, the Wrangler is a light duty off-road tyre with a good balance of toughness and road grip. Its only shortcoming is its narrow tread pattern which clogs with mud quickly. Its unagressive tread belies that fact that it is robust and able to cope with fairly tough off-road work although sharp stones can and do penetrate the tread with heavily loaded vehicles.

GOODYEAR

Model	mileage	s/wall	tread	punct	mud	sand	wet tar	dry tar	rocks
Wrangler	G	F	F	G	P	G	F	G	G

Michelin

Undoubtedly due to its fine reputation for making excellent road tyres, Michelin is, in my opinion, overated as a maker of off-road tyres. I drove on Michelin for well over a decade and the day I changed, my problems with tyres came to an abrupt and pleasing end. Michelin's offer traction as good as their competitors but some reason every Michelin I drove suffered repeated punctures. And, to back up my opinion, I still receive as steady flow of stories about the lack of strength or resistance to punctures of many Michelin products.

Michelin was the first manufacturer to tackle the leisure 4x4 market in a big way with the 205/16 M+S radial fitted OE to the Range Rover. In South Africa many suffered sidewall failures at high speed, some with fatal consequences. Michelin's conclusion was that the cause of the problem was that local Range Rovers were overloaded with air-conditioners, winches, power steering, bull bars etc. combined with under-inflation. The fact that it was always rear tyres that blew and my own imported vehicle, which suffered three such blowouts, had none of these fittings did not influence their conclusions.

Michelin LTX A/T

If you are operating a Range Rover on these now discontinued tyres change them before 40 000kms. Their replacement, the M+S200, is better but blow-outs are still happening. Interestingly, 95% of all recorded blow-outs occurred on the left rear wheel. The LTX M/S fitted OE to the Discovery is an excellent road tyre but its tread is too weak for a laden vehicle on gravel. The M/S is made in 14, 15 and 16-inches and the A/T in 15 and 16-inches only. The A/T appears to be considerably tougher than the M+S. The M+S 200 is one of the best snow tyres available.

Michelin LTX M/S

MICHELIN

Model	mileage	s/wall	tread	punct	mud	sand	wet tar	dry tar	rocks
XC M/S 200	F	F	P	P	G	F	G	G	F
LTX A/T	F	F	F	F	G	F	G	G	F
LTX M/S	F	F	F	P	F	G	E	G	F

Yokohama

One of the best Japanese off-road tyres is the Super Digger, a well known brand with a reputation of extremely long life and atrocious manners on wet tar. This has been changed with new models and it appears that the softer compound has improved the tyres performance in all but longevity. The Y815 is OE on the SWB Pajero and suits the vehicle well. The Y826 is the choice for those who like the 'fat takkies' look.

Left: Super Digger 815
Right: Super Digger 826

YOKOHAMA SUPER DIGGER

Model	mileage	s/wall	tread	punct	mud	sand	wet tar	dry tar	rocks
Y815	G	F	G	F	F	G	G	G	F
Y826/828	E	G	G	G	F	G	F	G	G

TYRE PRESSURES

The pressure a tyre exerts on the ground is something that can be adjusted – the lower the air pressure in the tyre, the less the ground pressure will be and therefore the less the tyre will penetrate the sand or mud over which it passes. In sand, penetration will halt progress, while in mud and snow this can sometimes be an advantage. Reducing or increasing tyre pressure is therefore a way in which the driver can change the effect his tyre will have on the ground before difficult terrain is negotiated.

The key element in deflating tyres for off-road driving is that low pressure increases the length of the tyre footprint (not the width), thus exerting less weight per-square-inch and thereby reducing

penetration. At the same time it subjects the sidewall to damage and if the vehicle is driven too fast or over unsuitable terrain the tyre is easily damaged. Tyre pressures and their effect is covered in detail in chapter 5 'Driving'.

A good pressure gauge is essential equipment for the off-roader.

Recommended inflation pressures for imported vehicles

Road conditions in the First World differ greatly from those in Southern Africa. Tyre pressures recommended for vehicles most often sold in other parts of the world, most commonly Europe, USA and Japan, are often inappropriate for local road conditions, loads, ambient and road surface temperatures. If you own an imported vehicle fitted with imported tyres, you may need to modify the suggested tyre inflation pressures to prevent poor wear patterns and inferior handling on rough roads.

SPARE WHEEL LOCATION

The location of spare wheels carried by 4WD vehicles varies and each position has its advantages and disadvantages.

Under the rear overhang

In almost all under the rear overhang fittings the spare wheel reduces ground clearance. This is particularly serious with vehicles such as the Toyota Land cruiser station wagon. Also, if the vehicle bogs down, a spare wheel makes an excellent base for a jack and a good anchor if it is buried. If the vehicle is bogged it may be impossible to get at the spare if it is located in this position. Most significantly, if it is stolen or falls off, it is unlikely that anyone will notice.

On the bonnet

When the release knob is pulled from inside the vehicle to open the bonnet, the catch often does not release due to its added weight. It is therefore difficult for a single person to open the bonnet if a spare wheel is stowed there. Forward vision is also restricted and safety in a head-on collision is compromised. An advantage of this position is that it offers excellent weight distribution. Removing the wheel and replacing it requires some physical strength and will scratch the bonnet's paintwork.

Inside the vehicle

A spare wheel carried inside the vehicle means that you may have to unpack your luggage to get to it. It takes up valuable load space that could be used for more delicate articles. Because it is heavy, it is important that it is well secured.

On a roof-rack

A spare wheel carried on a roof-rack is ideal because it is easily accessible, can be secured well forward to aid weight distribution, and the bowl of the wheel rim can be sat in when game viewing.

Swing-away wheel carriers are the most convenient way of carrying a spare. If you tow a trailer make sure that additions to the trailer draw-bar allow the wheel carrier to be swung clear of the tailgate. A single and twin-wheel carrier is made by Outback Extreme (011 397 8883)

Spare wheels are usually heavy and it may take two people to lift it onto the roof rack.

On the rear door

With current trends the rear door appears to be the place to carry a spare in terms of looking cool. A spare wheel carried on the rear door is without doubt convenient but negatively affects weight distribution and on some vehicles not originally designed to have it there has odd effects on handling.

If a special rack is fitted that is separate from the rear door it can be a useful place to carry other equipment such as a spade. Some door mountings are not strong enough to take the constant vibrations in rough country and eventually break. The Land Rover Defender's rear door is notorious for cracking and so a purpose-built spare wheel carrier must be fitted. If the wheel is attached directly to the door, the hinges and clamps should be periodically tightened and the door jam set so that there is no free play.

WHEEL RIMS

Magnesium alloy rims

Mag rims are unsuitable for heavy off-road work. The bead, the part of the rim most frequently damaged off-road, is the mag rim's weakness and when damaged they cannot be hammered back into shape as with a steel rim.

Steel rims

This type of rim should be selected for serious off-road use. Steel rims are constructed in two parts: a pressed steel centre boss and a rolled circular bed for the tyre. These parts are either rivetted or welded together, rivetted types being the strongest and most reliable. Steel rims are sometimes of inferior quality and in some cases severely warped rims are supplied with new vehicles, making perfect balancing impossible.

Damage and repair of steel wheel rims

Common causes of damage are overloading, running with less than the total amount of wheel nuts or driving over rocks, etc. Make

sure that wheel studs are clean and lightly oiled otherwise stud nuts can tighten against dirt and rust. Running with loose wheel nuts can cause severe rim distortion which is irreparable.

Slight damage can be easy to repair, eg. bending of the outer bead. This can be straightened using a shifting spanner and light use of a hammer. Make sure the bead is returned to its original shape and the distortion has not been transferred along the bead. Because wheel rims are made from high grade steel, welding should not be undertaken owing to the possibility of the temper being altered by the heat and resultant weakening of the rim.

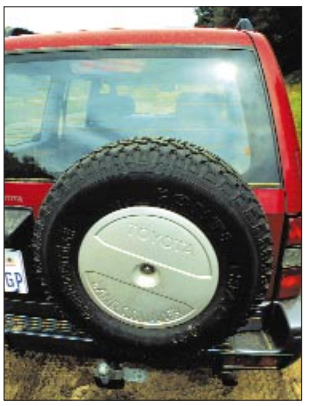
Maintenance of wheel rims

Rust is a bit of a maintenance headache when it comes to wheel rims. Because of the habits of male dogs and the fitting of tyres when the rim bead is unclean, tyres can weld themselves to the rim making them very difficult to remove. It is a good idea to remove each tyre from its rim and then to refit them before going on an extended safari to avoid having to repair a puncture in the bush and spending three hours simply trying to remove the tyre from a rusted rim.

A solution to this problem is hot-dip galvanising although this is not entirely suitable as excess zinc deposits can create small spikes that can cause punctures and zinc deposits on the tyre bead requiring smoothing with fine glass-paper. Sand blasting and then coating with epoxy paint is the most ideal rust preventative method.

Split rims

Some older vehicles were fitted with split rims of a two part design. This facilitates the removal of the tyre from the rim. These rims are unsafe and should not be handled by the uninformed. It is imperative that the tyre be totally deflated prior to splitting the rim as air pressure remaining in the tyre will cause the rim to split with explosive force which could cause serious injury. Also, when a tube is fitted onto a split rim, a gater consisting of a ring of shaped rubber must be inserted between the rim and the tube. Not fitting a gater with a tube will result in the tube wearing and eventually rupturing at the joint between the rim halves.



Right: A carrier attached to the rear of the vehicle is a very handy place to carry recovery gear. Above: Cosmetic rims covers should be removed and left at home during long trips.

TYRE MAINTENANCE IN THE BUSH

In my recent travels I have been lucky enough to have been loaned vehicles from various manufacturers to drive and photograph for my many books. All these vehicles were new and therefore very few were unreliable. These vehicles were also rarely fitted with the extras I would have liked, such as a roof rack, suitable jacking points or a second spare wheel. Rarely too were the vehicles fitted with tyres adequate for the trip in mind. The off-roading I do is no more strenuous than the average enthusiast and I drive with care and consideration for the vehicle, but I am frequently faced with multiple punctures or damaged tyres during the trip. I am therefore forced to carry a comprehensive set of tyre repair equipment.

The list is as follows:

- *Electric tyre pump*
- *Foot tyre pump*
- *Tubeless repair kit/Tube repair kit combination*
- *2x tyre levers*
- *2nd spare wheel*
- *Spare inner-tubes*
- *Jacks and tools to remove and replace wheels*

12-volt electric tyre pumps

Electric pumps available vary greatly – some are quick, efficient and costly and others are simple devices more efficient at converting noise into heat than inflating a tyre, but even these are less effort than using a hand or foot pump, and they take about the same time.

Electric pumps are fairly reliable, but if they break down they are not easy to repair. It is therefore advisable to carry a foot or hand pump as a backup. More expensive pumps that are driven directly off the engine fan-belt are well worthwhile should you intend doing a lot of beach or desert travel when constant deflating and re-inflating tyres becomes a chore. Another method is to carry compressed air tanks with tyre pump hoses attached. This is an expensive and bulky way to do it, but if you're a diver it may

Left: The Thomas air pump is one of the more expensive pumps available.
Right: The Bush Buddy air pump, sometimes called Volcano, a little smaller than the Hurricane pump but much cheaper and almost as efficient. It is excellent value for money.
Next page top: An example of a Hurricane pump mounted in an engine bay. Mounting a pump here saves space and is very convenient. Note the similarities with the Volcano.

prove an easy solution. One tank will be required for each vehicle.

No decent electric pumps go for less than R350. If you settle for the cheaper kind be happy to wait a while for your tyres to get pumped – 45 minutes to an hour for 4 tyres from 1-bar to 2,5-bar.

Foot and hand pumps

Foot pumps are perhaps a little less strenuous to use than hand pumps, but their use in sand can be awkward. They must be placed on a plate or tarpaulin to keep sand from entering the mechanism. Both hand and foot pumps are inexpensive and are easily maintained and repaired.

Automatic Tyre Deflators

When it comes time to deflate tyres off-road, it is a laborious process to go from tyre to tyre, deflate, check pressure, deflate some more and then check pressures again. Automatic tyre deflators solve this problem and will deflate tyres to a pressure preset on each unit, while the vehicle is driven. The kit consists of four valves that are preset (mine are set to one bar) that are screwed onto each tyre valve when its time to deflate. The valve opens until the preset pressure is reached and then shuts off. For the valves to open the tyre must be above two bar.

Automatic tyre deflators are a hassle-free way of deflating a set of tyres

REPAIRING A PUNCTURE

Tyre repair kits

A repair kit should comprise a set of a minimum of two tyre levers, a rubber repair kit with patches of varying sizes, a valve spanner and a pump. A tyre repair kit designed specifically by the author for the African off-roader is stocked by most 4x4 gear shops, AA stores and Makro. Ask for the 4xForum tyre repair kit or call 021 785 5752.

A combination tubed/tubeless repair kit with tyre gaters and spare valves is essential equipment, regardless of which type of tyre is fitted to your vehicle. Most off-road repair kits are for tubeless only, and will not go further than repairing a simple thorn type puncture. This simple but versatile kit is designed by the author.

Carry a second spare wheel and tube

By carrying a second spare, a puncture need not be repaired immediately. If the second spare is required, this is the time to make a repair. Do not wait until your vehicle is immobile before you make a repair or you may find your vehicle immobilised in

a position which makes it difficult for you to work. Change to the spare, drive to a shady place or set up camp and then repair the puncture in a relaxed, unhurried fashion. It may even prove enjoyable and will feel like part of the bushwhacking experience.

Repairing a puncture (tubed)

For punctures that cannot be repaired with the tyre on the rim, follow the instructions under the heading 'Repairing a Puncture (tubeless)' making allowances for the fact that the tyre patch (tube patches do not work on tyres) will be cemented (Solution for tubes may not work on tyres and tyre patches) onto the inside of the tyre. Read the literature that comes with the repair kit and follow the tyre removal procedure below.

For punctures that can be repaired without removing the tyre from the rim follow these instructions:

As these plug repair systems differ slightly, read the instructions that came with your kit. Locate the item causing the puncture and draw a circle around it. Do not assume that if you find what seems to be a nail/thorn in your tyre that this is the only cause of the puncture. Look carefully at the entire tyre including the inner and outer sidewalls marking all irregularities. Remove the nail/thorn. Insert the plug into the spiker and apply cement (some systems do not require cement) to the plug. Insert the plug and withdraw the spiker according to kit instructions. Inflate the tyre and splash water over the repair and over any other suspect areas checking for bubbles.

Repairing a puncture (tubeless)

Inspect the tyre and mark any objects which could have caused the puncture. Do not remove the object at this stage. Place the flat under your vehicle and use the jack and the vehicle's weight to break the seal between the tyre bead and the rim. Breaking the bead (separating the tyre from the rim) is the first and often most frustrating task when repairing a puncture in the bush. The problem is that when the tyre is driven over, or crushed using a high-lift jack, the opposite side kicks up. To prevent this, two high-lift jacks placed opposite each other and worked together works well. If you only have a single high-lift, use a bottle jack or similar to prevent the wheel from lifting.

Once the seal is broken, place the wheel on a ground sheet (it is important to avoid dust) and remove the valve. With a basin of slightly soapy water at hand, wet the tyre levers. Stand on the edge of the tyre and insert the levers between the tyre and the rim. Work your way around the tyre until the bead is over the rim. NOTE: Not all wheel rims are symmetrical. Start with the outside (the side with the valve). If you have difficulty removing the bead, try the other side of the rim. Then with the wheel standing upright, remove the tube where you think the puncture has occurred and mark it. Then remove the rest of the tube, replace the valve and inflate it. The puncture should then become easy to find. Immersing the tube and watching for bubbles is another way of locating the puncture, and may also reveal other defects such as a leaking valve. Mark the puncture and deflate the tube completely.


A puncture can occur in the most unexpected places. On this occasion we holed a sidewall on the banks of the Chobe River.

Repair kits come with a scraper which is then used to roughen around the puncture site after the tube has been dried. Clean away any rubber particles and apply the rubber solution. When it is touch-dry, remove the backing and apply the patch. Rub over the patch with the round end of a screwdriver handle or similar object until you are sure that a good bond has been made. Clean out the inside of the tyre and remove the object that caused the puncture. This is a good time to inspect the outside too, and remove any thorns, stones or nails that may be working their way through the tyre. Dust the tube with talc and fit it inside the tyre with the valve intact. Soap the tyre bead and, with the tyre levers, work your way towards the valve, pushing the tyre over the rim. Be careful not to pinch the tube with the tyre levers.

The final stage is to inflate the tyre. Roll the wheel looking at both sides checking that the tyre is seated uniformly on the rim. Then deflate the tyre and re-inflate it. If the tube is not correctly aligned it may split when it is run.

Getting a puncture on a steep slope

I have on two occasions needed to replace a wheel while my vehicle was pointing skyward at about 20°. This is no easy task. Preventing the vehicle from rolling off the jack is the first priority.

These are the steps:

- *Wedge all wheels with rocks or chocks.*
- *Anchor the vehicle using its winch cable or a chain to another vehicle. Do not use stretchable rope or a tuggum strap.*
- *The winch cable must be fully stretched before jacking can begin.*
- *Engage low-range first gear and lock all differentials that you can.*
- *Firmly apply the hand-brake.*
- *Remove the spare wheel from the vehicle before jacking.*
- *Have all occupants leave the vehicle before jacking and have them stand to the side. Keep bystanders from walking behind the vehicle.*
- *Make sure the vehicle remains stable as jacking begins and jack slowly. Only remove the rim once you are confident that the vehicle cannot roll further and fall off the jack.*

CARE OF WHEELS AND TYRES

Make sure that all of your tyres (including the spare) are fitted with valve caps. They form a positive seal and keep out mud and dust.

If you have a 4WD vehicle that is only used occasionally you have an added maintenance chore when it comes to tyres. When a tyre stands for long periods in the same position, the sidewall sections closest to the ground are subjected to sustained flex, causing minute cracks to develop in the rubber. These cracks admit dust, water and light all of which cause a slow deterioration process and ultimately damage the tyre. The solution is either to drive the vehicle once a week (which is not a bad idea anyway, considering the care required to keep the rest of the vehicle in good order) or to jack up the vehicle taking the load off tyres. Cover the tyres when the vehicle is parked in the sun – many makes of tyre are easily damaged by sunlight.

Balancing and rotating

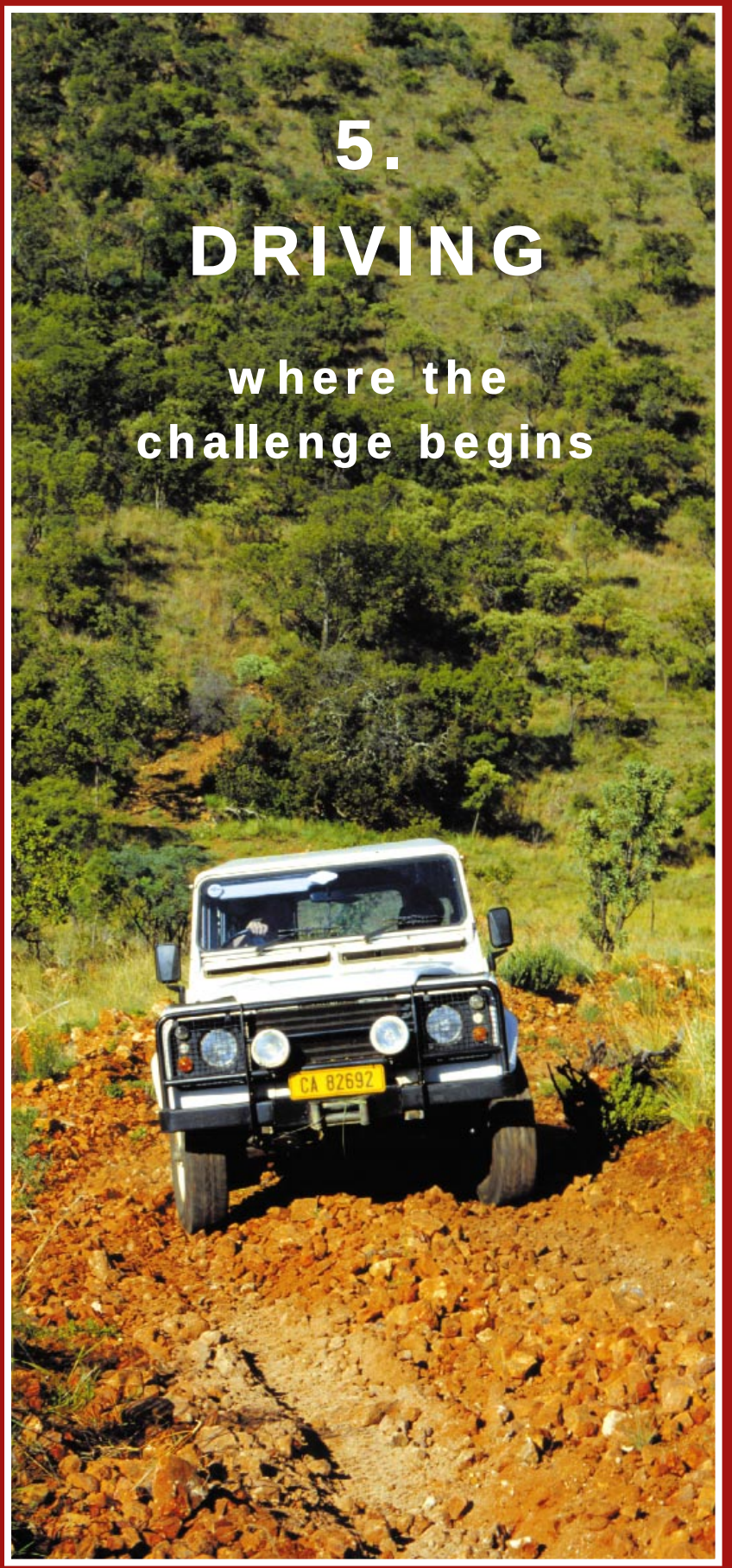
To get optimum mileage out of a set of tyres, the tyres must be periodically rotated. Most radial tyre manufacturers do not advise reversing the direction of rotation, ie. swapping from side to side. However this is not the case with vehicles equipped with permanent four-wheel drive transmissions, where tyres should be rotated; left front to right back and left back to right front. This should be done every 10 000 – 15 000 kilometres.

Balancing should be done every 35000 kilometres or thereabouts. 4x4s are generally on the heavy side and on some vehicles only when balancing is radically out is the vibration serious enough to be transferred to the driver. If this is left unchecked, premature failure of shock-absorbers and suspension bushes will result.

Maintenance of tyre pressures

Vehicles with the spare wheel stowed under the load bay means that the driver has to climb under the vehicle to check pressures and inflate it. Because off-roaders cannot afford to allow the spare to go flat or drop off without being noticed, a valve extender pipe is a good idea.

It works like this: the extender L-bend fits onto the spare and is hand tightened. The valve end is then permanently fixed to a convenient place. Ideal locations are under the tailgate (pickups) or next to the fuel cap hidden behind the lockable flap. Mounting is straightforward and is easy to do as long as there is easy access behind the location. Valve-Tyre-Extenders are available from good 4x4 equipment outlets and the 4xForum, 021 785 5752.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DRIVING
where the
challenge begins
CA 82692

Driving off-road is very different from any other kind of driving. It can be very enjoyable and can also be very frustrating, especially to a beginner who may find himself suddenly stuck in conditions that appear at first sight to be easy going. Although there are basic rules to follow when driving off-road, the combination of road condition, tyre tread, type of shock absorbers, driving style and a dozen other factors can have a marked impact on a vehicle's performance. What follows are guidelines to successful off-road driving.

The first time I took a vehicle off-road I got stuck because I did not pay enough attention to where I was going. I was driving slowly over flat veld, when the nose of the vehicle suddenly dropped away and we came to a grinding halt. The front bumper was jammed hard against the opposite side of a metre-deep ditch which had been obscured by tall grass. One front wheel was clawing at thin air and only one of the rear wheels was touching ground. I walked a long way to get help, which came in the form of a cheery old man driving a 4-ton truck and a long chain. We drove over a rise and my stricken vehicle came into view. It looked like a duck feeding in shallow water with its tail feathers in the air.

Driving off-road can be learnt by anyone - it just takes practice. People criticise off-road vehicles when they get stuck - if the vehicle in front of you bogs down and you manage to get through, it does not necessarily mean that you have a better vehicle - it probably means that you are a better driver!

USING FOUR-WHEEL DRIVE TRANSMISSIONS

Drivers of 4x4 vehicles do not use four-wheel drive as often as they should. Drive to all four wheels should not only be used when in difficulty but to increase tyre adhesion, even if it appears to be adequate. I will give an example; while researching a book in 1994 I was loaned an Isuzu KB260 for a trip into the Maluti Mountains. When the road ahead was blocked by a swollen river I was forced to about turn and head back up along the route I had come. To make matters worse it started to rain and it was getting dark. I was

forced to drive faster than I would have liked. In this situation permanent four-wheel drive is the best but the Isuzu has part time four-wheel drive. In two-wheel drive, I had to work hard to stay on the road, for although the surface was firm, we were sliding around. When I engaged four-wheel drive the Isuzu drove as if on rails and we travelled in complete safety. I did not need four-wheel drive but it improved safety and increased my speed. How much extra fuel did I use? I calculated for the 60 kilometres we travelled that evening, at a conservative 5% increase in fuel consumption, I spent an extra 92c on fuel!

Driving all four wheels offers better all round safety, handling and improved tyre life on anything but a perfect road surface.

THE BASICS

When Must Four-Wheel Drive be Engaged?

The key is BE PREPARED. Select four-wheel drive BEFORE you encounter difficulties. If you consider that the terrain over which you are about to travel could not be easily traversed in a normal motor car, then engage four-wheel drive. Even if it is just a rough track and the going is easy, engaging four-wheel drive will reduce wear on the transmission by distributing the pounding to all four wheels instead of just two. If you have free-wheel hubs, lock them immediately you leave the road - you will be able to engage your front wheels from inside the cab at a moment's notice. Do not wait until you need four-wheel drive before engaging.

Thumbs

Keep your thumbs outside of the steering wheel rim. Steering kick-back when hitting an obstacle can jerk the steering wheel around with such force that it can badly bruise a thumb or finger.

Seat Belts

Seat belts should be worn although many find that the inertia types are uncomfortable as they tend to tug and pull, locking and unlocking as the vehicle shakes around. Wear seat belts during steep climbs or descents and side-slopes or wherever a roll-over could result. Do not wear seat belts in deep wading situations or any similar situation where there is a risk that a quick evacuation of the vehicle may be necessary.

Holding the Steering Wheel

In almost all off-road situations it is not necessary to fight the vehicle, forcing it to change direction. It is far preferable to let the steering wheel slip through your hands, gently coaxing the vehicle to go in the direction you wish.

Inspections

In difficult off-road situations, climbing out to inspect the ground over which you are about to drive can prevent bogging down or vehicle damage. This is especially important when negotiating rocky terrain where transmission damage can result if rocks strike the gearbox or axles.

Avoid Misuse of the Clutch

Engaging the clutch at the wrong moment either to change gear or to prevent a stall can create problems off-road. The beginner should avoid the clutch whenever the vehicle is traversing an obstacle - avoid changing gears and rather let the vehicle stall on a slope than risk a backward slide out of control. Next to hooliganism, misuse of the clutch causes more accidents off-road than anything else.

WHEN DO I ENGAGE FOUR-WHEEL DRIVE OR LOCK A DIFFERENTIAL?

Part-time 4-wheel drive vehicles

Engage 4-wheel drive in conditions where you feel that a 2-wheel drive vehicle with similar ground clearance may battle to get through.

Permanent 4-wheel drive vehicles

Lock the centre diff if there is any danger that any of the vehicle's four wheels may lose traction and spin.

'Super-Select' 4-wheel drive (Mitsubishi Shogun/Pajero)

Engage 4-wheel drive centre diff unlocked in ALL conditions other than smooth dry tarmac. Lock the centre diff if there is any danger that any of the vehicle's four wheels may lose traction and spin.

Axle differential locks

Lock axle differentials (always lock rear axle before front) in soft conditions, in all undulating terrain or if there is a possibility of lifting a wheel. In flat soft sand axle diff locks can hinder progress due to the understeer they cause. This understeer results in the turn of the front wheels being exaggerated, exerting additional braking action, halting progress.

The transfer gearbox

Part of what makes an off-road vehicle special is the transfer gearbox, a second gearbox in which an additional set of gear ratios is supplied for off-road driving. Some transfer gearboxes are integral with the main gearbox, and others are separate units, lubricated by a separate oil reservoir. The transfer gearbox reduces the overall gearing, thus giving a new set of ratios that are changeable by the gears in the main gearbox. A 5-speed gearbox with a transfer box will give the vehicle a total of ten forward gears, and two reverse gears.

Incorrect use of the transfer gearbox can cause severe damage to it and other transmission components. Never use excessive throttle openings when in low-ratio first or second. Excessive torque loads can destroy differentials and twist off half shafts.

In the case of selectable four-wheel drive vehicles, additional lever/s attached to the transfer gearbox will select four-wheel drive. Therefore, the gears selectable with the transfer box will be:

- *Two-wheel drive - high-ratio (normal road driving).*
- *Four-wheel drive - high-ratio (easy off-road driving and for momentum-critical driving).*
- *Four-wheel drive - low-ratio (difficult, slow off-road driving).*

In the case of a permanent four-wheel drive vehicle, additional lever/s attached to the transfer gearbox will select:

- *Four-wheel drive - high-ratio (normal road driving).*
- *Four-wheel drive - high-ratio + centre differential lock (easy off-road driving and for momentum-critical driving).*
- *Four-wheel drive - low-ratio + centre differential lock (difficult off-road driving).*

Even for moderate off-road driving it is advisable to lock the centre diff whenever the low-ratios are selected. This will protect the differentials from damage due to excessive torque transmitted when in low-range.

The transfer gear lever may have a central position marked “N”. This is neutral and in this position no power is delivered to either propshaft. Neutral is used when the vehicle is being used to drive auxiliary engine driven equipment via power take-offs. It is also the position which should be selected if the vehicle is being towed for long distances.

FREE-WHEEL FRONT HUBS

The sole purpose of free-wheel hubs is to save fuel on the open road. The amount of fuel they save is not measurable under 50 kilometres. Often drivers of part time four-wheel drive vehicles use more fuel than their permanent four-wheel drive counterparts because when the going gets a bit difficult they are often too lazy to stop, get out and lock the hubs and instead battle through in two-wheel drive, spinning their wheels and using more fuel.

I am highly amused at the off-road driver who continually jumps out of his vehicle to engage the front hubs, only to disengage them again when the going gets easier. I once saw a driver, after he had stopped in knee deep mud, jump out of his vehicle, stand fumbling

in the mud to engage the hubs, climb back inside and then, to my amazement, on driving out, he jumped out and went to disengage them. The terrain was rough and there was quite a bit of mud around. He was under the misconception that driving with the hubs locked was damaging his vehicle or that he was using extra fuel.

TYRE PRESSURES

Part of the preparation for driving off-road is the deflation/inflation of the vehicle's tyres in order to enlarge the tyre footprint and thus increase floatation or penetration. This is a subject under much debate, as many think that as soon as off-road driving begins, one should automatically let one's tyres down. There are many things to consider.

When to let down tyres:

This subject is under constant debate and there are no absolutes. My own feelings are as follows:

- *If the tyres need to penetrate to obtain traction, such as rocks, hard and steep slopes, shallow snow, steep hard sandy inclines and shallow slippery mud the tyres should be inflated to normal operating pressures.*
- *If conditions require protection, such as sharp rocks and in conditions where the tyre sidewalls are threatened, then pressures up to 20% higher than normal operating pressures should be used.*
- *If conditions require floatation, where the tyres need to float over the surface and not break through, such as soft sand and thick, bottomless mud, tyres should be deflated.*
- *An experienced driver will quickly recognise when conditions require lower tyre pressures and will be able to estimate what pressures are required.*

When tyre pressures are reduced the footprint becomes longer rather than wider. Increasing the contact area with the ground reduces the pressure of each tyre on the ground thereby reducing penetration.

- *As a guide for beginners, start at 1,5-bar. If going is still difficult, drop to 1-bar. From this point drop pressures to as low as 0,6-bar for tubeless and 0.4-bar for tubed. This is about as low as you can go without taking the risk that the tyre will slip on the rim (tubeless) and deflate. With a tubed tyre you can go as low as 0,25-bar in emergencies.*
- *Speeds must be kept down to prevent tyre damage, especially if you are using tubed tyres.*
- *Incorrect procedures regarding the deflating of tyres, often done the moment that conditions look tricky, frequently leads to drivers finding the going even more difficult because they deflated their tyres when the conditions required normal tyre pressures. I have on several occasions seen drivers deflate tyres in conditions where a mountain road, layered with treacherous, slippery mud, required the tyres to bite through to the firm surface beneath the mud. As a result they found themselves unable to control their vehicles because their broad tyre footprint was sliding over the surface. This is particularly dangerous during a descent when steering control can become very difficult.*

Tyre pressures and the effect on tubed and tubeless tyres:

- *A vehicle with tubed tyres can be driven more aggressively because the tube serves to hold the tyre on the rim and if the bead is broken, there will be no air loss. For this reason pressures can be dropped lower than with tubed tyres.*
- *Excessive speed with reduced pressures with tubeless tyres will quickly wreck the tube and a blowout will result.*
- *Tubed tyres are more robust for driving at lower pressures because without a tube, internal friction is reduced.*
- *Tubed tyre emergency pressure: 0.5bar.*
- *Tubeless tyre emergency pressure: 0.7 bar.*

Slow speed and control is the essence of steep descents. Should engine braking be insufficient to slow the vehicle enough, brakes can be used if cadence braking is used. Never engage the clutch when on a steep slope, even if the vehicle threatens to stall.

STEEP SLOPES

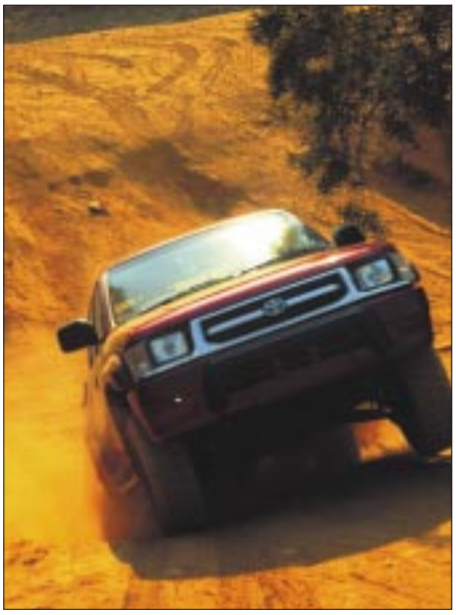
When descending or ascending steep slopes follow the fall line. Avoid tackling slopes at an angle as a slide and roll-over could result.

Descending a steep slope

The trick is to use the compression of the engine to slow the vehicle down. In doing so all four wheels are braked simultaneously. This eliminates, on all but the most severe slopes, the risk of the wheels locking and a slide resulting. The golden safety rule for driving, either up or down steep slopes, is under no circumstances engage the clutch.

The procedure on firm ground is as follows:

- *Remember the golden rule: if you depress the clutch at the wrong moment you may lose control. No matter what happens, the clutch is not required if the vehicle is moving.*
- *Engage four-wheel drive, ensure that free-wheel hubs are engaged and lock any differentials that you can lock.*
- *Select the lowest gear available; low-range first.*
- *Release the hand-brake and begin the descent.*
- *As the vehicle begins its descent take your feet off the pedals and place them firmly on the floor. If you're a beginner you may want to tuck your left leg under the seat to prevent the inadvertent use of the clutch.*
- *The engine will provide all the braking you need. You will have full control because there is no chance of locking the wheels due to action on the brakes.*
- *If the vehicle loses traction and starts to slide, steer towards the direction of the slide (downhill) and apply a gentle, careful acceleration.*
- *If engine braking is insufficient, gentle application of the brakes can be made. Do this when the vehicle is moving in a straight line. (so brake before a corner and take the corner under compression only)*
- *Apply brakes in short sharp jabs to avoid locking the wheels (cadence braking). Be aware that the use of brakes can induce a slide, so take care not to cause a wheel to lock.*



Climbing steep slopes requires a combination of momentum and traction. Too much speed reduces traction, too little speed reduces momentum.

- *If you are using the brakes they must be released the moment a wheel begins to slide or the vehicle's direction changes due to a slide.*
- *NEVER change gear during a steep descent. If the clutch is depressed the vehicle will speed down the slope out of control.*
- *If your engine stalls during the descent because your vehicle has hit an obstacle, start it with the starter motor while in gear and keep your foot well away from the clutch. Apply a little accelerator to get you going.*

Descending on slippery ground - all of the above and:

- *Use of the brakes is highly dangerous and can induce a slide from which you may not recover. Low range second is the gear of choice for very slippery descents and descending sand dunes.*

Ascending a steep slope

When confronted with a steep slope the driver must decide: do I need momentum or control? A higher gear and speed will provide momentum but if the slope is bumpy a higher speed will cause the wheels to lift, resulting in loss of traction. In this case a lower speed may be preferable. Climbing steep dunes requires a different approach where speed is the essence. (see dune driving)

The procedure is as follows:

- *Engage four-wheel drive, lock any differentials that you can lock and make sure your free-wheel hubs are engaged.*
- *Select a gear that will offer enough torque to get you up, but not too low as to promote wheel spin. Second or third gear low-ratio usually works well.*
- *As the vehicle begins its ascent give a little extra power. The more slippery the surface, the more momentum you will need to get over the top. If the surface is uneven, a lower speed will prevent the wheels from bouncing and leaving the ground, thereby losing traction.*
- *If the vehicle loses traction and wheels start to spin, decelerate very slightly and accelerate again once the wheels grip again.*
- *Decelerate as you crest the slope to avoid hitting an unseen obstacle or go careering over the edge in the wrong gear.*
- *If your attempt failed due to lack of power, select a gear one lower than the gear you first tried. If your attempt failed due to loss of traction, you have two choices - select a higher gear than before and/or, attack the slope with a little more speed.*
- *A gear change during the ascent may be needed if not enough momentum can be achieved at the lower section of the slope. A very rapid change down can be attempted but must be done at the place on the slope of minimum traction. eg. corrugations.*

Engine stall on a steep slope

If your engine stalls during a steep ascent the vehicle is in a potentially dangerous situation. The golden rule applies more in this situation than in any other: allow the vehicle to stall and do not try to prevent the stall by depressing the clutch. It is this single act that counts for more off-road accidents than any other.
Remember - DO NOT DEPRESS THE CLUTCH.

If your vehicle stalls on a steep slope:

- *Apply the hand-brake firmly simultaneously holding the vehicle with the foot brake.*
- *Depress the clutch , slowly and cautiously. If safe, engage reverse gear and release the clutch.*
- *If you are unable to engage reverse because the vehicle cannot be held by the brakes alone, have someone pack rocks behind the wheels to secure the vehicle. Once this has been done engage reverse and release the clutch.*
- *Release the hand-brake - slowly.*
- *Start the engine, (only kick the starter otherwise the starter motor will propel the vehicle down the slope) while engaged in reverse and your foot off the clutch, while simultaneously gently releasing the foot brake. The engine will fire and the vehicle will descend safely under engine compression braking to the bottom. From this point the procedure is described in 'descending slopes' but this time it is done in reverse.*

Side slopes

When a steep slippery mountain track tilts the vehicle the rear wheels often break away causing a slide. On clay-type mud this can happen without any provocation and is severely exaggerated when one is moving down a slope. This situation is corrected as follows:

- *Steer towards the direction of the slide.*
- *Decelerate gently.*
- *Do not use brakes as this will increase the slide.*
- *Once the vehicle is straightened up, cadence braking can be used to slow the vehicle.*

Side slopes on sand are particularly dangerous because of the danger of roll-over as the lower wheels penetrate the sand increasing the angle. When approaching a slope in thick sand take it at speed under full power, making sure that momentum is maintained.

MUD DRIVING

A good rule is to walk across the obstacle before you attempt to drive through it. With mud this is rarely done, and this is why 4WD vehicles can easily suffer structural damage while driving in mud. Rocks and logs often lie hidden under the mud and hard mud is often driven through with excessive speed. Mud driving can be tricky, especially for those who have fitted sand tyres onto their vehicles where the shallow treads quickly clog and sit on the surface without any grip.

Select the appropriate gear before hitting the mud. It is a balance of accelerating when traction is good and decelerating when wheel spin occurs, while also keeping speed constant.

A few rules can be applied when driving in mud:

- *Engage 4WD well before you need it and lock differentials. If you have both front and rear axle diff locks, leave the front disengaged unless the conditions are particularly bad - locking both axles causes steering difficulty. Make sure your free-wheel hubs are engaged.*
- *Select the appropriate gear before tackling the most difficult terrain. For thick, deep mud in a large engined vehicle, third gear low-ratio or first gear high-ratio is suggested. With smaller engined vehicles, select second gear low-range. The lower the gear, the more chance of wheel spin. The higher the gear the more chance of having to change down a gear, which could mean a loss of momentum.*
- *If wheel spin occurs, decelerate immediately, but delicately. If you take your foot off the accelerator completely your vehicle will slow down too quickly, and when you accelerate again the wheels are likely to spin. It is a balance of accelerating when traction is good and decelerating when wheel spin occurs while also keeping your speed constant.*

Slippery mud can be great fun but can also be very dangerous. Use low gears and keep speeds as low as possible. When a slide begins, release the accelerator and turn against the slide while avoiding the brakes.

- *Avoid doing anything suddenly. Keep your actions smooth and your steering wheel dead ahead if possible.*
- *If you find that the wheel spin continues and you are slowing down, it means that you are about to get stuck. If you avoid accelerating and continue to decelerate slowly while your wheels are spinning, and you still get stuck, rest assured that although you may have stopped, you will not be deeply bogged down. You would have avoided making unnecessary work for yourself by spinning your wheels and digging yourself in deeper.*

Another method to aid traction is to swing the steering wheel from side to side when the vehicle is moving. This works well if the wheels are spinning in ruts and the consistency of the mud is firm. The additional traction is given by the tyre sidewalls as they move from side to side.

When driving in thick mud with broad tyres designed for floatation in sand, spinning will not cause them to dig in as quickly as would narrow mud tyres. Instead, the treads clog with mud and the tyre loses all traction and spins on the top of the mud without driving the vehicle. In this case the best course of action is to drive through the mud at speed, keeping the wheels spinning. In the process the mud clogging the treads is flung out. There is a danger in this situation of damaging the vehicle by going too fast and hitting unseen obstacles hidden under the mud.

Allowing the wheels on one side of the vehicle to drop into a ditch at the side of a track is one of the most frequent ways in which vehicles bog down in muddy conditions. These ditches often occur on both sides of the track and are caused by water run-off that has eroded deep channels that catch the unwary. Unless your vehicle is fitted with differential locks on the axles, the wheels buried in the ditch will spin and the wheels on the outside will remain stationary. So, if you are travelling on a track that slopes away at its edges, drive slowly and carefully stay in the middle.

Steep mountain slopes in slippery mud

In Southern Africa many of the mountainous regions are blessed with high rainfall. This means that at certain times of the year the unsurfaced roads become difficult and dangerous to negotiate. In the late '80s, when I was acting as service crew for a privateer rally driver in the highlands of the Eastern Transvaal, over 400mm of rain fell in four days. Many of the special rally stages were closed and competitors and service crews were battling with the mud.

On a wet winter's day in the Maluti Mountains. The truck had swung wide to avoid a donkey and the slope had dragged in wheels into a roadside ditch. I attempted a rescue with the Isuzu.

I made the most of the conditions and enjoyed the rally more than ever - I was in my element.

On driving down one particularly steep hill - after having to stop and engage low range first in an attempt to keep my Range Rover from landing up in the deep drainage troughs running alongside the road - I came upon two stricken vehicles. Both had lost control and were lying with their left wheels in the troughs. As I arrived the party of a dozen men who had been battling all night to extricate the vehicles, yelled at me for coming down the hill, saying. 'Now we've got you to rescue too - there's no way out of here but up the hill because the river's flooded and blocked the road'. I apologised, engaged reverse and quickly drove back up the hill. None of these men had been in this situation before and it was obvious that they were out of their depth. I walked back down the hill, slipping and sliding as I went. They were now ready to listen and after an hour we had both vehicles free. To my astonishment, as the second vehicle was freed, the driver jumped in and raced down the hill, completely out of control, in two-wheel drive and in the wrong gear. He landed up in the same ditch a little further down. I drove down to him, told him what I thought of his driving technique and, to prove a point did a 3-point turn in the middle of the road and drove back up the hill.

Four-wheel drive vehicles are equipped with transmissions designed for all conditions - use the vehicle and its features to their full advantage.

Descending slopes in shallow, slippery mud:

- *Use low gear ratios and go slow. Do not be in a hurry. Lock up four-wheel drive even if you do not think you need it. Conditions change very quickly and if you are engaged in four-wheel drive you stand a better chance of handling them.*
- *Steering control is lost when the vehicle's motion exceeds the rotation speed of the wheels. This will occur if you use brakes in the conventional way - so if you need to stop, apply brakes in short sharp jabs.*

Rocking

This is a method using small wheel rotations (1/4 to 1/2 a wheel turn) to build up momentum when a vehicle is caught between two obstacles.

Select low-range second or third gear. Increase the engine revs and release the clutch. The moment before wheel spin occurs, depress the clutch. Your vehicle will roll backwards off the obstacle. As the rear wheels hit the obstacle behind you, the vehicle will bounce forward. Make use of this forward momentum and release the clutch again. Each time the vehicle is rocked back and forwards in this way speed and momentum will increase. At the moment when you feel that enough speed has been built up, release the clutch and accelerate gently.

Rocking works particularly well on rocky terrain and sometimes in mud, and will also work in reverse. If attempted in sand however, it usually digs the vehicle in deeper.

SAND DRIVING

More vehicles are seriously damaged when driving on sand than on any other type of terrain. This is due to a careless approach to dune driving where vehicles are inadvertently launched over the vertical lee side of a dune or drivers attempt U-turns on the slopes of a dune. While the angle does not appear to be beyond what the vehicle can handle, as the wheels bury themselves in the sand the angle becomes steeper and the vehicle rolls over.

Flat firm beaches are not playgrounds for 4x4s. Driving and turning sharply to kick up the sand often leads to disaster when the inside wheels hit a very soft patch and the vehicle rolls. On the thousands of kilometres of sand track criss-crossing the subcontinent, patches of soft slippery sand wait to catch the unwary.

Even if you have broad purpose-built sand tyres you will need to deflate them to broaden the contact area with the ground in soft sand. Everything will depend upon the floatation of the sand and often this can be determined only by driving on it. During the heat of the day, especially after long periods without rain, the air gaps between the sand particles will be larger and the sand will have less floatation. During the cooler hours, the sand will be more dense and will support more weight. After rain and in the early morning, moisture will compact the sand and make the going easier.

A few rules can be applied when driving in sand:

- *Engage 4WD well before you need it and lock up your transmission. Make sure your free-wheel hubs are engaged.*
- *Select the appropriate gear before tackling the difficult parts. You will need the highest possible gear that will give you enough torque to get through - try high-range first or if the sand is very thick, low-range third. A gear change in thick sand will halt your vehicle as quickly as if you had applied brakes. The lower the gear, the more chance of wheel spin. The higher the gear the greater the chance of having to change gear which could mean the loss of momentum.*
- *Follow other vehicle tracks. This reduces the scars on the landscape which in some desert areas remain visible for decades.*

- *If you need to stop, find a firmer patch and do not touch the brakes - simply slow down and let the vehicle come to a halt. Applying brakes will cause a weight shift and a little wall of sand to build up in front of the front wheels - this will make starting off difficult.*
- *Before starting off, or if you find starting off difficult, reverse a short distance (one metre is often enough) along your own tracks and pull away. This allows momentum to be gained before you reach the wall of sand that was created when your vehicle stopped.*
- *If you get stuck, try reversing along the same tracks you approached on. The opposite twisting action of the axles in reverse will help give traction. Attempting to leave the tracks may get you stuck. On your second attempt, go through with a little more speed.*

Sand dunes

Driving on sand dunes is a particularly delicate conservation issue and should never be undertaken in a thoughtless manner. If driving up and over a dune, check over the top for people, other vehicles and the sharpness of the descent on the other side.

Momentum is the single most important aspect when dune driving and everything a driver does must be geared to maintaining it - no matter how the conditions vary.

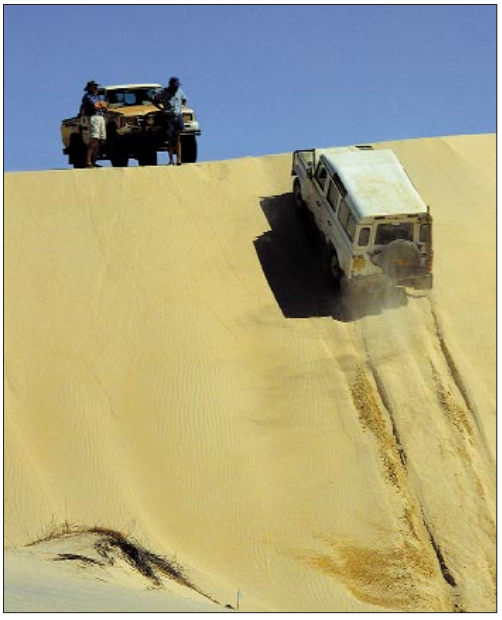
When a vehicle is on hard ground between dunes the correct speed and gear ratio for the climb must be established. In most dune conditions high (normal) ratio first, second and even third gears are appropriate. Avoid changing gear mid-slope as in most cases it will degrade the vehicle's momentum enough to stop it completely.

Gear selection in dune driving is, like all off-road driving, crucial. If you are using high-range first successfully, but occasionally need a lower gear to start off, use third, fourth and fifth low-range.

The secret of safe dune driving is establishing momentum at the base of the slope and then correctly timing the deceleration at the summit.

Never crest a dune without knowing what is on the other side. The lee slopes of dunes can be vertical. Always inspect your intended route.

All rules have their exceptions. In 1996 a group of friends in a Hilux and my family in a Land Cruiser went exploring the NamibRand Nature Reserve in Namibia, where we found some exhilarating dune driving. On one particularly long steep climb the Hilux in front balked at the steep dune and came to a halt. After about eight attempts the driver had run out of options and the dune remained unconquered. Approximately two thirds of the way up there was a length of corrugations where the track became a little steeper. The corrugations were created by drivers hitting the accelerator at the base of the gradient increase. Acceleration here simply meant spinning wheels, loss of momentum and the resultant corrugations. I then asked if I could give it a go. On the early part of the slope I realised that flat out in second gear high-range was not going to give me enough momentum to overcome the difficult patch and I was unable to back up further to give me extra speed. So, when I reached the corrugations, at the moment when my wheels would start to spin, I changed into first gear and powered my way up the final 30 metres to the top. My friend, now in the



Left: On this attempt to climb the dune I was not successful and decided not to try again. The severe jolt as I hit the base of the dune persuaded me not to put my vehicle through that torture again.

Steering feedback is very vague in sand. Hold the wheel gently and make sure your front wheels are not 'ploughing' as demonstrated here.

Land Cruiser, with much more power and momentum at his disposal, did the entire climb in second. In situations like this a gear change may be required and vehicles with more power require less effort to drive.

Rules of dune driving:

- *Deflate tyres before dune driving.*
- *Keep power constant on the slope.*
- *Maintain the momentum of your vehicle.*
- *You must aim to stop at the crest in order to inspect the descent and to engage the correct gear for the descent. The aim is to get your vehicle to stop at the top, even if it means touching the sand under its belly. Ideally its nose should be over the edge and the vehicle lying horizontal or pointing slightly downhill. If it is pointing uphill you may need to go back down and try again.*
- *You will need to decelerate as you near the top and judge it perfectly to get it right. If you stop and are still pointing uphill you will have to reverse back down and try again. Do this once you have checked the gradient and know what you are up against. Once your vehicle is successfully perched at the top, the next step is to dig away the crest that is touching the chassis between the wheels. Survey the drop and engage the low-range first for the descent. Keep your feet off the pedals and begin the descent. If the vehicle starts to slide sideways, steer towards the slide and apply gentle accelerator.*

Side slopes on sand

Never attempt to go sideways when ascending or descending a dune, because if you do the lower wheels will dig in and your vehicle will roll. Loaded roof racks are ill-advised when dune driving, and a conscious effort should be made to keep the vehicle's centre of gravity as low as possible when loading your vehicle. That will make dune driving safer. If the track ahead runs for a short distance along the side of a dune where the vehicle may slide, power is the only thing that will prevent the rear wheels from breaking away and the vehicle stopping at a precarious angle. Keep the power on and keep moving. If the back breaks away turn into the slope (downhill) and keep the power on. Getting stuck on a side slope is often a dangerous situation and the first priority

should be to secure the front of the vehicle to prevent it from sliding any further and increasing the angle and the risk of rolling the vehicle.

Sand tracks

When driving on thick sand tracks engage four-wheel drive even if you do not require it. Tyre wear will be reduced and vehicle control will be easier. Fuel consumption will also be improved because, even if you don't realise it, in two-wheel drive wheel spin will occur over the bumpy patches and speed is lost. The proof of this is the effect that a two-wheel drive has on this type of road. The spinning rear wheels cause large waves of sand to be built up and, after a time, driving on these roads is like riding a roller coaster.

When driving along deep sand tracks there is a natural tendency to fight with the steering wheel. This is due to the wheels sliding over the sand with very little feel being transmitted back to the driver as to which way the front wheels are pointing. Deep tracks can be driven without a hand being placed on the steering wheel at all. But don't be fooled by this, as I once was and play a game of chance along the narrow sand tracks in the Kalahari - many 4x4s have come to grief as the front wheels spin out and the vehicle suddenly rolls over. On this type of track the vehicle moves as if it were on rails and the inexperienced driver will tend to fight the steering wheel and most of the time the front wheels will not be pointing in the direction of travel - the front wheels will plough through the sand, absorbing power and consuming excess fuel. Very little steering effort is needed to guide a vehicle in these conditions. Let the vehicle steer itself while holding the wheel firmly enough to catch it if it suddenly swings, gently coaxing the vehicle in the direction you wish to go.

When driving along tracks through thick bush it is important to keep the windows rolled up to eye height. This is done to prevent branches along the edges of bush tracks from whipping into the passing vehicle and causing injury to the occupants' eyes.

Sand tracks that have very high walls are difficult to get out of. To get out of the trough, decelerate lightly, swing the wheel over quite hard and then IMMEDIATELY SWING IT BACK to just off the dead ahead position. If the steering wheel is left in the hard over position, a slide and a roll-over could result. If it works, the vehicle's

Sand tracks in the Kalahari. Engage 4WD or lock the centre diff even if you don't think you need it.

front wheels will ride over the ridge and the rear wheels will follow. If it does not, centre the steering and try again. If you find it impossible to leave the track, as can sometimes happen, stop the vehicle and try it in reverse. If you are forced to leave the track due to an oncoming vehicle, stop and turn on your headlights. Try the reverse procedure pulling off to the left hand side of the track.

On two occasions I have come across a 4WD vehicle lying in the middle of a sand track on its side. On both occasions the driver had tried to get out of the track. He had swung the wheel hard over and when nothing happened he turned it even more. All of a sudden the front wheels had hit something solid and the vehicle left the track so sharply that it rolled over. This is a common occurrence. Don't let it happen to you.

So remember:

- *Engage 4WD even if you don't need it.*
- *Hold the steering wheel gently.*
- *Slow down well in advance when you see oncoming traffic.*

BEACH DRIVING

Beach and sand driving have obvious similarities, but other important points should be considered when driving on the beach. Make sure you carry a can of Q-20, or a similar water repellent as well as a tyre gauge and pump with you. Drop tyre pressures before venturing onto the beach.

If the engine stalls or splutters because of water contaminating the electrical system, a dry rag and a spray of Q-20 in the distributor and on the HT lead connections is an instant cure. If you stall and are unable to restart, select 4WD low-range first gear and turn over the starter. Progress will be slow but if your battery has a good charge, you should be able to get out of reach of the waves. If the tide is threatening steer away from the water but remember that turning the steering to full lock will put a lot of resistance against the wheels and the starter motor may stall or the wheels may spin. If your tyres have a heavy tread, deflate them to as low as ten percent of normal road pressures.

An outgoing tide is the best time to drive on the beach due to the extra time to dig yourself out should you get into trouble. Do not underestimate the speed at which the tide comes in - you may lose your vehicle if you do! Drive as close as possible to the water's edge without getting splashed and you will be driving on the firmest surface. Beware of shiny wet patches and keep them between you and the surf - they indicate deep patches of sand saturated with water. Areas of pebbles or shells which even under the best lighting conditions are difficult to detect, are treacherous. They are invisible when the sun is low in the sky. Avoid driving on an unfamiliar beach at night.

Driver techniques for beach driving vary, and the method described for sand driving works on the beach. Additional speed can be used due to the absence of obstacles (as long as there are no people about). There are no paths or roads on the beach so if there are other vehicles about, give way to anyone who appears to be having difficulty, and watch out for children.

Low gear ratios will induce wheel spin unless the driver is very careful about how he applies his right foot. For example, hitting the accelerator once in the difficult patch will immediately spin the wheels - and if you bog down after wheel spin, your vehicle will be much deeper than if you had simply run out of traction.

Another method is to 'walk' your vehicle by using low-ratio first gear and crawl through, never allowing your wheels to spin. When using this method there is always the temptation to race the engine and go a bit faster. Don't be tempted - it's an invitation to disaster!

WADING

Off-road vehicles are often required to forge through deep water. Before doing so, check the vehicle manufacturer's specification data sheet on maximum wading depth, (or the vehicle handbook). This depth can only be exceeded if the following precautions are taken:

Water is ingested by the engine if the engine stalls and water is sucked up the exhaust pipe or if the water is too deep, the engine intake can suck water into the combustion chambers. SHOULD THIS HAPPEN DO NOT ATTEMPT TO RESTART THE ENGINE. IN MANY CASES IT IS THE RESTART THAT CAUSES THE SEVERE DAMAGE. Recovery from a drowned engine is covered in chapter 9.

In deep water the engine cooling fan splashes water around the engine bay, so either keep engine revs low, or remove the fan belt. Viscous-coupled cooling fans are ideal because when they hit water the friction slows the fan, reducing the splash. Some vehicles come equipped with bell housing drain holes which allow oil collecting in the bell housing to drain away. These holes should be sealed to prevent water coming into contact with the clutch.

Many years ago (when I was a lot less careful about such things) my vehicle was called upon to extract a yacht from deep water. I was unable to seal the bell housing because of a missing plug but I went ahead regardless and paid a high price. Water entered the

An unexpected hole in the river bed caught me out here. With no snorkel fitted the engine drowned but in this case there was no damage. The recovery of a drowned engine is in chapter 9.

bell housing and because the water was very cold, and the engine and gearbox were quite warm, the cooling effect caused water to be sucked into the engine through a leaking rear main bearing oil seal. The water, which was already mixed with fine sand, mixed with the engine oil and wrecked the main bearings. The engine had to be completely rebuilt.

Slow speed is essential and low-range second gear is recommended for most wading conditions. When entering the water do so slowly and avoid creating a splash that will wet electrical components. Drive at a speed that creates a clean bow wave. If you have ever seen a boat moving at speed and then slowing down, you will have noticed the bow wave catching up and pushing the boat from behind. This is exactly what happens to a vehicle in deep water. If you have created a bow wave and lose traction, the bow wave will push your vehicle forward as it catches up. This little push may be just what is needed to get you through a sticky patch, or up a river bank.

When crossing running water, test the depth and strength of flow before proceeding. If the flow is too powerful to walk against, rest assured that driving through it will be dangerous. Moving water will create more turbulence than still water, so consider this when calculating the depth. Move diagonally across the flow with the water pushing you. Crossing still water is safer but the possibility of deep sediment is more likely.

After wading, bell housing sealing plugs should be removed. Inspect the engine air filters if you think water may have entered

the carburettors. Water can contaminate gearbox and axle oils by entering through the breather valves. Because oil floats, it is easy to remove this water. Allow the vehicle to stand for a while and remove the drain plugs. The water will drain first and when you see oil, stop the draining process. If your engine oil has turned a milky grey colour, water has entered the engine sump. You will need to drain away the oil, flush the engine at least twice with oil or engine flush and then refill with new oil. Universal joints must be pumped with grease after being submerged.

Should an engine ingest water into the cylinders it normally stalls before any serious damaged is caused. This however is not the case with diesel engines - they are normally destroyed if this happens. There are few off-road experiences more rewarding than a difficult wading situation that is accomplished successfully.

UNEVEN TERRAIN AND OTHER SURFACES

Ridges

When crossing a ridge, stay at right angles to the ridge, passing both wheels on each axle over the obstacle at the same time. Crossing at an angle could result in lifting a wheel off the ground and the loss of traction on that axle.

Troughs

When negotiating a trough, cross at an angle so as to drop only one wheel at a time into the trough. This will always keep at least one wheel from either axle on firm ground. When moving along a series of troughs do so carefully and slowly, otherwise the differential may be grounded if a wheel drops to one side.

V-Shaped gullies

Driving along V-shaped gullies must be done with extreme caution. If one side of the vehicle slides down, and the wheels drop into the gully, there is a very good chance that the vehicle will get stuck. Getting out is also very difficult and digging may not work. One has to lift the lower wheels out of the gully, and to do this without momentum is very

When crossing troughs, allow a single wheel to drop at a time.

tricky. In this situation, differential locks on individual axles help a great deal.

When a V-shaped gully is entered, it should be done at an angle so as not to drop more than one wheel into the trough at a time. Exiting a gully should also be done at an angle so as not to allow both wheels on the same side of the vehicle to drop into the trough. Good axle articulation will assist a vehicle negotiating this type of terrain.

Ruts

Deep parallel ruts should be negotiated with one wheel in and one wheel out. If you allow both sides to drop into the rut the chassis may bottom out and progress could be halted. This would mean a great deal of digging to clear the underside of the vehicle to put the vehicle's weight back onto its wheels again.

Rough tracks

Although four-wheel drive may not be needed for traction, it is wise to engage it. This will reduce wear on transmission components and will afford the driver greater control. Avoid the constant use of brake and clutch and rather select a low-ratio gear that will keep the vehicle going at a steady speed. Look well ahead at the track surface and beware of sharp rocks that can tear tyre sidewalls.

Boulders and river beds

Engage 4WD and lock the differentials, even though you may think you do not need it. Large vertical wheel movements will be required and if a wheel does lift off the ground, only if all four wheels are being driven will you keep moving. Select low-range second gear. Low-range first can be used if the terrain is particularly difficult - the pace will be slow but if part of the vehicle hits an obstacle there will be less damage. In this gear, wide throttle openings should be avoided. Beware of the vulnerable parts of your vehicle such as the axle differentials and gearbox casings, especially if they protrude below the chassis frame as in the case of many 4x4 bakkies. To avoid striking these, make sure that the wheels ride over the higher boulders, clearing the axle and chassis.

Slow speed and control in low gears is needed to prevent damage to the vehicle.

Salt pans

Driving over salt pans is a nerve wracking experience and to do it successfully will require experience and luck. Don't be fooled by the apparent firmness and dryness of the surface. Underneath lies thick, black, enveloping mud.

In 1974, Mark and Delia Owens ventured onto the Makgadikgadi Salt Pans in Botswana. I quote from their book 'Cry of the Kalahari':

"I bent over the steering wheel, scanning the white salt crust ahead for dark patches, a sign that the pan had not dried out completely. But there were none. It was like driving over a billiard table, and I began to relax. Then about 800 yards from the edge I saw some timbers and poles sticking at odd angles from a depression in the grey, cracked surface. We got out to investigate. What could have made such a hole? And where had the timbers come from? There were no tracks or any other clues. Puzzled, I looked into the deep, ragged pit, to the place where the ends of the posts converged and then disappeared into an abyss of mud. The throat suddenly tightened - someone had tried, unsuccessfully, to save his truck. I glanced quickly at ours.

"My God! The truck's sinking! Get in - hurry - we've got to get out of here!"

Its wheels were slowly settling through the salt crust into a pocket in the softer clay beneath. The surface was giving way; in seconds our truck would break through.

I tried to drive forward, but the engine stalled. The wheels had sunk too deep. Working frantically, I restarted the motor and jammed the gearshift into low-range four-wheel drive. Spinning and throwing clay, the Land Rover churned forward until it heaved itself up onto the firm surface again. I quickly shifted into high-range for better speed, swung around, and raced to the safety of the grass bank at the edge of the pan."

If, after reading that, you are still keen, then here is what to do. Before you venture across the pan, skirt around the edge to find

JOHANN DU TOIT

This One Ten rolled during a low-speed pancake on a salt pan. The weight-bearing properties of the crust are often indiscernable from the surface.

the shortest possible route across. If you have decided to go across test the surface by walking some distance in front of your vehicle. If your feet are breaking through the crust, then do not attempt to drive across, no matter how broad your tyres are. If your feet are stepping on firm ground, then dig a hole about 25cms deep. If the earth is hard and dry, then it may be safe to cross. Unfortunately, there may be areas in front of you that are still soft.

The lower your tyre pressures are the better your chances are of getting through - in theory. In practice is doesn't appear to make much difference. Engage four-wheel drive, lock differentials and hubs, select low-range third or fourth and proceed fairly slowly. If you rush and the surface breaks you will be a long way from the firmer ground behind you. Follow the direction of other vehicle tracks if they look fresh, and drive parallel to them while making your own tracks. By taking it slowly you can assess the firmness of the surface by how much power you are giving to the wheels. Look down at the wheels to gauge the depth of the tracks you are making.

If the surface breaks and you start sinking, either floor the accelerator or stop. Accelerating may get you through the soft patch, but if not you will be a long way from firm ground when you bog down. By stopping immediately you feel the vehicle sink it will be easier to dig out because of the close proximity of firm ground and suitable anchor points, such as another vehicle. Avoid sudden movements of the steering wheel. Turning will only make matters worse, because your wheels will act as a plough. If you choose to stop, attempt to reverse in your own tracks or try to steer out by making a gentle turn. If your vehicle resists leaving your tracks, straighten the steering wheel and let the vehicle steer itself. If you are making progress and the reverse is getting you out of trouble, all is well. If not, the mud may be so bad that even digging is sometimes pointless.

If you have another vehicle with you, which is highly recommended when driving on salt pans, do not waste any time - start the recovery operation without delay. Work fast - your vehicle may be sinking. Watch the recovery vehicle closely - and don't get that stuck too!

Bogging down on a salt pan is a miserable experience. The mud is the worst kind you are likely to find anywhere, and without the aid of another vehicle equipped with a winch it may be days before you get out. Above all, don't take driving over salt pans lightly - they are treacherous. In Botswana vehicles are consumed by the pans almost every year. Do not stop and look at the scenery, no matter how solid the surface appears.

Lastly, please consider both the environmental effect your vehicle tracks will have on the pans, and your fellow travellers that will pass after you have departed - in any event, it is far more pleasant and a great deal safer to walk than to drive.

Grasslands

Fit a grille guard to prevent grass seeds from clogging the radiator and causing overheating. Fire may be caused by dry grass wrapping itself around the propshaft or exhaust. The grass dries out and ignites, so frequent checks must be made and any grass collecting under the vehicle must be removed immediately. Tall grass also hides ditches, logs, ant hills and rocks, so caution is vital. Remember that your tracks will be clearly visible for some time after driving over grass, so in the interest of conservation use existing tracks if you can.

Grass hides logs that roll over and puncture tyres. Watch for hidden deep ditches. Even driving slowly cannot prevent bogging down or vehicle damage in tall grass.

Unsurfaced roads

Long stretches of unsurfaced roads present their own dangers.

Firstly, if you wish to overtake, check that your outside wheels do not hit the sand that piles up at the edge of the road; it will drag at the wheels on that side of the vehicle and can cause a spin. Secondly, if the road is convex, overtaking or even avoiding oncoming traffic can put your vehicle at a tilt, and this can cause a dangerous slide. If you see an oncoming truck throwing up clouds of dust, take the precaution of either slowing down to a crawl and getting well clear, or alternatively leaving the road and stopping altogether. There are very good reasons for this; for one thing, you will avoid loose stones being thrown up like bullets. For another, there could be another oncoming vehicle overtaking the truck through the dust. I was given this advice by an experienced traveller on the Caprivi road from Kongola to Katima Mulilo.

Many main roads through the Kalahari are made from a substance called as calcrete. Calcrete roads appear blinding white in the midday sun, and can be very dangerous. They are particularly prone to the effects of big trucks and storm water, and after a week of rain can be transformed from a smooth dusty flat that can be covered at 90 kph, to a virtually impassable quagmire. A driver needs to be very alert when driving on calcrete and driver changes should be regular. Driver concentration can be hard

to maintain on long stretches and surface changes are very difficult to see against the blinding white. On the 300 kilometre calcrete road from Nata to Maun in Botswana, there were a number of fatal accidents caused by vehicles travelling at high speed hitting deep ruts caused by the heavy rainfalls. Several vehicles rolled.

If you see a deep rut or trough in front of you and it's too late to stop, apply brakes as hard as you can without locking the wheels. Do this

Take it easy when driving on corrugations - they can cause the vehicle to slide even when moving in a straight line.

until the very last moment and then, the instant before the front wheels hit, release the brakes. As the foot brakes are released, the vehicle's centre of gravity moves towards the rear and weight is taken off the front wheels. Now the vehicle hits the trough with less than the normal weight on the front axle. Doing this could mean the difference between a broken axle and simply a heavy bump.

One more piece of advice: if you are travelling on a busy and dusty road, turn your headlights on - you will become visible through the dust.

Corrugations

Corrugations are to be found on all dirt roads that are used by heavy vehicles and are especially bad after rain. They can cause a great deal of damage if driven over too fast. Suspension components are stressed to extreme limits if the vehicle is heavily laden and torsion stresses on the chassis frame can cause cracks in the steel.

Corrugations can also cause loss of control, especially with vehicles that are softly sprung. Upon hitting the corrugations, vehicles like these tend to go into a slide, losing traction at the back end. Loading a vehicle does tend to dull this tendency, but an overload will have the opposite effect, in which case over-steer increases dramatically. The Land Rover Discovery and old Range Rover are particularly prone to this. By fitting gas shock-absorbers this tendency is reduced. It's a cause of more accidents on dirt roads than any other, save for alcohol.

Driving at night

If you intend travelling through Third World countries at night, my advice is avoid it at all costs! The dangers cannot be over stressed. Third World countries are generally unfenced, so cattle, goats, chickens and antelope are a constant danger. If you collide with a cow at 80 kph you will be in a lot of trouble! You may wreck your vehicle and if you are lucky enough to get out unhurt, the local tribesman will require compensation. Litigation against owners of animals straying onto public roads in Third World Africa is expensive and time consuming, and in most cases unsuccessful. Trucks without lights are an even bigger danger. They are normally filthy and any reflectors fitted will have a thick layer of dust on them so that when you do see them it may be too late to avoid a collision.

What is more, on dirt roads at night if there is a lot of dust, your visibility will be impaired by the light bouncing back off the dust, making your long range lights useless. I cannot stress this point strongly enough: it is extremely unwise to travel at night in the Third World.

Snow and ice

Even in Southern Africa snow and ice can present a challenge to the off-road driver. During Easter of 1984, I was caught by snow in the Lesotho Highlands, the only time I have ever had to deal with such a situation. We were descending the mountain at the time, so this made the going even more treacherous. I stayed locked in combat during the entire descent, changing between low-range

One of my first trips alone - One of the few breaks in a Lesotho snow storm, April 1984. Hours in low-range second consumed 45lit/100km!

second and third for over six hours. During this time we covered only 25 kilometres and fuel consumption measured 45 litres per 100 kilometres. My advice is to take extreme care, especially if the area is mountainous. Ice is often invisible and the road surface and tyre adhesion can be very difficult to anticipate. If the ice is thin and the tyres are not gripping, it can be melted by spinning a wheel. This can be tricky in hilly country as the spinning wheels cause the vehicle to slide around without much control. Broad tyres are dangerous in snow, floating over the surface. Narrow tyres with block treads and hard shoulders are best for snow conditions as they have a better chance of breaking through the snow to grip the surface beneath. Only in virgin powder snow are broad tyres preferable, and in these cases tyre pressures must be dropped to the absolute minimum - to 0.5 bar and speeds kept below 10 kph.

Snow chains are particularly valuable and if only a single set is available, place them on the rear wheels for tricky uphill climbs and on the front wheels when descending steep slopes. When tyre chains are fitted to only the front wheels there is the tendency for the back wheels to slide out, so extreme care should be taken.

Turn your headlights on in dusty conditions.

Here's some additional advice about sub-zero conditions:

- *When a vehicle is parked for long periods, lift the windscreen wipers - they will stick to the windscreen otherwise. Do not leave the hand-brake on overnight, as some hand-brakes freeze. Rather park on level ground and chock the wheels.*
- *Weather conditions in high altitudes in winter can change very rapidly and it is imperative that when exploring such areas in winter, food and water rations for at least three days should be carried.*

Handling characteristics induced by four-wheel drive

4WD gives a vehicle peculiar handling characteristics - acceleration will promote understeer and deceleration will induce over-steer. If you find yourself in a situation where traction is poor and you need to steer with accuracy, steering with the accelerator pedal and/or hand-brake will be essential. The best way to test this is on a skid pan, a flat smooth surface on which water is sprayed. The more water on its surface, the less grip the tyres will have. This can be a hilarious experience so take some friends along. Apart from skilled use of the accelerator, rear wheel hand brakes must be used for steering the vehicle. Those vehicles equipped with transmission brakes that in effect lock all four wheels are not able to do this. Professional instruction would be very worthwhile.

Blow-outs

I have experienced four blow-outs while driving at speed in a loaded 4x4. Three occurred on the rear wheels and one on a front. 4x4s tend to have large wheels and tyres and so have a high centre of gravity. The result is that they tend to roll onto their roofs a little easier than normal road cars, especially if the vehicle is carrying a loaded roof rack. Catastrophic tyre and tube failures (blowouts) cause a vehicle to become difficult to control even if the failure occurs on a rear wheel. In such a situation the natural reaction is to stop as quickly as possible, but this is not always the most appropriate course of action. Hitting the brakes with any force in a blow-out situation tends to lead to loss of steering control followed by a slide. If the wheels strike a ridge or trough, even a shallow one, the vehicle can easily roll over. Avoid hitting the brakes. Simply take your feet off the pedals and gently change down one gear ratio. Take your time. Keep the vehicle on the road and away from the camber that will accelerate a slide. Causes of blow-outs range from under-inflation and overload to a twisted inner-tube. See chapter 4 for further insight into preventing blow-outs.

A convoy in the Cedarberg

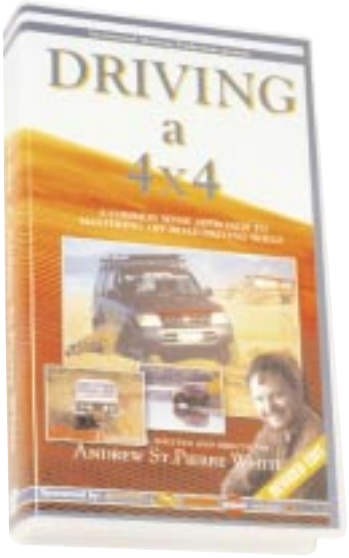
Convoys

The rule for convoy driving is that you are responsible for the vehicle behind you. It is good manners for the vehicle behind to indicate that a turning ahead has been noted so that the vehicle ahead can proceed. Flashing lights is the common method. This also helps the following vehicle in that it does not need to travel close to the leader and therefore drive in its dust and when driving at night, can drive with its headlamps in high-beam.

Driving a 4x4 video - a common sense approach to mastering off-road driving skills

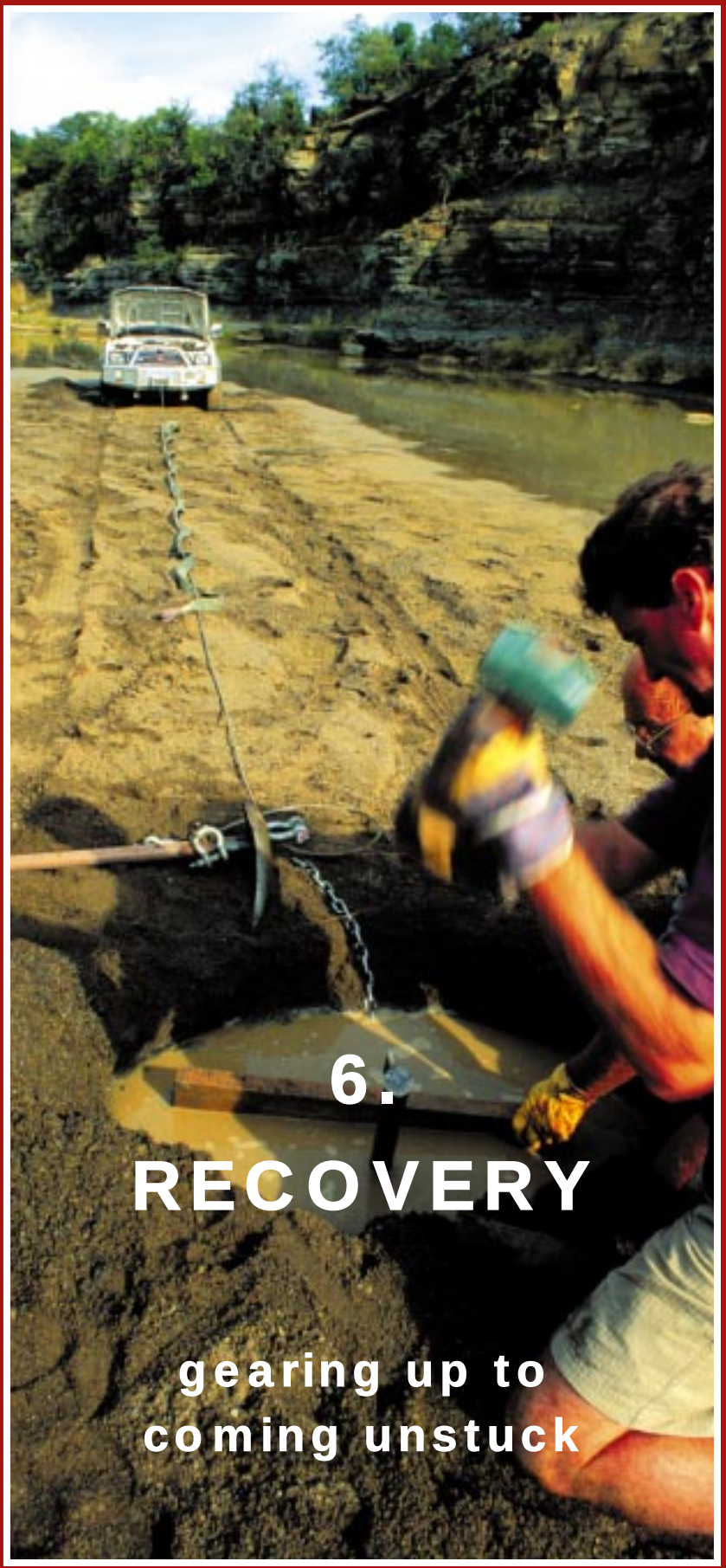
Before writing and publishing full-time, I edited TV and cinema commercials for 17 years. Because of my background, I combined my film skills with my love for the subject of off-roading and wrote, directed and produced a video on driving.

It is a little over 50 minutes in length and covers all of the terrain, excluding snow, that you are likely to find in the wilderness. These include: sand tracks, beach, dune, salt pans, mud, wading, high-speed gravel, river beds and steep slopes. It also covers the use of gear ratios and differential locks.



As a teaching tool, video works very well in this arena. Seeing how a vehicle behaves when driven incorrectly and the difference when correct driving principles are applied is very effective. I am pleased to report that critics have praised it as one of the best of its kind in the world.

It is the first in a series of three, the second being '4x4 vehicle Recovery' (see chapter 6) and the third, 'Working in the Wilderness'. They are available through the Continental 4xForum, http://www.4xforum.co.za or by calling 27 21 785 5752.



6.
RECOVERY

gearing up to coming unstuck

Don't be fooled into thinking that experienced off-roaders don't get stuck - they get stuck more than anyone! This is because they are keen to try the impossible, are not afraid of ridicule nor are they unfamiliar with the processes of getting a vehicle unstuck. It is important to realise that there is no shame in getting a vehicle stuck.

The most important tool required to free a vehicle from a sticky predicament is common sense. I have lost count of the number of times I have come across a bogged vehicle where the driver has taken out his winch or snatch strap without thinking through the problem. Three minutes with a well used spade and a gentle right foot and the vehicle is free. Common sense and a methodical approach often results in little work and a seemingly miraculous escape for the vehicle concerned.

This chapter covers the vast array of recovery equipment available and is followed by tips on using the equipment and a common sense approach to getting unstuck.

Vehicle recovery equipment makes up a large proportion of a typical off-road load. The following is a list of equipment that the serious off-roader should carry to free a vehicle or to get it over an obstacle where normal driving has failed:

WINCHES

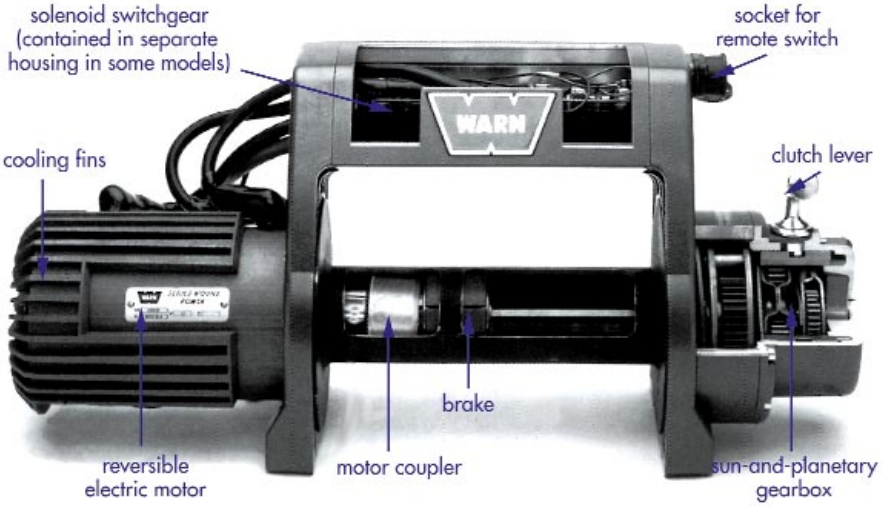
Novices sometimes think that a winch makes them invincible. The fact is that the winch is perhaps the most overrated piece of off-road recovery equipment available. This is because a winch relies on anchor points, which in the vast majority of cases just aren't available when you need them. And even if an anchor can be found, additional equipment such as a high-lift jack and a spade are needed to work in conjunction with a winch to extricate a vehicle. In a situation where there is no anchor, one can be constructed, but in most cases it is easier to use a jack and spade and dig the vehicle free than to create an anchor and use a winch. In severe cases, both may be needed.

Winches are, however, indispensable for some tasks such as aiding in the recovery of other vehicles and dual vehicle operations where one vehicle can assist another to traverse difficult terrain. Other jobs where a winch is essential are hauling boats up the shores of muddy rivers and for removing obstacles such as fallen trees from the vehicle's path.

WINCH TYPES

Five types of winches are available: electric, hydraulic, engine driven, hub capstan and hand. Hydraulic and electric are either drum (horizontal) or capstan (upright).

Using recovery gear is more common sense than anything else. Here the Trooper cannot move because it has come to rest against a boulder. The high-lift was used to move the boulder away from the Trooper while the Jeep used a tuggum strap to move the boulder out of its path.



Electric drum winches

The most common type of winch is the electric drum winch, manufactured by companies such as Ramsey, Warn and Superwinch.

Drum winches with sufficient capacity for vehicle recovery are supplied with steel cable of between 25 and 40 metres which is neatly stored on the drum. They are heavy, and require high capacity batteries to drive them (preferably deep-cycle). They overheat quickly in extended use and must frequently be left to cool.

They are supplied with a hand held switch with a long extension lead enabling the operator to stand at a safe distance or sit inside the vehicle while winching. The switch allows the winch to wind forward and in reverse. Safety spring return type switches are fitted to stop the winch if the switch unit is dropped.

Capstan winches

These are normally engine driven and often perform superbly when all else fails. Their biggest disadvantage is that they are best operated by two people. This is because a second pair of hands is required to tail off the winch, a procedure like that used for

operating the sail winches on large yachts. Only a seasoned expert will operate a capstan winch alone and if this is the case, an emergency engine ignition cut-off switch must be fitted so as to enable the operator, who will not be seated in the cab, to shut down the engine if required. I saw a Series One Land Rover fitted with an original Fairey 3000lb-capacity capstan winch haul 14 vehicles across a stretch of axle-deep liquid sand that no vehicle could traverse. The last and fifteenth vehicle proved too much for the small winch and the worm drive stripped. In the same situation, an 8000lb electric drum type would have overheated by the third or fourth vehicle. The rope for the capstan must be stored elsewhere as there is no provision for storing it on the winch.

Hydraulic winches

Hydraulic power is the most efficient method of powering a winch and those that use it offer immense pulling power. Hydraulic winches require an engine-driven hydraulic pump to run them and until recently they were no more than a dream to the ordinary 4x4 motorist, being fitted to very few non-military vehicles.

A new range, powered by a standard power-steering hydraulic pump, is now available for all makes of 4x4. Called Mile Marker, these winches, in comparison with similar specification electric winches, meet if not beat the competition in terms of pulling power while not suffering from rapid overheating at times of high load.

Fitting one of these new hydraulic winches is as simple as fitting an electric type. Instead of requiring heavy-duty battery, alternator, cables or switching solenoids a power steering pipe is interupted with a valve which supplies power on demand to the winch. The winch gearbox has two speed settings, permitting rapid retrieval of the winch cable. Operating these winches is the same as a regular electric winch, the hand control switch operating the winch by electrically opening and shutting a valve while the engine is idling. Their most significant disadvantage shows itself when the engine stalls and the winch stops working. This could cause a difficulty in a situation on a beach with an incoming tide and an engine failure due to water.

Pulling power

When selecting a drum winch, its rated pulling power represents its pulling strength when the cable is being wound onto the drum itself, not onto layers of cable wound around it. In effect, the smaller the diameter of the drum, the more its pulling power. So, when cable is wound onto a drum and cable is winched in on top of it, the diameter of the drum increases with each layer. For example, a winch rated at 8000 lbs is (theoretically) able to pull 8000lbs on the drum, about 6750lbs with a single layer of cable down, about 5800lbs with two layers of cable down and only about 5150lbs with four layers.

For a winch to be useful to extricate a fully laden medium-sized 4x4 (for example a Isuzu Fronier) from deep mud, a winch of no less than 8000lbs rated pull is required. From this point, a heavier vehicle will require a stronger winch and a lighter vehicle, a lighter-duty winch.

Hub capstan winches

Designed specifically for self recovery, hub capstans bolt directly onto the wheel rims and with a cable attached, the capstan winds up the line and hauls the vehicle out as the wheels spin. To overcome the effect of the axle differential, two capstans must be used simultaneously. Hub capstans can pull a vehicle free in both directions, are lightweight, easy to operate, very effective and are cheap. Because only a portion of the wheel nuts secure the capstan, it is not necessary to jack up the vehicle to remove them and therefore a single set can be used by a number of common vehicles.

Left: A hub capstan winch attached to a Land Rover Defender 's standard steel rim. Lightweight, practical and cheap, it is unfortunate that hub capstans are not available for a wider range of vehicles.

Electric versus Hydraulic

One of the most common questions put to me by those wanting to buy a winch is: 'electric or hydraulic?'. The two most important considerations to bear in mind are: The hydraulic has a high duty-cycle. It pulls and never tires. Electric winches tire and must be left to cool. The hydraulic requires that the engine be running. The electric, although it works better when the enging is running, will operate without. Read the comparison table on the following page for more information.

Portable electric winches

Removable winch kits enable a winch to be moved from back to front or from one vehicle to another, the location of which is determined by where a special mounting bracket has been attached. Warn call it the Multi-Mount system.

Mounting a winch

There are a few choices when it comes to mounting a winch. The first and easiest option is to purchase a bull bar with integral winch plate and have the entire thing assembled and attached by the supplier. The second option is to make your own. When I mounted a winch on my One-Ten, no 4x4 workshop had designed a plate that did not affect the approach angle. So I designed a plate and had an engineering workshop make it up for me. A third option is

COMPARISONS: MILE MARKER HYDRAULIC AND ELECTRIC	
MILE MARKER HYDRAULIC	ELECTRIC
Can be used only with vehicles that have power steering.	Can be used on any vehicle.
Installation simple. Vehicle can be returned to 'original' state with ease.	Installation simple. Vehicle can be returned to 'original' state with ease.
Powered by power steering pump.	Powered by battery - preferably twin deep-cycle type.
Most non-US vehicles have lower pressure output from steering pump therefore winch does not run at efficiency rated by manufacturer.	No independent test I have ever seen has any winch, electric or hydraulic, meet the manufacturer's claims.
Two-speed retrieve. forward and reverse. High gear for cable retrieve and low for pulling power.	One-speed retrieve, forward and reverse.
Retrieve speed (low) is considerably slower than most electric models.	Retrieve speed is aprox the same as Milemarker set in high gear.
The engine must be running.	Will operate without engine running. The engine should be running for alternator to assist the batteries.
High duty cycle. Will operate at full load, without a break, virtually until vehicle runs out of fuel.	Will operate for a short time - from 1 to. 3 minutes under high load when overheat ing or a shortage of current from batter-ies will stop it. Alternators are not pow-erful enough to keep batteries charged.
Operates under water.	Not recomended for use under water however will operate in emergency.
Power steering fluid has been known to overheat when operated at the same time as the power steering. This is an unusual sitauation and not a cause for concern.	Severe drain on batteries and reduces their life expenctancy. When run with deep-cycle batteries, these batteries must not be rapid-charged as it can cause irreversible damage.
Braking effect (when used to control a descent) is not as efficient as electric winches. Winch tends to over-run.	Braking effect superior to hydraulic winch.
Very efficient and even with the decrease in operating power due to lower pump pressures. Pulling power is oustanding.	Electric winches are better established in the marketplace and although not as efficient as hydraulic, work well and have served off-roaders for years.

to buy a winch plate and do the installation yourself. This is without doubt the most cost effective. An ideal plate for such an installation is Front Runner's winch plate. The plate is common to all vehicles, very strong and designed to restrict airflow as little as possible. The mounting brackets are vehicle-specific. The winch plate fits all common electric and hydraulic winches and just about every 4x4 on the market.

Front Runner winch plate with vehicle-specific mounting brackets.

Mile Marker

Mile Marker is the first commercially available hydraulic winch powered by the vehicle's power steering pump. It is modelled to fit most existing winch mounting brackets and bullbars. Like a conventional electric winch it has a clutch and can be operated in reverse. Two gear ratios permit rapid retrieval of the cable and higher pulling power than any drum winch available today. The cable is also thicker than that fitted to similar-rated electric drum winches. Pipes, valves and all fittings included and the price is comparable to the electric alternative. Once sold only by Safari Centre, Mile Marker is now available at all 4x4 equipment outlets.

Superwinch

Famous for their contribution to the Camel Trophy, Superwinch make a range of 22 hydraulic and electric winches although the brand seems poorly supported in Southern Africa. For this reason only the Camel Trophy 'Husky' model is featured here. Superwinch's vehicle recovery winches feature a slower retrieve than others, making them more suited to heavy-duty use. Superwinch are manufactured in Connecticut, USA, and Devon, England.

Ramsey

Ramsey electric drum winches are manufactured in Tulsa Oklahoma, USA. The range is the broadest in the business, from the Standard Duty REP series, Performance Duty PRO series and worm geared Heavy Duty RE series. All winches are supplied with a fairlead, remote switch, battery cables and mounting bolts. Ramsey is sold by many off-road equipment suppliers.

Warn

Warn electric drum winches are made in Milwaukee, Oregon, USA and are one of the top selling winches in the world. They are reliable and easy to service, which needs to be done fairly frequently if the winch is well used or has been immersed in water. The solenoids are either integral with the winch or housed in a separate box. Supplied with fairlead, remote, cables and mounting bolts.

Warn also produce the Multi-Mount system which consists of the winch frame and the front receiver, which are sold separately. The winch frame plugs into any standard 2" class-3 receivers which give the added option of winching from the rear and are available for many vehicles. It is suitable for M5000, M8000, X8000i and XD9000i models.

MILE MARKER 2-SPEED HYDRAULIC	
Pulling power (kg) low gear	4772 at 1500psi with a flow rate of 4GPM
Pulling power (kg) high gear	727 at 1500psi with a flow rate of 4GPM
Amp draw at full load	2 amps
Gears	3 stage planetary
Rope	30metres/9,5mm diameter aircraft wire rope
Motor	Uses vehicle's power steering pump
Gear ratio	6:1
Weight	approx 30kg
Drum diameter/length	n/a
Dimensions (LxDxH) mm	550x160x230
Switchgear	separate valve and socket

SUPERWINCH HUSKY (CAMEL TROPHY MODEL)	
Pulling power (kg)	3863
Amp draw at full load	360 amps
Gears	worm
Rope	38metres/9mm diameter aircraft wire rope
Motor	1,9hp 12-volt DC electric
Gear ratio	294:1
Weight	43 kg
Drum length	225mm
Dimensions (LxDxH) mm	618x233x247
Switchgear	integral

RAMSEY REP 5000/PRO 5000	
Pulling power	2260 kg
Amp draw at full load	230 amps / 220 amps
Gears	3 stage planetary
Rope	24metres/6mm diameter aircraft wire rope
Motor	1,3hp 12-volt DC / 1,4hp 12-volt DC
Gear ratio	294:1 / 210:1
Weight	27 kg/31 kg
Drum diameter/length	63mm / 140mm
Dimensions (LxDxH) mm	452x152x162/458x156x200 mm
Switchgear	separate housing / integral

RAMSEY REP 6000/PRO 6000	
Pulling power	2720 kg
Amp draw at full load	230 amps / 250 amps
Gears	3 stage planetary
Rope	30metres/6mm diameter aircraft wire rope
Motor	1,6hp 12-volt DC / 1,4hp 12-volt DC
Gear ratio	294:1 / 210:1
Weight	30 kg 33 kg
Drum diameter/length	63mm / 228mm
Dimensions (LxDxH)	540x152x162 mm / 545x156x204 mm
Switchgear	separate housing / integral

RAMSEY REP 8000 / PRO 8000	
Pulling power	3620 kg
Amp draw at full load	280 amps / 350 amps
Gears	3 stage planetary
Rope	29metres/8mm diameter aircraft wire rope
Motor	1,8hp 12-volt DC / 1,9hp 12-volt DC
Gear ratio	210:1
Weight	34 kg/ 38 kg
Drum diameter/length	63mm/228mm
Dimensions (LxDxH)	525x152x162 mm / 550x156x204 mm
Switchgear	separate housing / integral

RAMSEY REP 9000 / PRO 9000	
Pulling power	4070 kg
Amp draw at full load	400 amps
Gears	3 stage planetary
Rope	29metres/8mm diameter aircraft wire rope
Motor	1,9hp 12-volt DC electric
Gear ratio	138:1
Weight	42 kg / 43 kg
Drum diameter/length	63mm/228mm
Dimensions (LxDxH)	592x156x162 mm / 592x156x204 mm
Switchgear	separate housing / integral

RAMSEY RE 10 000 / REP 12 000	
Pulling power	4530 kg / 5440 kg
Amp draw at full load	390 amps
Gears	worm
Rope	30metres / 9mm diameter aircraft wire rope
Motor	2,5hp 12-volt DC electric
Gear ratio	470:1
Weight	59 kg / 61 kg
Drum diameter/length	89mm / 212mm
Dimensions (LxDxH)	565x273x260 mm
Switchgear	separate housing

WARN M12000	
Pulling power (kg)	5400
Amp draw at full load	400 amps
Gears	3 stage planetary
Rope	38metres/9,5mm diameter aircraft wire rope
Motor	2,5hp 12-volt DC electric
Gear ratio	261:1
Weight (kg)	62
Drum diameter/length	90mm/210mm
Dimensions (LxDxH) mm	620x220x280
Switchgear	separate housing

WARN M10000	
Pulling power (kg)	4500
Amp draw at full load	475 amps
Gears	3 stage planetary
Rope	38metres/9,5mm diameter aircraft wire rope
Motor	2,5hp 12-volt DC electric
Gear ratio	199:1
Weight (kg)	57
Drum diameter/length	90mm/210mm
Dimensions (LxDxH) mm	620x220x250
Switchgear	separate housing

WARN XD9000 / WARN XD9000i	
Pulling power (kg)	4100
Amp draw at full load	400 amps
Gears	3 stage planetary
Rope	30metres / 38 metres 8mm diameter aircraft wire rope
Motor	2,5hp 12-volt DC electric
Gear ratio	156:1
Weight (kg)	39
Drum diameter/length	64mm/230mm
Dimensions (LxDxH) mm	550x160x230
Switchgear	separate housing / integral

WARN XD8000i / X8000i	
Pulling power (kg)	3600
Amp draw at full load	423 amps
Gears	3 stage planetary
Rope	30metres/8mm diameter aircraft wire rope
Motor	2,1hp 12-volt DC electric
Gear ratio	216:1
Weight (kg)	34 kg
Drum diameter/length	64mm/230mm
Dimensions (LxDxH) mm	550x160x230
Switchgear	integral / separate housing

WARN M5000	
Pulling power (kg)	2200
Amp draw at full load	280 amps
Gears	3 stage planetary
Rope	24metres/8mm diameter aircraft wire rope
Motor	1,7hp 12-volt DC electric
Gear ratio	216:1
Weight	25 kg
Drum diameterre/length	64mm/230mm
Dimensions (LxDxH) mm	550x160x230
Switchgear	separate housing

WARN M8274 HI PROFILE	
Pulling power (kg)	3600
Amp draw at full load	435 amps
Gears	spur gear
Rope	46metres/8mm diameter aircraft wire rope
Motor	2,1hp 12-volt DC electric
Gear ratio	314:1
Weight	50 kg
Drum diameter/length	90mm/220mm
Dimensions (LxDxH) mm	420x220x390
Switchgear	separate housing

Hand winches

Relatively light and inexpensive and very versatile, hand operated winches are effective for situations where winching odd directions is required as the winch can be made to pull in any direction required. They can also double as a hoist. Hand winches need physical strength to operate and the pulling power can be sufficient for quite difficult pulling jobs. Some hand winches, such as the Turfor, are a favourite with hardened off-roaders as they are light and although not inexpensive are cheaper than drum winches. The steel cable on Turfor type winches needs to be stowed somewhere on the vehicle but because steel cable does not flex as easily as rope, it must not be kinked or crushed. This can be a problem if stowing it inside a vehicle and cable clamps mounted on a bush-bar or roof-rack are a better alternative. Turfors work by two sets of jaws biting the cable and pulling it through the winch. The cable must be well cared for as damage can cause the cable to slip. Should the cable need replacing, the diameter required by the winch is critical for it to work properly. The snatch block, described below, increases the pulling power of the hand winch.

RECOVERY ACCESSORIES

Equipment:

- *Spade*
- *Five-metre chain*
- *Gloves*
- *High-lift jack & jacking plate*
- *Q20 or similar*
- *Length of ski rope (safety line)*
- *Two large bow shackles for attaching straps.*
- *Two large D-shackles for attaching chains & straps to vehicles.*
- *Two small D-shackles for linking chain.*
- *Tree protector/ winching strap to attach to an anchor.*
- *Tuggum-strap for snatch recoveries.*
- *Snatch-block to increase winch pulling power or change direction of a pull.*
- *Sand ladders/PSP to assist self recovery.*
- *Winch (vehicle-mounted or portable, electric, hydraulic or manual).*

D-shackles and bow-shackles

When a link needs to be made between elements in the recovery operation, in most cases a shackle is the most suitable and reliable way to do it. Using the incorrect type of shackle can result in damage to the strap or a failure under stress. When selecting shackles for your recovery tackle don't be tempted to go the cheap route. There are some Chinese shackles which are a direct copy of some excellent English products but are not as strong.

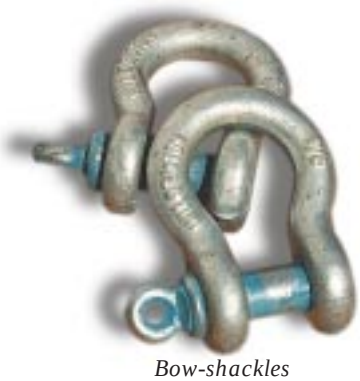
A recovery rig with multiple stakes. The more bits of chain, different sizes shackles and lengths of strap you have, the easier it is to construct a complex rig.

Working load markings

Quality shackles are marked with indelible information such as the safe working load, the maker's name and sometimes 45° marks. If there are no markings on the shackle it is probably inferior and cannot be trusted. The safe working load is the important bit of information. Decent sized bow-shackles are 4 $^{3}/_{4}$ tons. This means that the shackle's breaking load is 5,4 times that much. In the case of a 4 $^{3}/_{4}$ ton shackle the breaking load is 25,65 tons.

Important rules when using shackles:

- *When using a shackle for recovery operations, tighten the bolt and then loosen it by a quarter of a turn. This prevents damage to the thread and makes releasing the bolt easier.*



Bow-shackles

D-shackles

Clip-shackles are dangerous and must not be used for vehicle recovery.

My recovery kit and its components:

- *When using a shackle for a long-distance tow, hand-tighten the shackle bolt firmly.*
- *Good quality shackles rarely fail - they simply distort so that they are difficult to undo. It is normally the chain or tuggum that fails first.*
- *Shackles designed to snap closed are unsuitable for vehicle recovery as they are not strong enough and can fail even in light duty operations.*
- *NEVER use two shackles to join two tuggum straps together. If one strap should break the attached shackles become a deadly missile. Joining two tuggums together is illustrated later in this chapter.*

D-shackles are used in the following ways:

- *Joining sections of chain or attaching a chain to a vehicle.*
- *Attaching a snatch block to a vehicle.*
- *Attaching a chain to anchor/tree strap bow-shackle.*

Bow-shackles are used whenever straps need to be connected. The extra width of a bow-shackle prevents the strap from being crushed during maximum stress.

Bow-shackles are used in the following ways:

- *Attaching tuggum straps to chains and anchor straps.*
- *Attaching snatch-blocks to tree straps.*
- *Attaching tuggum-straps to vehicles.*
- *Always place the strap over the bow section and the chain or snatch block over the bolt.*

Towing rings and eyes

Off-road vehicles should have towing eyes at both front and rear for use during vehicle recovery operations. Do not attach towing lines to a bush bar or to any part of the vehicle body or steering mechanism. If there are no towing eyes, attach lines to suspension components such as spring shackles, but beware of sharp edges damaging the rope or cable.

Snatch blocks

A snatch block is a hook or eye attached to a large pulley wheel through which the winch cable runs. A snatch block effectively gears down the pulling power - it doubles the pulling force at half the speed and is used in conditions where the winch power is insufficient for the task.

The following uses and advantaged are associated with using snatch blocks:

- *Doubles pulling power.*
- *Winching from difficult angles.*
- *Overheating of electric winches reduced.*
- *Current draw is reduced and are therefore kinder to batteries.*

Rings and eyes

All off-road vehicles should be fitted with numerous easily accessible towing eyes for vehicle recovery and winching. Factory fitted towing eyes are suitable for light and medium duty towing operations. They are not designed for use with tuggum straps. Therefore when a tuggum strap is used, both towing eyes must be used. This is illustrated in a later chapter on vehicle recovery. The correct alternative is to fit heavy-duty towing attachments.

Familiarise yourself with the location of your vehicle's towing eyes before venturing off-road. When a vehicle is stuck in deep mud, it can be difficult to reach towing eyes that are located far beneath the vehicle or low to the ground.

Spades/Shovels

A spade is not a spade when it comes to off-roading. Apart from it being the most important recovery tool, the spade must be designed right - garden spades work, but not nearly as well as those designed for the job.

Ideally, an off-road spade should have a cupped blade, more like a shovel, for removing mud or wet sand, for which a flat blade is very inefficient. A long handle will permit reaching well under the vehicle should it be caught on the axles or chassis but if it is too long it can be awkward. Collapsible camp shovels have handles far too short for digging out a vehicle. A pointed blade is better than square as it is more suited to digging sand from under a tyre and provides easier penetration. It should also be painted a bright colour because spades are often

The 4xForum off-road shovel - purpose designed for the job of digging out a vehicle. Available from Safari Centre stores.

left lying in the bush after a receovery operation and only found missing the next time someone gets stuck.

When selecting a spade consider the following:

- *Feel the weight. It must not be unnecessarily heavy.*
- *The length should be sufficient to dig under a vehicle.*
- *Fold-away type camp shovels are far too short and make removing material from under a vehicle almost impossible.*
- *The blade should be a shovel-shaped. A flat blade is far less effective. The blade must not be too big - this adds weight and makes clearing under a vehicle more difficult.*
- *Fancy materials such as stainless steel are pointless - a spade is a spade, not a work of art. And, they get lost.*
- *Find a way of attaching your spade in a convenient place. Front-Runner make a nice roof-rack mount. Place the shovel on the side near the front of the rack so that the curve of the blade bends around the front corner. In this way it will not be caught by bushes that pass close to the vehicle.*

Loose-fitting leather gloves are essential equipment for all off-roaders.

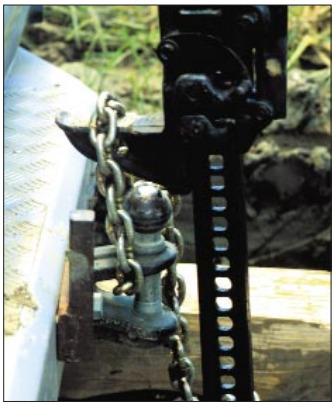
Gloves

Gloves are a major asset to the off-roader and when a recovery operation begins, put on a pair of loose-fitting leather gloves. They help prevent possible injury when handling winch cable, can prevent serious injury when working at the winch and when sand ladders and jacks get hot under the desert sun they are a big help. They are also very useful in preventing blisters when digging and oily hands when jacking.

Anchor straps are usually 3 or more metres long and are used in some way in most winching operations.

Anchor straps/Tree protection

When using a tree as an anchor, cable or chain will cut into the bark and this could kill the tree. To protect it use an anchor strap. They are best made from polyester and must have no stretch. Purpose-made anchor straps are available from 4x4 equipment outlets. This can be said to be an essential piece of equipment and is used in a multitude of ways in all kinds of recovery situations.



One of a hundred and one uses for a length of chain.

Chains

Carry a length of chain in your recovery kit. Chains are an excellent addition to the complete recovery kit and a length of two metres is sufficient for most jobs. They are particularly useful for attaching straps onto vehicles not well equipped for off-road recovery. An ideal chain is one with an 8000kg breaking strain, electroplated with grab hooks attached to both ends. The chain can be folded back

on itself, and the grab hook hooked to any link, thereby shortening the chain to the desired length. Spanset make them. Makro sell them.

Use and care of chains:

- *Do not shock-load a chain as this weakens the links. Normally a weak link goes undetected until it fails.*
- *Keep away from sharp edges when under load.*
- *Do not let a chain kink.*
- *A knot in a chain weakens it dramatically.*
- *To prevent rust, clean the chain in soapy water, allow to dry in the sun and then apply a light coat of Q-20 or similar before storing in a canvas bag.*
- *Galvanised chain should be selected in preference to untreated mild steel.*

A simple safety line is created by winding a snatch strap over the cable. Should the cable break the extra weight and drag will bring it down quickly and safely.

Safety lines

A safety line must be considered whenever a recovery operation is set up. The purpose of a safety cord is to prevent a missile being created by anything in the recovery tackle breaking. Laying a blanket or towel, or rolling a strap around the cable is quick and easy.

Tyre chains

Chains linked to form a ladder and wound around each tyre are particularly useful when driving in snow or very thick mud. The diamond style of chains are the best. Drive onto the chains attaching the inside chain first. Drive the vehicle five car lengths and then re-tension them if necessary. It is a good idea to practice fitting tyre chains before departing because fitting them in ice and snow conditions is messy and awkward without practice. You will need a pair of gloves to fit chains. Do not fit chains to the front tyres alone - driving like this can be very dangerous because the inferior traction on the rear wheels tends to make the vehicle spin at the slightest provocation.

Tow bars

Tow bars are designed and fitted for towing trailers and must not be used for vehicle recovery. Original vehicle manufacturer tow bars are generally stronger than those fitted by tow bar fitment centres, but as a tow bar should never be used for anything but light-weight towing and recovery operations a tow bar must not be considered as a primary recovery attachment.

TUGGUM / SNATCH / KINETIC STRAPS

Tuggum straps are elesticised towing straps used to extract a vehicle by another vehicle. Because of the stretchability of tuggum straps the tow vehicle can move under power and 'jerk' the vehicle from its bogged predicament. Off-roaders use tuggums as the first option when debogging a vehicle. This is the lazy way out because:

1. Tuggums are dangerous. One mismatched component of weak mount can be disastrous. Tuggum straps have killed people.

2. Tuggum straps have a limited life and are expensive. Depending on the load, about twenty pulls and a strap becomes 'stretched out'. Using it for tuggum operations after this is extremely dangerous. The stress is absorbed by the stretch. No stretch=major stress.

Selecting a tuggum strap:

- *Don't go a cheap route.*
- *Protective sleeves on the end loops are a good idea especially if they slip, or better, if they can be removed easily for cleaning and replacement.*
- *Breaking strain rating is important but know the weight of your vehicle. When fully loaded, a vehicle may weigh 3000kgs. A breaking load factor of four should be estimated. Therefore: 3000x4=12000kgs minimum breaking strain is required.*
- *A stretch of 20% is sufficient. Most good straps have a rating of 20-30%.*
- *Tuggums should be more than six metres long. The longer the strap the higher percentage the stretch and longer the working life. Eight or nine metres is ideal.*
- *Buy all the attachment accessories you need to avoid having to jury-rig equipment not designed for the job. When breakages occur it is more often attachments. Buy the best quality gear.*

Tuggum straps are unpredictable:

- *The actual stretch is determined by many factors: moisture content of the air, previous pulls and their loads, the time the strap has had to rest, how well was the strap cleaned.*

Top: SpanSet heavy-duty strap - an excellent performer.
Next down: ARB is one of the better straps is rated at 25% stretch.
Next down: Warn heavy-duty strap is rated at 20% stretch.
Bottom: Locally produced cargo-carrying strap sold as a tuggum. At best they have about 10% stretch and are unsafe for tuggum operations.

Bogged on a beach with an incoming tide, work fast as a tide rises deceptively fast. Have a wide range of equipment; for example two sizes of shackles for chains and straps. A poor selection or badly cared for equipment can cost a vehicle in situations such as this.

- *An average strap doing one hard pull stretching to its full capacity needs between 6 and 24 hours to recover (contract to its original length) Time needed depends on previous work load. A newer strap recovers faster.*
- *When a strap stops recovering fully - to within 90% of its original length it is 'tugged out'. Using it as a tuggum and relying on its stretch, which at this point may be as low as 5%, is dangerous. The strap is now good as a pull strap. It can also be used as a winch strap but the small amount of stretch left in it may not be ideal.*

More facts about tuggum straps:

- *Genuine tuggum straps (those made for the job) are polyamide, not polyester.*
- *Cargo carry straps (broad green straps) sometimes sold as kinetic straps are often not suitable and when used shock-load the vehicle and attachments.*
- *The more moisture, the longer the stretch but the breaking strain is decreased.*
- *Sand and grit in the webbing accelerates the wear and decreases the breaking strain.*
- *Tuggums with a built-in indicator filament (a strip of coloured material is woven along the length of the strap. When it breaks the tuggum is 'stretched out") have been outlawed in most countries. The system is unreliable and must not be trusted.*
- *Tuggum straps cannot be told apart from non-stretch straps unless they are labelled. Using the wrong strap could be disastrous. Novices beware. Only experts in polyamide technology would be able to tell the difference by just looking.*

JACKS

High-Lift

The high-lift jack is the most useful off-road tool available. It is an indispensable and highly versatile device but can only be used if a strong vehicle jacking platform is available. Working four-wheel drive vehicles should have adequate bumpers for this, but unfortunately most modern 4X4s do not. Rear tow bars make good jacking points but on the front end of most vehicles there is nowhere to use the jack. The cure is simple: have your off-road equipment outlet fit them for you. Armed with a spade and a high-lift jack, in most cases, you are better equipped for the unexpected than a vehicle equipped with a spade and a winch.

There are a number of manufacturers of high-lift jacks, but the original American-made Hi-Lift has proved itself time and time again to be the best. In most cases high-lift jacks are carried on the outside of the vehicle and dust clings to the oily lifting mechanism, which causes it to jam. Q-20 or a similar spray lubricant must be used to free the mechanism before it is used. But take care: this can cause the formation of a mixture of dust and oil - a grinding paste which quickly wears the components. The only way to prevent this is for the jack to wear a jack-nappy when in transit. Alternatively wrap the mechanism in cling film and secure it with tape or a rubber band and lightly oil the shaft immediately before use.

A jack-nappy protects the moving parts from dust. When dust clings to the grease, the grease turns into grinding paste, damaging the jack when it is used.

Air/Balloon jacks

These are large polyurethane bags placed under the vehicle and inflated by exhaust gas to lift the vehicle so that objects which aid traction can be placed under the wheels. Balloon or air jacks have some disadvantages off-road and are not as versatile as the high-lift. They are nevertheless quick and easy to use and do not require much physical strength to operate. advantages and disadvantages are listed on the chart on the previous page.

Balloon jacks come in various sizes and colours. The strength of the top and base are important as thorns, sticks, bolts and hot exhausts can cut through and render the jack useless.

COMPARISONS: HI-LIFT JACK VERSUS BALLOON JACK	
BALLOON JACK	HI-LIFT JACK
Can be used with almost every vehicle	Can only be used with vehicles fitted with suitable bumpers or add-on jacking points
Does not require jacking plate	Jacking plate required on soft ground
Very easy to use effectively	Requires familiarisation in order to use effectively
Safer. A vehicle cannot easily fall off a balloon jack unless it is punctured in which case it pops like a balloon and the vehicle falls heavily.	Can be dangerous in many ways: Unstable, jacking arm can spring up and injur.
Not suitable for repair work under vehicle	Not suitable for repair work under vehicle
Can be used for 'jack and pack' technique	Can be used for 'jack and pack' technique
Cannot be used for 'jack and push' technique	Ideal for 'jack and push' technique
Not versatile	Extremely versatile can be used for winching, lifting, pushing, clamping and many other less obvious purposes
Subject to puncture by stones, thorns and hot exhaust. Rendered useless if there is even a small hole in the exhaust system. Can roll over during lift and get punctured	Reliable if kept well lubricated
Dust does not affect operation	Dust jambs mechanism. Lubrication solves this problem
Reliant on the engine to operate	Independent power source (biceps and back muscles)
Small punctures can be repaired	Spare parts readily available. Simple to repair and maintain

Bottle jacks

These are available in a very wide range of lifting capacities from one to 15 tons and over. Bottle jacks tend to be rather tall so before you set off on your safari, simulate a puncture by releasing the air out of one of the rear and one of the front wheels and make sure that the jack fits under the axle now that the tyre is flat. Bottle jacks must be upright to work and periodically need topping up with hydraulic fluid. To jack up a fully loaded 4x4 you will need one with at least a five-ton capacity.

Upright Screw-thread jacks and scissor jacks

These are sometimes supplied with a vehicle as standard jacking equipment. Those that resemble bottle jacks are worthwhile although a little tedious to operate. Some designs are intended to work on one specific vehicle only. The screw threads must be kept clean and well oiled to prevent jamming by dirt and dust. Unlike a hydraulic jack they function at any angle, which is useful when using the jack to straighten bent bodywork.

Scissor jacks are generally unsuitable for off-road use, as they jam easily as dirt clog the threads and are unreliable and break in heavy duty use.

Jacking plates

When using a jack, other than a balloon jack, on soft ground something to prevent it from sinking while the vehicle is being raised has to be used. A steel or thick wooden plate approximately one foot square, preferably with lugs attached to its surface to prevent the jack from slipping sideways, is ideal. A heavy wooden laminated bread board with large wood screws to act as lugs is easy to make and works well. An even cheaper jacking plate can be made from two square 16mm pine boards. Laminate them together with a waterproof wood glue, making sure that the grains run perpendicular to each other. As a last resort the spare wheel makes a very effective, if cumbersome, jacking plate.

When using a regular bottle jack a wood block about 45mm thick can be very useful as a jacking plate, and also for when the bottle jack is used in awkward predicaments, for example when the maximum stretch of the jack is not sufficient. It is also very useful when the bottle jack is used to aid vehicle recovery. This happens when the jack is made to lift an individual wheel so that a more tractable item can be slid underneath or digging can take place.

TRACTION AIDS

Traction aid encompasses purpose made articles that are placed under the wheels to aid traction. The are made from plastic, rubber, steel or alloy. Some work, others don't.

SAND LADDERS/PSP/TANK TRACKS

Sand ladders, perforated steel plate (sometimes made from aluminium) and tank tracks are all used as traction aids for vehicle recovery. They are used to pack under wheels in slippery or loose ground to aid traction. These are lengths of galvanised steel or aluminium ladder or perforated plating, generally one to two metres long, that have been used by civilians and the military for years. Their design has changed little and they are bulky, heavy and awkward to use. They are effective in mud and sand. There are some modern and cheaper equivalents made from steel and alloy that look like ladders. These are similar in effectiveness but often easier to stow and lighter.

Flexible alloy trac-mats.

Perforated steel plate.

Flexible sand ladders, called Trac-mats are more effective than traditional rigid types in most situations. Each section of the track is pressed with sharp projections that increases grip and they work in clay mud as well as in sand. Being flexible they tend to mould into the ground. Because of this less digging is required to

lay them and they do not kick up and damage the vehicle as sometimes happens with rigid types. They are also compact, easy to stow - in fact, in most respects more versatile than rigid ladders. Use gloves when handling sand ladders to prevent pinched fingers (flexible types) and burns (hot climates). Both perforated steel plate and flexible ladders offer excellent grip either wet or dry and are equally effective in sand and mud.

RUBBER MATS

Lengths of rubber mat normally used as industrial flooring are being sold as debogging aids with varous names. They are cheaper than metal, fairly effective in sand but utterly useless in mud. Rubber does not grip on rubber when wet.

PLASTIC CLIP-TOGETHER

Half-metre lengths of moulded plastic ladder clip together to make a traction aid as long as you like are a good idea and work fairly well. Grip in wet is okay but good in the dry. When it gets very muddy the plastic edges designed to grip the tyre are too small and quickly disappear under a coating of mud. At this stage tyres spin with little grip. They are also made too narrow. In wet conditions they must be anchored to be effective.

STEEL LADDERS

Many off-road workshops fabricate simple steel ladders as traction aids. They are cheaper than PSP or Trac mats but most seem to suffer in the same way - when they get muddy tyres lose their grip.

COMPARISONS: RIGID PLATE (PSP) VERSUS FLEXIBLE SAND LADDERS (TANK TRACKS)

RIGID LADDERS	FLEXIBLE 'TANK TRACKS'
Bulky to transport. Must be periodically flipped over so that a bend does not set in.	Folds up and easy to transport Do not distort easily.
On uneven ground plates tends to kick up and hit the vehicle	Excellent for uneven ground as the flexible tracks conform to the shape of the ground
Versatile in that they can be used as a short bridge when strapped together	Cannot be used as a bridge
PSP plates are shorter than tank tracks	Added length aids recovery

GOLDEN RULES OF VEHICLE RECOVERY:

- *Stop spinning your wheels the moment it appears you are stuck. Trying too hard only makes things more difficult. Each unnecessary rotation of the wheels only digs you in deeper.*
- *Establish if any part of the vehicle's weight is resting on anything other than the wheels. If so jack up the vehicle and correct this first.*
- *Take a close took at all four wheels and establish which one is halting progress. Work on this wheel first.*
- *Take a second look at each wheel. Any other wheels that do not have a clear path ahead of them must be worked on next.*
- *Do not be tempted to try to drive out after a half-hearted attempt to de-bog a vehicle. Failure means that all the work done the first time will have to be redone.*
- *Should your initial attempts fail, stop, have something cool to drink and try to analyse why the vehicle cannot be freed. Logic and common sense are your allies - use them.*
- *Use all the resources at your disposal. These include all areas behind or in front of the wheels that are firm (push the vehicle in that direction), a slight slope (gravity can be a major ally).*
- *Look out for things that will hinder progress. These include a slight slope (gravity can also be an enemy), front and rear wheels dropping into a ditch simultaneously (arrange things so that wheels drop alternately).*
- *Your equipment can be used in more ways than meets the eye. Adapt them to your needs.*

The use of tow bars for vehicle recovery

NEVER use a tow ball with a winch or snatch strap. Imagine the tow ball snapping during a snatch operation or during heavy winching! I heard a story of a Range Rover winching out a badly bogged vehicle. The driver correctly insisted that his passenger leave the vehicle and stand well back. The winch cable was simply hooked over the tow ball of the stuck vehicle. At maximum stress the tow ball snapped and the cable with the round ball attached tore through the Range Rover, cutting through the roof and splitting the front passenger seat in two. The Range Rover was declared a write-off. Because of other precautions taken nobody was hurt. Tow balls are mild steel - not the correct material for high-stress pulling. The only time a tow ball can be used for vehicle recovery is if

If you have a 4x4, remove the standard tow hitch and fit one designed for the job. The type above can be used for towing AND recovery.

The best and worst vehicles, and novice and expert drivers get stuck - there is no shame in it. In fact experienced drivers get stuck more often because they are more adventurous - it is the only way to get experienced.

one vehicle is pulling out another from a static start. (Non-inertia pulls. Recovery is dependent upon the traction of pulling vehicle only)

Using a spade

Using a spade to dig out a vehicle may appear common sense, but there is more to it when in the field. Bear in mind that in 90% of all recovery operations some digging or clearing of the path in front of the vehicle should be undertaken. In many cases a little digging is all that is needed.

On the beach

Assuming that the tyres have been deflated to the required pressure, bogging on the beach can easily be overcome with a little digging, as long as the driver hasn't got the vehicle in so deep that the axle is buried and the vehicle has grounded. Once the vehicle has stopped, dig out a good measure of sand from all four wheels and attempt to reverse out. If this fails and a tuggum or winch is to be used, always clear a path with your spade.

Over-extended axles

Over-extending the vehicle's wheel articulation, creating a situation where a wheel has no weight on it, is a common way of getting bogged. The most common practice is to place material under the spinning wheels. This is far less effective than digging under the wheel in the opposite corner which has the most weight on it. By doing so you are reducing the required axle articulation. In effect you are placing the vehicle's own weight on the wheels that are airborne and spinning.

Hung-up

When a vehicle attempts to traverse uneven terrain and exceeds its break-over angle and the chassis between the front and rear axles touches the ground the vehicle has 'grounded' or is 'hung up'. This is very much an unforgivable situation because the cautious driver should have had someone marshalling the obstacle from the outside who could warn of impending disaster. The recovery procedure is to dig away the ground from under the vehicle or to raise the vehicle with a high-lift jack and place material under the wheels. Do not climb under a vehicle supported only by a high-lift jack.

Although there are rules and guidelines for vehicle recovery, no two recovery operations are the same. Ingenuity, common sense and a wide range of equipment are needed for most recovery situations. However, safety must be first priority. Don't create campfire stories by being injured or killed by shortsightedness or carelessness.

Direct pull

One vehicle pulling another using a non-stretch rope or chain will require good traction to be able to exert a meaningful pull. A four-wheel drive will easily spin its wheels on firm gravel or sand even if pulling a vehicle that is only lightly bogged. When attempting a direct pull, always look for an advantage, like a slope or a surface where the wheels will get a better grip. Be careful that the recovery vehicle does not bog down while attempting the recovery.

THE USE OF WINCHES

Winches are potentially hazardous. Study these key points:

- *Place a single individual in charge of the winch. This person will be the ONLY one to use the switch - and the ONLY one handling the recovery of the winch cable once the winching operation is complete. This is done to prevent anyone losing fingers - a common injury when the cable handler lets someone else handle the switch.*
- *Before winching have everyone stand well clear. The slingshot effect caused by a cable break under load can cause serious, even fatal, injury.*
- *Wear gloves when handling winch cable and use a cable guide when feeding in loose cable.*
- *The winch cable should be cared for and wound neatly on the drum under tension.*
- *Always have five turns of cable wound around the drum before winching. Less than five turns could mean the cable clamp on the drum coming undone.*
- *Never stand in the 'V' of a winching layout under tension.*
- *Never step over a strap or cable after it has been attached in a recovery layout, even when it appears to be lying harmlessly on the ground.*
- *Never hook a winch cable around an object and then back on itself. This is a common cause of cable breakages among the inexperienced. Anchor straps are used to prevent this.*

ANCHORS

Natural anchors

Natural anchors are anything that you find suitable to attach a cable to - trees, rocks and signposts (signposts on gravel roads are unreliable and pull out of the ground very easily) If you are going to use a tree as an anchor, protect the tree by using a tree-strap to prevent the steel cable from cutting into the bark as this can kill a healthy tree. Attach the strap as close to the ground as possible.

The strength of an anchor depends on how badly the vehicle is bogged and how much preparation is made before winching begins. Assess the strength of the anchor first - if it appears weak, then pre-preparation to the vehicle will need to be extensive. If the anchor is fool-proof, little or no preparation may be needed, and if winching fails nothing is lost and some digging and clearing can be done.

Have someone monitor the condition of an anchor during recovery. If it appears to be loosened by the winching, then halt the process before it is weakened further because even a weak anchor is better than no anchor at all. To put less stress on the anchor more clearing around the wheels and jacking must be done before further winching.

Man-made anchors

If there is no anchor to which a winch cable can be attached, a man-made anchor can be created. No made-made anchor of any reliability can be made without a lot of effort. Consider the alternatives - what is the effort and time likely to amount to, to create an anchor, dig a bit and then use the winch; or, dig a lot and maybe use a jack and then drive out. In very difficult situations all of these will be required.

Anchor construction tools:

- *Heavy hammer*
- *Iron standard/s or purpose designed stakes*
- *Danforth boat anchor/Pull-Pal anchor*
- *Chain, shackles and anchor strap*

If the vehicle is bogged down where there are no good anchor points, an anchor can be created.

Here's how:

- *Drive steel stakes into the ground at 45° and about one metre apart and then attach the cable to the stakes as close to the ground as possible. Create 'Vs' between the top and bottom of each stake. See photograph on page 194.*
- *Danforth-type boat anchors also work well if the ground is soft. This is because the harder the pull, the deeper they drive into the mud - in theory. The angle of pull must be as close to the ground as possible. Pull-Pal from Orvas (011 646 9708) is an effective anchor in soft ground. Both the Danforth and Pull-Pal are bulky and overly heavy for expedition use.*
- *A long length of chain run along the ground secured with ten or more long tent pegs. The more difficult the winching operation, the more tent pegs will be required. This man-made anchor takes little effort and if the vehicle is not deeply bogged it is a quick and effective way of creating a light-duty anchor.*
- *As a last resort a spare wheel can be buried either horizontally or vertically which is the more conventional but less effective way. The winch cable is passed through the middle of the wheel and attached to a steel bar (use a power bar or a heavy wheel spanner). After burying the spare wheel, dig out from under the vehicle making sure that no soil is supporting the vehicle's weight. This is a last resort because burying the wheel is hard work and despite perserverance it is often a waste of time.*

Danforth boat anchor

Remember: the harder the effort put into an anchor, the better its effectiveness. Before using your man-made

anchor - which under most conditions will be suitable only for a light-weight pull - dig out channels in front of all four wheels to allow easier forward movement. Do not be in too much of a hurry when preparing the anchor or digging out soil from under the vehicle. If you try to winch before you are absolutely ready, you may fail - and have to go through the entire process again. Once you are ready to begin winching, aid the process by having everyone not directly involved with the winching pushing the vehicle. Engage low range second and apply as little throttle as possible. Do not permit the wheels to spin.

Winching in deep cloying mud

Mud can sometimes be the most difficult stuff. When it is particularly thick it creates a vacuum under a vehicle and no matter how much winching and heaving, the vehicle just won't move. When this occurs the vehicle's progress is halted as much by the lack of traction as by the vacuum. Here a combination of high-lift jack and winch is required.

This is the way to go about it:

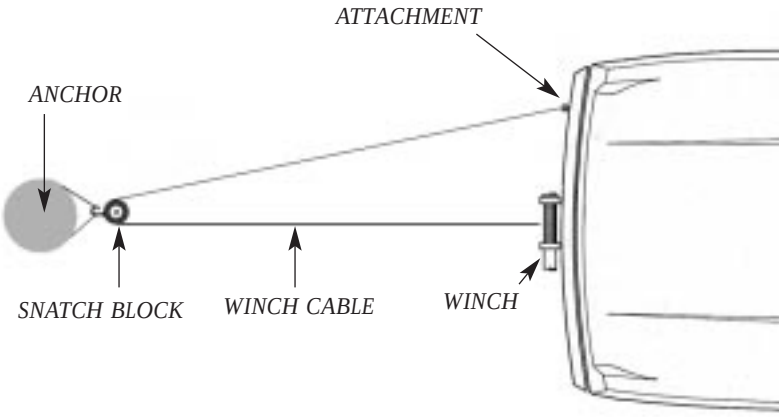
Place the jack about a metre in front of the bogged vehicle and lift up the jacking step to shoulder height. Run the winch cable over the jacking step to the anchor. Tilt the jack away from the vehicle and take up the tension. Now, with someone supporting the jack, begin winching in. As the cable is retrieved the jack is pulled upright, simultaneously pulling the vehicle forward and up, releasing the vacuum. Repeat this as many times as required.

The use of hub capstan winches

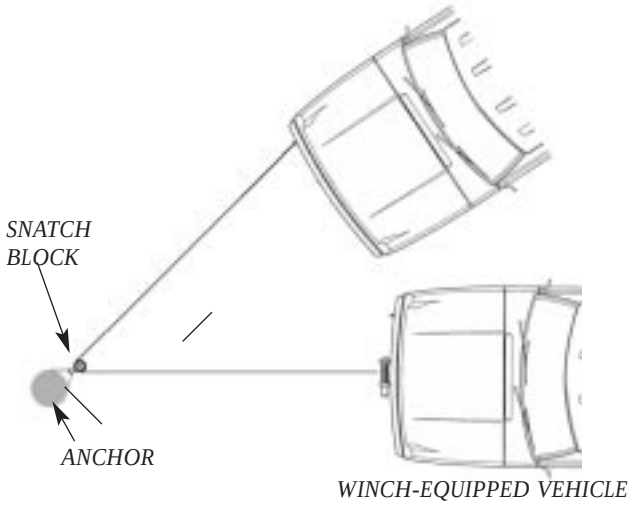
These simple devices allow the spinning wheels of a bogged vehicle to act as a winch. Hub capstans are attached directly to the wheel rim and a rope or cable is guided through a groove in the steel and secured with a knot or buckle. The rope should then be wound around the capstan at least five times, crossing over itself. The direction of wind and the gear selected (forward or reverse) will determine the direction of pull. Hub capstans on both wheels on the same axle must be used simultaneously as the axle differential will not allow winching on a single hub. Because rear half-shafts and differentials are generally stronger than those in front, it is recommended that the rear wheels are used for pulling. The vehicle must be engaged in four-wheel drive, hubs must be engaged and for those operating permanent four-wheel drive vehicles, the centre differential must be locked. Using hub capstans can damage the vehicle if the cables are allowed to get too short when the wheels are pulled together by the narrowing angles between the two lines.

Unfortunately no local manufacturers make hub capstans and the only vehicle I have ever seen them fitted to is a Land Rover.

USING A SNATCH BLOCK



CHANGING THE DIRECTION OF PULL



The winch cable is passed through the snatch block and is then returned and attached to a towing eye

THE USE OF THE SNATCH BLOCK

The snatch block is a heavy-duty single-line pulley. It is used to increase the pulling force of the winch or change the direction of pull.

Self-Recovery

During self recovery the snatch block is attached to the anchor. Run the cable from the bogged vehicle through the pulley and back to the vehicle where the cable is then attached. This is where dual towing eyes are very useful. Normal winching at half retrieval speed and double the pulling force is then performed.

Two-vehicle recovery

During two-vehicle recovery where the free vehicle's winch is used, attach the snatch block to the bogged vehicle. Run the cable from the winching vehicle through the snatch block and back to the vehicle where the cable is then attached to a towing eye. If your winch is rated at or under 6000 lbs pulling power, then it is very likely that a snatch block will one day be necessary.

If you have a winch fitted you will be in a good position to help another vehicle that has bogged down. This is where a winch is really useful.

To prepare for winching, follow this procedure:

- *If the area is slippery, anchor the winch-equipped vehicle by chaining it to a tree or by digging holes into which the front wheels will be driven. Alternatively, place wheel chocks in front of the front wheels.*
- *The line of the winch cable should follow the route that the bogged vehicle will move along when it is pulled out. If the winch is pulling from an angle, the winch cable will gather on the one side of the drum.*
- *Dig channels in front of the wheels of the bogged vehicle and remove any obstacles in its path.*
- *Once the stricken vehicle is attached to the winch cable and the cable is pulled taut, everyone should stand well clear.*
- *By opening the bonnet during the winching operation, the windscreen will be protected from damage should the cable break.*
- *The winching vehicle should have its engine running to keep the battery charged and the operator's foot should be on the brake.*
- *The driver of the bogged vehicle should engage low-range second and gently release the clutch as the winch takes up tension, rotating the wheels very slowly to assist the winch. Avoid spinning the wheels.*
- *When the vehicle is free, drive clear of the obstacle. Avoid driving over the winch cable.*
- *Where an anchor point is not in front of the bogged vehicle, or in the case of lack of space in front of a bogged vehicle in which to allow the winch equipped vehicle access, the snatch block is invaluable. Here the snatch block is used to change the direction of pull.*

Using a snatch block to pull a vehicle over an obstacle

If you wish to drive through very deep mud or climb a slippery slope and you suspect that your vehicle will not be able to do it without some assistance from the vehicle accompanying you, the use of a snatch block to change the direction of pull may be the solution. Attach the snatch block to an anchor on the other side of the obstacle. Run the winch cable from one vehicle, through the snatch block and back again to the second vehicle. As the second vehicle reverses on terra-firma it will pull the first up and over the obstacle. Now with one vehicle through, it can use the cable and pull the second vehicle directly towards it over the obstacle. No matter how easy the pull, always have a competent person at the wheel of the vehicle being pulled as in the event of equipment failure the driver must know how to stop the vehicle safely.

USE OF TUGGUM STRAPS

Tuggums or tuggum straps are dangerous but effective. Recently a woman passenger was killed when an attachment broke under load and the snatchum ripped through the towing vehicle. She was sitting in the passenger seat and the top half of the vehicle was cut in half. My own approach to snatch staps is that they must only be used for vehicles that are lightly bogged. This advice goes unheeded however, and it is only a matter of time before another victim falls to reckless use of snatch straps. Therefore, the rules below will not necessarily ensure safety but will go a long way toward it.

IMPORTANT RULES FOR USING SNATCH STRAPS:

- *Do not use the snatch strap if the vehicle is badly bogged i.e. with its weight resting on its chassis. Use a jack and spade to put the weight back onto the wheels first.*
- *The pulling vehicle must be similar in size and weight to the vehicle being pulled.*
- *The pulling vehicle must run in a straight line. Do not attempt to pull at an angle of more than 10°.*
- *Use bow-shackles to attach the snatch strap to the vehicles.*
- *Do not compromise on the security of attachment points. Use both tow eyes if the vehicle is fitted with them.*

The most important part of a tuggum layout - good, strong attachment points. This one is a rare find - a standard recovery point strong enough for tuggum operations on the back of the new Nissan Patrol

Using a snatch strap is straightforward: Attach the snatch strap to the front or back of the bogged vehicle. Do not select back or front without first considering which is the most effortless direction of travel.

Then follow this procedure:

- *Manoeuvre the recovery vehicle to the bogged vehicle and stop at a point no less than half the total length of the snatch strap.*

- *Attach the snatch strap to the bogged vehicle, making sure that there are no knots in the strap.*
- *Lay a blanket over the tuggum or attach a safety line (ski rope is ideal). In the case of the strap breaking the weight of the blanket will rapidly absorb the energy of the broken strap.*
- *With a go-ahead signal from the driver of the bogged vehicle, the recovery vehicle moves off at normal take-off speed in first gear. Accelerate very gently and keep the speed constant. As the pull of the rope is felt, try to maintain a constant speed and continue to accelerate very gently - it is not engine power and torque that is doing the work, but the vehicle's momentum and energy being transferred through the elasticity of the strap.*
- *It has been proven that speeding off in the tow vehicle does not increase the pull. It does, however, over stress the tuggum.*

Double tie a tuggum if possible. This reduces the likelihood of damage to the vehicle or breakage which can cause serious injury. Should a single towing eye, which is designed as a lashing point rather than a recovery point, be used for a snatch recovery it will probably break. If it does, someone is likely to get badly hurt. THE STRENGTH OF VEHICLE ATTACHMENTS FOR SNATCH OPERATIONS MUST NOT BE OVERESTIMATED. ALL SNATCH OPERATIONS ARE DANGEROUS.

Unfortunately, if the bogged vehicle is badly stuck, something will break. If it is an attachment it becomes dangerous to both bystanders and drivers.

Double tuggum-straps used together.

As we have discussed, having the towing vehicle move off with more speed does not increase the pulling force. Doubling the length of the strap together with a higher speed does, however, have the desired result. To do this a joint must be made linking the two straps. UNDER NO CIRCUMSTANCES join two straps together with shackles. Should one strap break the shackles become a deadly missile.

To make a safe join:

- *Pass the loop of strap A through the loop of strap B.*
- *Take a short piece of rounded and smoothed wood and pass it through the loop of strap B and pull tight.*
- *Using a rectangular shaped or rough piece of wood will damage the snatch strap.*

Safe use, care and maintenance of snatch straps

Never have a light vehicle try to 'snatch' a heavy vehicle that is deeply bogged. It may recoil and hit the bogged vehicle.

Case history: A Suzuki Jeep attempted to snatch a Land Rover Defender. The Suzuki took off at full speed from a distance of only about a metre from the Land Rover (which was the incorrect procedure anyway), The Suzuki came to the end of the stretchability of the strap and instead of the Land Rover moving forward the Suzuki recoiled and smashed into the Land Rover. Both vehicles, and the Suzuki driver, needed a lot of painful repair work.

Never have a heavy vehicle try to 'snatch' a light vehicle that is deeply bogged.

Case history: The SADF in northern Namibia some years ago used a military snatch strap, normally used to free armoured vehicles weighing up to 20 tons, on a deeply bogged Land Rover and an armoured troop-carrier was used as the tow vehicle. Instead of the snatch strap breaking, the Land Rover's chassis was torn from both axles, which remained firmly stuck in the mud.

Clean nylon straps with washing-up liquid after use. Dirt abrades fibres and speeds deterioration. Beware of detergents attacking the nylon. With extended use their stretchability deteriorates and they quickly become dangerous.

Measure the static length before use. Write it down. When the length of the strap has increased by 10% of its original length, it is no longer suitable for snatch operations. However, it still has many uses; long distance towing, extra long tree protector etc.

USE OF THE HIGH-LIFT JACK

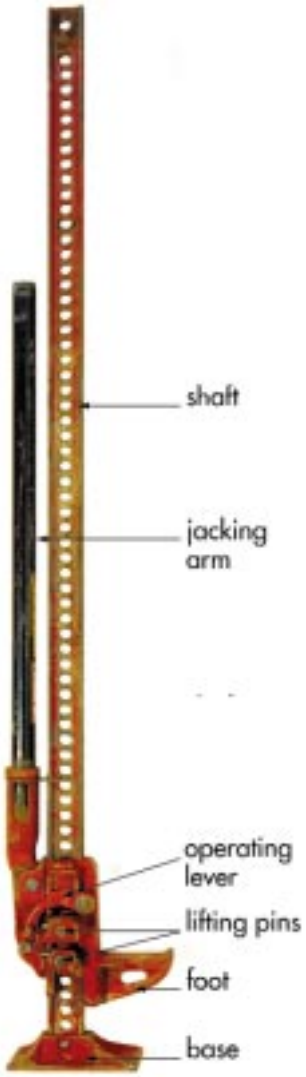
There are few bogging down situations that cannot be overcome with a high-lift jack, a spade and a strong back. The high-lift jack is without doubt the most valuable piece of equipment that an off-roader can carry. The jack discussed here is the American standard brick red-coloured unit that has been around for many decades. Although there are competitors' jacks on the market, the 'old favourite' is virtually unbreakable and as long as it is kept well lubricated it is reliable. Unfortunately, more and more 'off-road' vehicles are being introduced with fancy curved plastic bumpers - impractical for bush work because of the absence of points where a high-lift jack can be used. There are cases where a vehicle has bogged down so comprehensively that jacking has been the only way out. Personally I would not venture to a place like the Makgadikgadi Pans in a vehicle not suited to jacking with a high-lift.

The jacking mechanism is used in the following way:

To lift a vehicle:

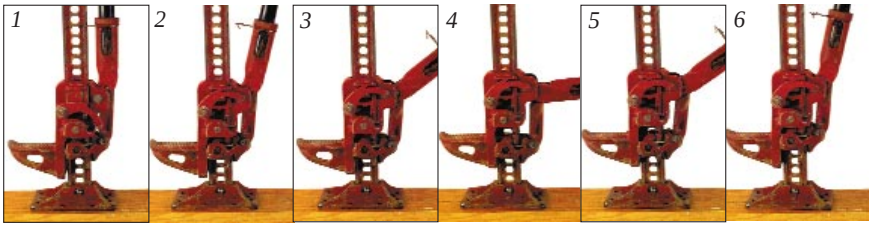
- *Stand the jack under the jacking point and push the operating lever (small L-shaped lever on top of the lifting mechanism) down.*
- *Raise the jacking arm to the upright position to hoist the entire mechanism up the shaft so that the jacking foot is positioned under the jacking point of the vehicle.*

- *Adjust the jacking foot position exactly. Once this is done pull the arm down, thereby lifting and firmly locating the foot under the vehicle jacking point. Should the position need changing, lift the arm and readjust. Once satisfied with the foot's position, lower the arm once again all the way down until the lifting pin enters the perforations in the upright shaft or 'ladder'. It will click into place.*
- *Lift the arm to the upright position until a click is heard.*
- *Pull the operating lever into the upper position. It will click into place. The jacking foot will be held at that height. The vehicle is ready to be lifted.*
- *Hold the lifting arm with both hands. Gripping it firmly, pull it down once again until the pin locates and clicks into place. Lift the arm to the upright position and the second lifting pin locates itself. Continue until the vehicle's wheel/s are off the ground.*



To lower a vehicle:

- *Raise the jacking arm to the upright position.*
- *Push the operating lever down.*
- *Gripping the arm with both hands, lower the lever so as to release the lifting pin. At this point the vehicle's weight is in your hands. If you do not have a good grip and your weight is pressing down on the arm it can shoot up and cause injury. Have bystanders stand well clear.*
- *From this point jack the vehicle down by lifting and lowering the arm to its fullest extent.*



WARNING

High-lift jacks can be dangerous.

The following simple safety advice must be heeded: when lifting or lowering a vehicle, hold the jacking arm firmly and with both hands. If released at the halfway point while under load it will shoot upwards with great force. It can smash teeth, cause concussion and the upward movement can release the lifting pin, causing the arm to drop by itself, starting an auto-jacking sequence which rapidly lowers the vehicle onto the ground. Once this auto-

jacking has started it is too dangerous to try and stop it running its full course. Holding the jacking arm firmly is especially important when lowering a vehicle.

When the jack is left unattended and under load, the jacking arm must ALWAYS be left in the upright position, clipped to the upright with the supplied wire clip. In any other position the jack poses a threat to anyone close to it.

High-lift jacks are unstable. Never climb under a vehicle that is supported only by a high-lift jack. If you need to dig under the vehicle, do what you can before you jack it up.

The following situations demonstrate how the high-lift jack can be used to extricate a vehicle:

Jack and push

Your vehicle is stuck on soft ground with the axles grounded on a ridge; or you have dropped into a gully and two or more wheels are off the ground and spinning. If the ground is soft, place the jack on its broad base and jack up the vehicle, high enough so that the one set of wheels is higher than the ridge on which the axle has been caught. Now push the vehicle sideways. The vehicle will pivot on the jack and land on the ground with the wheels on the ridge, thereby clearing the axle from the obstacle. In some situations you may need to do the same with the both axles. Vehicles with spare tyres attached to the tailgate may have to either remove them or swing them clear as the falling jack may catch on them and damage the vehicle bodywork. If they are removed from a separate wheel carrying frame, the frame can be closed and used to protect the rear of the vehicle from the jack during this operation.



Jack and pack

Quite often the ground under the jack is soft and slushy and in these cases the jack and push method is not effective - the vehicle topples off the jack, the wheels dig into the mud or sand and the vehicle settles back onto its chassis. In this situation the best course of action is to jack up the wheels that are the most deeply dug in. Once this has been done find something to place under them - sand ladders, trac-mats, carpets, rocks, branches or logs - in fact anything lying around (in wet mud, grass seems to make matters worse). Lie items in the direction of travel so that the wheels can gain some momentum as they ride over them. If all four wheels are deeply dug in, this must be done to all wheels.

Before attempting to drive out think about the gear ratio to use. Should you use a gear ratio that is too low, the result may be

wheelspin, and you may not only undo all your hard work but still have a bogged vehicle. Select the highest gear you think may work - try to remember the gear ratio that was getting you through difficulties beforehand, because once off the mats or logs you must be able to keep moving without a gear change. Selecting this gear ratio is critical and for each vehicle and for each situation it differs. The vehicle is then lowered and with everyone pushing, the clutch is let out gently with acceleration as smooth as possible. If the wheel spin occurs decelerate gently.

Jack & Pack - lift with the high-lift and then lay sand tracks under the front wheels.

High-lift winch

The high-lift jack can also be used as a hand winch. Heavy manila rope must be used (the stretch of nylon rope renders it ineffective)

Proceed as follows:

- *Remove the steel foot from the jack by sliding out the pin.*
- *Lay a length of rope from the bottom of the jack to the bogged vehicle. Do not attach it to the jack.*
- *Attach a cable or rope to the top of the jack and then onto the anchor.*
- *Position the lifting foot of the jack at its lowest position.*
- *Join a short length of chain to make a loop. Lay this loop across the rope at the bottom of the jack. Pass your hand through the loop and underneath the rope. Grip the chain and pull it through so that the chain loops around and grabs the rope.*
- *Using a D-shackle, attach the end of the chain you are holding to the hole in the base of the jacking foot.*

The jack is used as if lifting a vehicle. As the rope is pulled taut, the chain grips the rope. When the jack is at its highest point, slacken the rope and chain, slide the jack back down to its lowest position, slide the rope through the chain, and begin jacking again. Although it is a time consuming process, it is often successful when conventional winching techniques have failed.

Care of a high-lift jack

If carried on the tailgate of a vehicle, some method of preventing the mechanism being clogged by dust should be devised such as the jack-nappy, a washable nylon sleeve that covers the mechanism. The 'old favourite' is criticised by its competitors for jamming under load. It's a valid criticism and to prevent this the lifting mechanism must be clean and well lubricated. Have a can of Q-20 handy and at the first sign of slicking, give it a good spray. Despite this it remains, in my opinion, the best high-lifter on the market.

USE OF SAND LADDERS

An experienced driver would call for a sand ladder before too much digging is required. Four-wheel drive and hub locks should have been engaged long before sand ladders are needed.

If the vehicle has been allowed to dig itself in to the extent that the vehicle's weight is resting on the axles or chassis, a great deal of digging will be required. Do not dig a little and then attempt to drive out. This is a waste of time - if the attempt is unsuccessful the entire digging effort will have been wasted because the spinning wheels will replace the sand you have removed. Dig until you are sure that more digging would be a waste of time.

Dig channels in front of the wheels that appear to have the least traction and lie the ladders in front of them. If in doubt as to the wheels under which to lay the ladders, select the front wheels, since once the vehicle gets moving the rear wheels will also get the benefit of the extra traction (assuming you are driving out forward).

If in sand with the rear wheels sunken and the front wheels remaining clear, place the ladders under the rear wheels.

Dig out a channel in front of the other wheels so they do not have to roll over any ridges of sand that may have built up in front of them.

In very deep sand the sand ladders may get buried when the vehicle drives over them, so mark the position of the ladders with the spade.

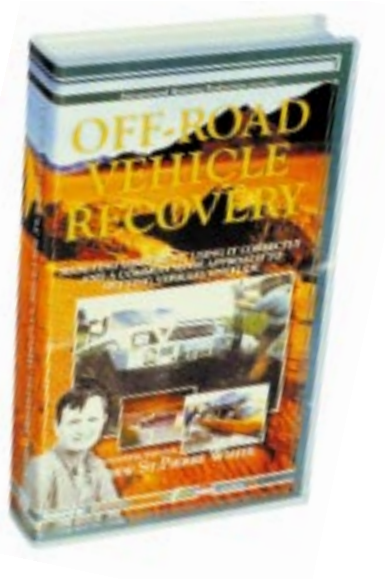
Unfortunately for those doing the pushing, this may mean a bit of a walk, as it is important for the vehicle to be driven to firmer ground before it is stopped. The sand ladders will have to be dug up and carried. Attaching a rope to tow them out is not wise as the extra drag can cause the vehicle to bog down again.

Not only men and machines are attracted by mud.

Always consider a push - its quicker to organise than a winch or tuggum.

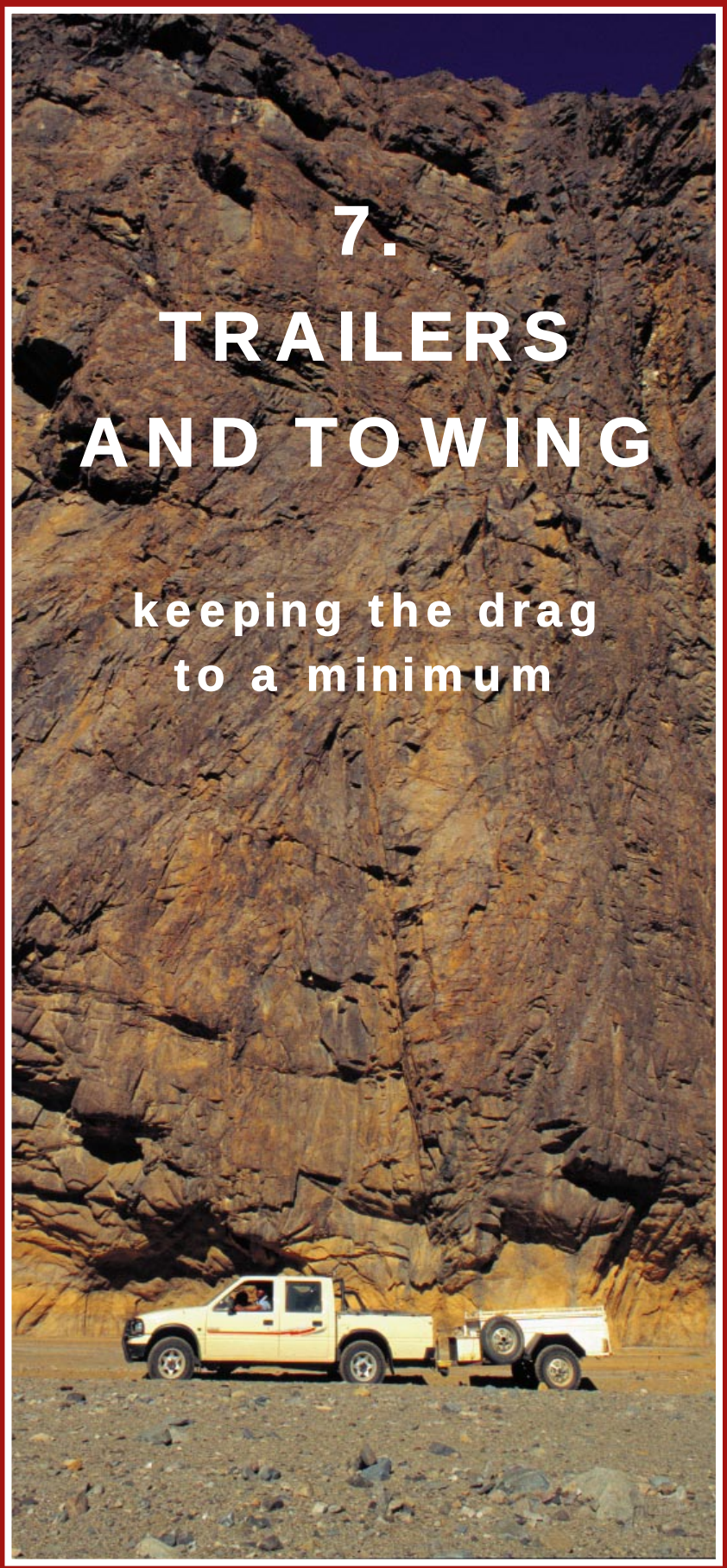
Off-Road Vehicle Recovery - Selecting equipment, using it correctly and a common sense approach to getting vehicles unstuck.

A sequel to the Driving a 4x4 video discribed on page 181 is the video, Off-Road Vehicle Recovery. Like in the driving video, I have attempted to explain off-road recovery in a simple but not simplistic way. The video explains all of the equipment needed, and wanted, and illustrates their use. Because all recovery situations are unlike any before, and after, it is a subject which creates much argument and comment. I have no doubt this video does it too. Because none of the recovery situations in the video were contrived, not everything works as planned - like the real world.



There we are, expecting everything to work as planned, and we end up trying four, five and six times to extricate a vehicle. The result is an understanding of how frustrating, rewarding and sometimes humerous off-road recovery can be. It will educate and entertain - this much I can guarantee.

It is 55 minutes long and is available at all major 4x4 outlets and good book stores, or by calling 021 785 5752.



7.
TRAILERS AND TOWING

keeping the drag to a minimum

Off-road trailers are a practical alternative to roof racks for carrying bulky safari equipment on overland trips. They must be designed and built to withstand extended outback travel - sand, mud, rocks, ridges and troughs and axle-cracking corrugations. More off-road trailer models are built in South Africa than any in any other country, most of which are well built and tough enough for such travel.

Trailers - their advantages over roof racks are:

- *Easier to load and unload, especially heavy items such as full jerry cans.*
- *Payload is significantly higher than a roof rack.*
- *They can be used for the permanent location of items such as a fridge.*
- *Trailers do not negatively effect the vehicle's centre of gravity.*
- *Extra equipment can be loaded onto the trailer lid which can also be used as a work surface.*
- *Packing and unpacking is often quicker than a vehicle.*
- *Built-in kitchens help take the chore out of camp cooking.*
- *Heavy stuff carried in the trailer can be left at 'base' while game driving and exploring.*

Their disadvantages over roof racks are:

- *More difficult to tow over loose and uneven surfaces.*
- *Experience required when driving off-road and reversing.*
- *Trailer can be a severe hindrance in any terrain where traction is a problem.*
- *A poorly loaded trailer can cause instability when cornering and braking.*
- *A trailer adds wear and tear to the towing vehicle, exaggerated when the trailer is badly loaded or when towed by inexperienced drivers.*

Off-road trailers are an alternative to roof racks for carrying bulky safari equipment. They do however have a serious effect on a vehicle's ability in difficult conditions

TOWING EQUIPMENT

Tow hitches

Beware of tow bars fitted by independent fitment centres. Four-wheel drive vehicles often stress their tow bars far in excess of what would be considered normal towing operations. Vehicle

manufacturer-approved towing devices are essential - do not fit any old tow bar that is available - you may live to regret it.

- Towing off-road stresses a tow bar far more than ordinary towing.
- Tow bars are sometimes used for vehicle recovery, although this is very unsafe and ill-advised.
- Off-road trailers are bigger and heavier than the average family man's little 'Venter'.
- When considering a tow bar; if the one being offered looks similar in strength to those fitted to a normal road car then it is not strong enough for your 4x4.
- Broken tow hitches occurring in the wilderness are not uncommon and depending where the breakage occurs, it can be difficult to repair without welding equipment.
- The standard 50mm tow ball is rated to a maximum 3500kg trailer weight. This rating is calculated for towing on a paved surface not over rocks or in heavy sand.
- Maximum permissible weight on a standard 50mm tow ball is 150 kgs. This is often exceeded when towing off-road.
- When calculating how much weight the vehicle can carry after the trailer is hitched up, double the tow hitch weight and deduct that from the vehicle's carrying capacity.

Ideal vehicle - trailer combinations

- *Long wheelbase combined with short rear wheel-to-tow ball distance makes for a stable tow vehicle.*
- *Short rear wheel-to-tow ball distance with long trailer tow hitch to axle distance improves stability.*
- *Trailer's vertical C of G must be less than 40% of the trailer's tow hitch to axle distance.*
- *Short vehicle wheelbase or short rear wheel-to-tow ball distance combined with long trailer tow hitch to axle distance make for easier reversing.*
- *Vehicle tow ball height must equal trailer tow hitch height when trailer chassis is horizontal. Essential when towing twin-axle trailers.*
- *Mud flaps must be fitted to the rear of the tow vehicle to prevent damage caused by flying stones.*

Off-road trailer design

Choosing an off-road trailer is not easy because those produced in South Africa are all so similar that no single trailer stands out as the best. Some are advertised as the 'best' purely because the list of auxiliary equipment available is the most elaborate or that the materials used in their construction are the most expensive. Do not let this cloud your vision.

At the risk of incurring the wrath of designers and developers of off-road trailers I will attempt to guide you as to what is important and what is gimmickry when it comes to off-road trailers.

Suspension and chassis

The type of suspension is critical to the success of an off-road trailer. Trailers tend to bounce around a great deal so it must be built to withstand severe punishment. Suspension types range from torsion

bar to leaf spring. Torsion bar suspension is NOT AN OPTION and fails in off-road use. Leaf spring fitted with shock absorbers are the strongest and appear to work the best. Check where the springs mount onto the chassis - this is where breakage occurs and it must be reinforced. The chassis should be a rigid steel frame, preferably using steel tube and not chanelling, extending all the way to the rear spring shackles. Springs mounted directly onto a stiffened loadbox are rarely strong enough. Breakages also occur at the joint between the A-frame and the loadbox and this should be reinforced. The trailers's tow hitch must be attached with high-tensile steel bolts. Mild steel bolts are not strong enough. Check your trailer's bolts and change them if they are mild steel.

There is some contention when it comes to shock absorbers fitted to leaf spring-sprung trailers. I recommend their use for two reasons; shock absorbers reduce bounce and reduce shock loads to the axle. I have witnessed the performance of trailers fitted with high quality shock absorbers and I recommend their use. Vertical wheel travel is of little importance in trailer design but the ability of the axle to absorb shock and not bounce is.

Wheels and tyres

To improve stability on bush tracks the wheel track should closely match the towing vehicle's. To avoid having to carry spares specifically for the trailer and to allow its wheels and tyres to be interchangeable with the vehicle's, they need to have interchangeable wheel rims with identical tyre diameters.

However, trailers with wheels that have a larger diameter than the vehicle's will pull better through sand. If you can carry a spare specifically for your trailer, fit over-sized wheels and tyres on the trailer. These tyres can then be deflated to pressures below that of the vehicle and the trailer will cause far less drag.

Materials used

For the chassis rails and draw bar three or four millimetre steel channel or tube is sufficient. For the body, 1,5 or 2mm mild steel or stainless steel plate is adequate. The lid needs to be well reinforced if made from steel plate as it takes a lot of punishment during the safari. Some manufacturers use 3CR12 which is called stainless although it is not. 3CR12 is a chromium steel with a resistance to corrosion that can be compared to the lowest grades of stainless steel.

Rust protection

Most trailers are stored outdoors and therefore are prone to rapid decay by corrosion and a trailer cover is a good idea. A stainless steel body is only necessary if you intend to use your trailer extensively on the beach. Galvanized mild steel is an excellent alternative and is almost as good, easier to repair and cheaper. For use inland, sealer-protected mild steel is fine if the trailer is stored under cover. Preferably the steel chassis frame should be hot-dipped galvanised. Trailer components that seem to deteriorate first are attachments such as hinges and clamps. These should be stainless steel and attached by stainless bolts. When looking at the

many South African off-road trailers, most manufacturers have placed rust prevention high on their priority list.

Weight

Trailer manufacturers should avoid excess weight in the construction without compromising strength. The weight should be in the chassis and axle. The loadbox can be made of lightweight material as long as the design and engineering is done in such a way as to add strength.

Stability at speed

With all of the well-known off-road trailers built in South Africa, stability depends more on weight distribution in the trailer and in the towing vehicle than on trailer design. There is no simple way of testing a trailer's stability at high speed other than to tow it yourself. Weight distribution is critical to stability.

If you have deflated trailer tyres to assist progress through sand, this will cause instability when you get back on the road. Remember to reinflate your trailer tyres.

Length

The distance from the tow ball to the trailer axle will determine ease of use. The shorter the distance the better it will handle off-road but the penalty comes with reversing and on-road stability.

Over-run brakes

Many off-road trailer manufacturers omit over-run brakes or offer them as an option. This is because in very heavy dust conditions brake drums tend to fill up with sand which wears out the shoes and can cause seizure. This only occurs in excessive dust conditions. If the wheels are as large as the vehicle's, which they should be, the same dust problems occur to the vehicle brakes as well. If dust does become a problem simply remove the shoes from the drums and lock the brakes open at the tow arm, an hour's job for both wheels. As for me, I would rather take the safe route and the unlikely risk of troublesome brakes than drive at 120kph with a ton of unbraked load behind me. Another argument against the fitting of brakes is that when driving over uneven terrain the brakes engage and disengage as the trailer bumps around. All over-run brake systems are fitted with a locking device on the tow arm. This is a hinged piece of steel that wraps around the arm to prevent the brakes from activating when reversing. This must be engaged when driving over uneven ground where speeds are low and over-run brakes are no longer required.

Trailer manufacturers may place a weight restriction plate stating 750-kgs on a trailer capable of carrying a ton or more, because with a stated payload of over 750 kilograms the trailer must, by law, be equipped with a braking system. The choice is yours; are you prepared to take a risk and tow such a large mass without a braking system? Under normal driving conditions you may not realise the risk, but do an emergency stop and it could mean the difference between stopping clean or rolling your vehicle. In my opinion, if a loaded trailer with a gross weight of more than 500 kilograms is not fitted with over-run brakes, don't even consider it.

Jockey wheel

This wheel supports the nose of the trailer when standing alone. Because off-road trailers are often left parked on uneven ground, the longer the jockey wheel the better. It must be able to be removed completely and stored on the trailer when driving off-road. If it is simply raised, it is vulnerable to damage off-road.

Trailer-top racks and tents

If you intend to place a roof-top tent on your trailer then a rack is required. If you do not then the rack raises the trailer's centre of gravity and it must not be loaded with anything but the lightest equipment, such as the camp table and a couple of chairs. Trailer racks raised high above the loadbox look great and are very practical when at the campsite, but they add to the trailers instability, especially off-road, even without a load.

Auxiliary equipment

A vast range of equipment can be specified when ordering a trailer as most manufacturers build to order. Articles fitted range from built-in water tanks with camp showers, dual battery systems linked to the vehicle, fridge/freezer units and simpler items like jerry can and gas tank racks. Each manufacturer has its own list of preferences. The only guideline here is that the more you fit into your trailer, the heavier it will become and the more difficult it will be to handle off-road. A series of power points and a fluorescent light fitted inside the lid and connected to the vehicle electrics is very handy, especially if it can be removed and double as an extra lamp around the camp. Fridges fitted into trailers tend to get damaged because of the severe vibrations on rough or corrugated roads.

Storage systems

Weight distribution in a trailer is very important. Some trailer designs have all the jerry can brackets and water tanks fitted behind the axle which can cause low trailer hitch to total weight ratio. This in turn can cause severe instability, especially when climbing steep hills, where the trailer lifts the rear of the towing vehicle. I have seen a Pajero battling to get up Sani Pass, which is normally effortless for a 4x4, because its traction was seriously compromised by the badly packed trailer it was towing. Consider carefully where the optional extras you choose for your trailer are fitted. Nose-cones storage boxes and boxes on the mudguards are

Equipment on the draw bar must not be too far forward. Check that the tailgate can be opened with the trailer hitched on.

very handy and must be dust-proof and lockable. Jerry can mounts on a trailer must be low down to keep C of G low. Trailers are ideal for carrying spare fuel.

If your vehicle carries its spare wheel on the tailgate make sure that it can be swung free with the trailer hitched on. Spare wheels carried here can make hitching awkward and any boxes, clamps or other attachments above the tow arm can make matters worse. Another reason for limiting attachments on the towing arm is that anything that could obstruct the wheel carrier from being opened can also hit the spare wheel when driving through a dip, when the trailer lifts and the vehicle drops. The option of removing the spare wheel carrier and placing it on the trailer is an alternative, but remember that the vehicle needs to carry a spare when the trailer is left at 'base camp'.

Practicality

When judging if a trailer is suitable, open and close all of the boxes and the lid. Pretend you are at your camping site and you need to find something in the trailer. Many trailers are fitted with a tailgate - a very useful feature as you can pack travelling items such as the day's lunch or a tool box at the back which can be easily accessed when travelling. Other features include cubby holes, exterior boxes or interior compartments, some of which are cleverly designed and some impractical for reasons such as a narrow aperture which become frustrating when packing and unpacking. Some trailers fitted with tailgates require that the roof be opened in order to open the tailgate. That is bad enough but some go even further in poor design - to open the tailgate the lid must first be opened. But in order to support the open lid the tailgate must be closed. Draw your own conclusions!

Summary

Assuming that you have decided that a trailer is the way to go, look for a lightweight trailer with a good sturdy chassis frame, a heavy axle (2,5-ton) on leaf springs and a minumum of weighty gadgetry. Remember, if you tow a big trailers you will always find a way to fill it, so keep it small and sensible.

TOWING - ON-ROAD

The most important safety considerations when it comes to towing on-road is straight-line stability, oscillation or weave and stability in a turn. Factors which affect these are as obvious as trailer hitch weight and trailer weight to vehicle weight ratio as well as items which are seemingly inconsequential such as the spring rates of the towing vehicle and trailer centre of gravity.

In this section we illustrate causes and effects of vehicles and trailers in an attempt to improve safety. I give credit here to Tom Sheppard's outstanding book, 'The Land Rover Experience', published by Land Rover, from where much of this information and many of his analogies are taken.

Straight-line stability

Consider a trailer being towed on an undeviating course by a vehicle moving in a straight line. Here the only force acting on the trailer is via the tow hitch and as a result the trailer moves in a straight line. Now consider a gust of wind or undulations in the road surface (supposing that the vehicle is unaffected), the trailer now acts under a new force - sideways. The trailer's tyres will as a result be at an angle, albeit small, to the direction of motion. As a result an opposite side force is excerpted by the tyres bringing the trailer behind the vehicle again. Understanding this simple principal is required as we go further.

Oscillation - decaying or increasing

Let us distinguish between decaying or increasing oscillation and how it relates to towing. Consider an ordinary school ruler with a hole in one end. With the ruler swinging on a pencil pushed through the hole, properties governing oscillation can be demonstrated. With the pencil stationary, the ruler hangs straight down by the force of gravity or in our scenario a vehicle moving on an undeviating course. Take the bottom of the ruler and pull it sideways and release it, keeping the pencil stationary. The ruler exhibits decaying oscillation at it swings back a few times quickly coming to rest, demonstrating straight line stability as described above. Now, take the pencil and simulate a vehicle moving over an uneven road surface by moving it sideways as the ruler is pulled sideways and released. If the frequency of the movement of the pencil matches the frequency of the swing, increasing oscillation takes place. This will happen as you instinctively try to match the phase of the ruler swing, trying to make the ruler swing as high as possible.

COURTESY BUSHMAN TRAILERS

A heavy trailer nose weight combined with a vehicle heavily loaded on the rear axle will cause instability. Note the jerry cans on the trailer draw bar and more on the back of the roof-rack. Concentrating heavy articles forward of the rear axle will improve things.

Whiplash effect

Again let us use the school ruler to demonstrate whiplash. This time hold the ruler in a horizontal plane with your forefinger and thumb over the hole. Flick your wrist to the right and left. As you do so, the ruler trails the wrist movement and then overshoots.

Applying what we have learnt

With all these analogies it can be seen that an incorrect combination of hand and wrist action, ruler weight and thumb grip can produce varying effects. Getting these combinations right, the

action of the ruler is very much as described. This in turn demonstrates that the varied actions of the ruler (trailer) and the wrist (towing vehicle) result is varying degrees of decaying oscillation, increasing oscillation and whiplash. Understanding these principles will assist in improving performance and safety.

Centre of gravity (C of G)

A trailer's C of G exists in the horizontal and vertical plane. Both have an effect on the trailer's stability. To demonstrate C of G in the horizontal plane consider a round bottle (trailer) laid on its side and spun. It will spin around its centre of gravity. Grab the bottle by one end while it is spinning. Instead of spinning around its C of G it will now spin around the end where it is held (trailer hitch). Energy is transferred to this end and will exert a reactive lateral force (the bottle will attempt to rotate and spin simultaneously) on your hand (tow hitch). It is necessary therefore to consider the position on the trailer's C of G and its associated lateral force acting on the vehicle thereby affecting stability. An operator can control this C of G by packing sensibly and making sure that the trailer's C of G is at an optimum - which lies 10 - 20 cms in front of the axle.

C of G in front of the axle

With the trailer's C of G ahead of the axle, as the towing vehicle swings the trailer exerts a force on the vehicle that reduces yaw and as a result the oscillation begins to decay. On the other hand, trailer C of G in front of the axle degrades cornering stability. When the C of G is too far forward it can provoke a slide and roll-over in a turn as a result of the same forces in place in our rotating bottle example.

C of G behind axle

With the trailer's C of G behind the axle the result of vehicle swing creates a force that amplifies yaw and begins what can become increasing oscillation.

Towing on-road - Summary

All stability problems are amplified as the trailer gets heavier. Once the trailer's weight exceeds 70% of that of the towing vehicle you are entering the critical zone with regard to stability and safety. The onus is on you to take extra care.

Try and estimate the trailer's C of G at 10 - 20 cms ahead of the axle.

Concentrate heavier articles over the axle thereby reducing inertia and improving stability.

Remember to keep the tow ball greased and replace the grease in very dusty conditions because grease + dust = grinding paste.

Take extra care in tight bends - the forward trailer C of G tries to push the vehicle's tail around the corner faster. A break-away can result.

TOWING OFF-ROAD

A vehicle's ability on slippery ground is degraded significantly when pulling a trailer. The forces exerted by a trailer off-road are similar to those on-road but are amplified. Instability and control problems can manifest themselves at very low speeds.

Off-road towing points to be considered

- *Disconnect the jockey wheel and stow it before the ground gets rough.*
- *Disengage the over-run brakes by sliding the lock over the towing arm, preventing it from retracting and engaging the brakes. When driving, allowance rarely need be made for the trailer's ground clearance as in most cases it exceeds the vehicle's. However, a trailer will reduce manoeuvrability off-road and off-road trailers are frequently damaged by trees, stumps and bushes that the tow vehicle runs past.*
- *Make allowances for the additional weight when braking and descending steep slopes by braking gently and changing to low gears timeously.*

Descending steep slippery slopes with a heavy trailer behind you is one of the most difficult off-road manoeuvres and should be done with extreme caution. The loss of steering control experienced in such conditions is exacerbated by the trailer. As the driver tries to direct the vehicle from the front, the trailer acts on the tail, steering it anyway it feels. In this predicament jack-knifing can occur and no amount of expert action on the part of the driver seems to be able to stop it. If gentle acceleration fails to pull the trailer straight or if acceleration is too risky in terms of losing control of the vehicle, then the only way out may be to disconnect the trailer and to manhandle it down the slope on the end of a winch cable.

ELECTRICS

The diagram below illustrates the standard tow-hitch socket wiring. It should be protected with a fuse of no more than 30 amps and the cables should not have a core diameter of less than 3mm.

BACK VIEW OF A 7-PIN TOWING SOCKET WITH THE HINGE AT THE TOP

1. Left-hand indicator
2. Power point (fridge etc.)
3. Earth
4. Right-hand indicator
5. Right-hand tail light
6. Stop lights
7. Left-hand tail light and number plate

PACKING A TRAILER

Trailers should be well packed and items secured as the amount of vibration and bumping far exceeds that inside the towing vehicle. It is a bad idea to mount a compressor fridge into a trailer - the excessive vibration damages them. The main cause of failure is fracture of the copper tubes. For this reason compressor fridges are less robust than heat-transfer types which can be mounted in a trailer and in some respects this is preferable to mounting inside a vehicle. In this case the trailer must be secured by steel straps of cables with turnbuckles and have ventilation apertures which must be opened when the fridge is powered by gas in camp at night when the trailer lid will be closed. Heat generated above a gas fridge can damage the trailer lid, so an aperture must be fitted above the vent pipe as well as at the base near the burner. These apertures must be dust-tight and closed when on the road, when the fridge must be run on electricity.

TRAILER COVERS

Trailers tend to suffer more wear and tear in storage than on the road because more often than not they are left under a carport or parked under a tree in the garden, where exposure to the elements rapidly erodes corrosion resistance and damages tyres.

Coverite now manufacture a range of trailer covers customised to specifications set by Mr Conradie to suit our Southern African climate. The covers carry SA patents and the range fits most South African-made trailers, with and without nosecones. All covers are backed by a two year factory warranty.

Coverite covers are made from a fabric called Silvertech. It's light, soft and durable, and UV and water repellent. Clever design, incorporating a double-stitched elastic hem around the complete bottom edge, ensures that the cover is pulled around the shape of the trailer with ease. Once fitted, there is sufficient ventilation to prevent condensation under the cover.

The cover can be easily fitted by one person and a major advantage of the soft fabric is that it will not scratch paintwork. Big emphasis has been placed on security. To deter thieves, the cover comes with a heavy duty plastic grommet on both sides, where an optional lock and cable can be attached, securing the cover to the trailer. While the trailer is on the road, the cover can be easily stowed in the carrier bag made of the same fabric as the cover.

Coverite is available from selected dealers of Venter Trailers, Speedy Exhaust centres and Midas auto spares centres. For further trade or customer enquiries, contact Retief Conradie on phone (018) 462-5338.

HIRING A TRAILER

An alternative to buying and equipping an off-road trailer is to hire one first. Better still, if you are thinking of buying a trailer but are not sure how you will enjoy it or handle it off-road, hire one for a trip and see how you like it. Doing this will not only give you an idea of a trailer's viability as a piece of safari equipment but will also help you to make a good choice when it comes to choosing one for yourself.

One of the most successful trailer hire companies is Bundu Rent and their safari product is called Campa. Campa is a fully equipped off-road trailer which comes with a standard range of equipment and options from jerrycans to portable showers. Trailers are handed over with a comprehensive instruction manual covering items from erecting the tent and shower to loading advice and tyre pressure guides.

Because the electrics depend on correct tow hitch wiring, the applicable wiring for Bundu Rent trailers is on page 231.

OFF-ROAD TRAILER BUYERS' GUIDE

An astonishing number of off-road trailer models are available in South Africa and I would be prepared to bet that we lead the world. At one point no fewer than 14 manufacturers built at least 29 models. Off-road trailer manufacturers seem to come and go, so only the major players are listed here and 'work from home' operations deliberately excluded. The best trailers are designed and built by people who go off-roading and tend to continually alter designs and improve the range of options. At time of going to print, the information listed here is correct, but many changes are likely during the long shelf-life of this publication. If there are options you require that are not listed here, contact the manufacturer for clarification.

ARMOUR STEEL

Ian Armour of Armour Steel in Hout Bay (tel 021 790 1980) has developed a number of off-road trailers, all with an unusual method of construction where the cage and chassis are integral, which stiffens the structure. Suspension is by leaf springs and shock absorbers and the body options include the 'Safari' and the 'Kitchen'. There is also a 1,8 metre trailer suited to light 4x4s. Many optional accessories are available for clients customise their own trailer.

Armour Steel Kitchen trailer

Armour Safari Trailer

This is a conventional single loadbox trailer (illustrated on previous page) fitted with extra boxes on the wheel arches and draw bar. Accessories are attached as per clients requirements including a carrier and roof top tent.

ARMOUR STEEL SAFARI TRAILER	
Loadbox height, width, length:	500 x 1100 x 2000. (optional lengths 1,8 and 1,6 metres)
Payload:	350 kgs
Body:	Galvanised sheet
Chassis:	Galvanised steel channel
Unladen weight	n/a
Wheels & Tyres:	Specify when ordering
Suspension:	Leaf spring with optional shock absorbers
Brakes:	none
Jockey wheel:	Removable
Colour:	silver, white or beige. Other colours on request.
Standard features:	Gas-strut supported lid with integral carrier of steel with wood slats. Carrier suitable for roof-top tent. Single com partment with partitions, 2 jerrycan brackets. All seals are silicone dust-proofed.
Optional features:	Roof top tent, over-run brakes

ARMOUR STEEL 'KITCHEN' TRAILER	
AS ARMOUR SAFARI TRAILER WITH THE FOLLOWING CHANGES AND ADDITIONS:	
Loadbox height, width, length: 500 x 1100 x 2000	
Payload:	1000 kgs
Brakes:	Over-run drums
Standard features:	Three doors into 3 divisions - back, storage and side kitchen 3 electrical power points, over-run brakes, 50-litre s/steel water tank.

Armour Kitchen Trailer

Armour Steel's Kitchen trailer is a kitchen on wheels. All kitchen utensils are accessible from the three dust proofed containers, the left side being the main kitchen unit with the other two as storage bins. The trailer also has a roof top carrier suitable for a tent.

B'RAKHAH SAFARI TRAILER

The B'rakhah Safari Trailer concept claims to be the most advanced safari trailer available in South Africa - and judging by the features and optional extras this may very well be true. It is designed to be maintenance free, it has a hot-dipped galvanized chassis, heavy duty tail-light clusters, aluminum lid-top rack, all bolts are cadmium plated or galvanized and the build quality is excellent. It comes standard with an over-run braking system. As a testament to the reliability of leaf springs and shock absorbers, B'rakhah have now replaced their original torsion axle to leaf springs suspension. B'rakhah will modify trailers with torsion bar suspension to the new axle at very reasonable rates. This I would say is not an option as the torsion bar axles break with repeated off-road use. The B'rakhah Trailer is a Land Rover-approved accessory.

Contact Hein Engelbrecht at 012 663 4501, 082 565 0467.

B'RAKHAH SAFARI TRAILER	
Loadbox height, width, length:	450, 600 or 800 x 1100 x 2100
Payload	1550 kgs.
Body:	Mild steel plate and alloy.
Chassis:	Galvanised steel tube with high-lift jacking points.
Unladen weight:	480 kgs
Wheels & Tyres:	'Prowhite' rims. 215 R15 off-road tyres. Alternatives can be specified.
Suspension:	Leaf springs and shock absorbers
Brakes:	Over-run drums
Jockey wheel:	Heavy duty extendable and removable
Axle rating:	2500kg
Colour:	White
Standard features:	Left and right mudguard lockers with auxiliary battery compartment, belly-mounted tent pole compartment, opening tailgate. Belly - mounted fuel or water tanks, lockable spare wheel bracket, aluminium jerry and water can brackets with internal tie-down rings.Side access for freezer.
Optional features:	A broad variety of optional equipment can be fitted

BUZZARD INDUSTRIES

Buzzard industries build three trailers, the Overlander, Bushpig and the Buzzard, all suitable for camping and heavy off-road use. Construction is a combination of steel channel chassis and tubular space frame with lightweight panelling resulting in a strong, below average dry weight trailer. Each product carries a lifetime guarantee against faulty workmanship or materials.

Buzzard Industries, 13 Northgate Park, 116 Malacca Road, Durban North, tel. 082 455 7092

Left: Buzzard Bushpig
Right: Buzzard Overlander

BUZZARD OVERLANDER AND BUSHPIG	
Loadbox height, width, length:	820 X 1200 X 1800 mm (Overlander) 820 X 1100 X 1500 mm (Bushpig)
Payload:	750kg (unbraked), 1250kg (braked)
Body:	tubular frame and 1mm chromadek panelling
Chassis:	Galvanised steel channel
Unladen weight:	340 kgs (Overlander), 305kg (Bushpig)
Wheels & Tyres:	'Prowhite' rims, Conti RV180 or General SAG radials
Suspension:	Leaf springs. Shocks optional
Brakes:	None standard. Over-run brakes available on request
Track:	Specified when ordering to match towing vehicle.
Axle:	Rated at 1800 kgs.
Colours:	White
Standard features:	Removable jockey wheel, solid hinged lid with rack and gas helper struts. Two jerrycans and 2 water tanks with taps stabilisers, spare wheel, roof rack, hinged tailgate, two side doors.
Optional features:	Roof-top tent, cutlery set, Side toolbox, front toolbox, spare battery system with light, extra rear-mounted spare wheel carrier as well as other customised configu rations.

BUZZARD	
This is a basic , no frills, four sided box trailer with gas-assisted lid	
Loadbox height, width, length:	650 X 1100 X 1500 mm (Overlander)
Payload:	750 kgs
Unladen weight:	238 kgs

CONQUEROR TRAILER

Mega Manufacturers, a company with years of experience building military trailers, builds a top-of-the-range safari trailer. Each trailer is an individual design built on a proven miltary chassis. The concept is a good one, build quality excellent and some of the ideas ingenious. If you are looking at a top trailer with all the frills take a look at the Conqueror. Mega Manufacturers, 62 Schoeman Street, Heidelberg, tel. 0151 96 533.

CONQUEROR SAFARI TRAILER	
Loadbox height, width, length:	600 x 1200 x 1880
Payload	1180 kgs. depending on fittings
Body:	Mild steel plate.
Chassis:	Channel and steel tube
Unladen weight:	315 kgs
Wheels & Tyres:	'Prowhite' rims.15" rims. 16" rims can be specified.
Suspension:	Leaf springs and shock absorbers
Brakes:	Over-run drums with auto reverse coupler
Jockey wheel:	Heavy duty extendable and removable
Axle rating:	2 500 kgs
Colour:	White
Standard features:	Lashing rails, three lockable access doors, nose cone.
Optional features:	Just about everything you can think of is purpose designed and installed at the factory.

CUTS SAFARI TRAILER

Cuts Manufacturing of Port Shepstone, which began building trailers is 1978, custom-build off-road trailers to order as well as specialist trailers for the mining and agricultural industries. They built two models of conventional single loadbox off-road trailer - The Eco Safari Trailer and the Bundu Safari Trailer, the larger of the two. Build quality is maintained by MIG welding, chassis rust proofing by filling with Tectyle anti-rust and all electrical wiring is run inside the chassis tube. The large nose cone is a standard feature and all hinges are 316 stainless steel, all bolts are galvanised,

the bin interior is rubberised and the chassis and trailer bin are sandblasted and then immediately coated with primer and 2-pack

CUTS BUNDU AND ECO	
Loadbox height, width, length:	600 X 1050 X 2000 mm (Bundu braked)
Loadbox height, width, length:	600 X 1050 X 1800 mm (Bundu unbraked)
Loadbox height, width, length:	600 X 1050 X 1800 mm (Eco)
Payload	n/a
Body:	2mm steel plate. 1,6mm (Eco) 2mm plate nosecone and front impact area
Chassis:	Full-length rectangular tube
Unladen weight:	n/a
Wheels & Tyres:	Must be specified to match vehicle
Suspension:	Leaf spring and shock absorbers (Bundu) or rubber torsion (Eco)
Brakes:	none
Track:	Specified when ordering to precisely match towing vehicle.
Axle:	Rated at 2500kgs (Bundu) and 1800kgs (Eco)
Colour:	White.
Standard features:	Removable jockey wheel, removable lid, gas struts, lid rack, removable bins.
Optional features:	Many basic features but few 'motorhome' type luxury accessories.

car paint. Cuts Manufacturing tel. 039 682 0693/3000, fax. 039 682 1923.

DESERT WOLF

Two trailers are built, both heavy duty and both with good reputations for strength and durability. The chassis is full-length rectangular steel tube and the modular design permits the user to select a configuration according to needs, from a single-bin to a multiple-bin kitchen outfit. The body is made of 316 and 304 stain-

DESERT WOLF WOLF AND CUB	
Loadbox height, width, length:	610 X 1100 X 2100 mm (Wolf) 610 X 1100 X 1430 mm (Cub)
Payload	325 kgs (Wolf) or 625 (Cub)
Body:	316 and 304 stainless steel plate
Chassis:	3CR12 corrosion-resistant steel
Unladen weight:	475 kgs (Wolf) or 375 (Cub)
Wheels & Tyres:	Must be specified to match vehicle
Suspension:	Leaf springs, axle stabiliser arms with adjustable or Old Man Emu gas shocks absorbers
Brakes:	Over-run drums with auto reverse
Track:	Specified when ordering to match towing vehicle.
Axle:	Rated at 1800 kgs.
Colour:	Natural stainless steel. Other colours may be ordered
Standard features:	Removable jockey wheel, stabiliser feet, hi-lift jack points, water and fuel tank brackets, roof frame brack ets, wheel-arch containers, 3 removable containers
Optional features:	A very broad range - too many to list here


Desert Wolf trailers

less steel and the chassis, 3CR12 corrosion-resistant steel. Call 012 811 1168, 082 450 5921.

HI-TECH BUSHMAN TRAILERS

Hi-Tech Bushman build a range of trailers to suit every requirement, their range being the broadest in the business. Their designs are non-conventional and they are among the most attractive trailers on the market. There is a very large list of accessories custom built into their trailers, including tents, cookers, tables, crockery, braai tools and spice racks.

Little Bushman

Lightweight trailer but strong enough for off-road use. Standard equipment is a roof-top tent, load-box doors which fold out into useful working spaces and four plastic utility boxes Options include the usual jerry can brackets and storage boxes.

Bushman Camper

A medium to heavy-duty trailer designed for the family camper. There are three large storage areas accessible from the sides and from the rear. A roof-top tent is standard and children can even sleep between the tent and the load area with mosquito net windows. A complete fitted kitchen is featured at the rear.

Bushman Tracker 1

A heavy-duty trailer with three large storage areas accessible from the sides and from the rear. All doors open out to form three large working surfaces. Standard equipment includes a roof-top tent, a fully equipped kitchen, tarpaulin covering the working area, a fold-out gas braai, water on-tap and many more. This sophisticated trailer is a complete kitchen

on wheels and is finished in the Bushman's familiar green colour scheme.

LITTLE BUSHMAN	
Loadbox height, width, length:	550 X 550 X 1500 mm
Payload	350 kgs
Body:	2mm mild steel plate, acid etch prime and two coats 2K epoxy
Chassis:	Galvanised steel channel (rubberised)
Unladen weight:	350 kgs
Wheels & Tyres:	185x14 with Continental tyres
Suspension:	Leaf springs
Brakes:	none
Track:	1400
Axle:	Rated at 1500kgs.
Colours:	Green (standard) Colour can be specified (excluding metallics)
Standard features:	Removable jockey wheel, solid hinged with rack and gas helper struts.
Optional features:	many

BUSHMAN TRACKER 1 / CAMPER	
Total height, width, length:	2000 X 1800 X 2900 mm (Tracker 1) 2050 X 1800 X 3500 mm (Camper)
Payload	750 kgs
Body:	2mm Mild steel plate, acid etch prime and two coats 2K epoxy
Chassis:	Galvanised steel channel (rubberised)
Unladen weight:	650kgs
Wheels & Tyres:	'Prowhite' rims. Wrangler 251 R15 off-road tyres. Alterntives can be specified.
Suspension:	Leaf springs with Old Man Emu gas shocks
Brakes:	Over-run drums
Track:	Specified when ordering to match towing vehicle.
Axle:	Rated at 1500kgs.
Colours:	Green (standard) Other colour can be specified
Standard features:	Removable jockey wheel, solid hinged with rack and gas helper struts.
Optional features:	A very broad range

Bushman Tracker 2

Similar to the Tracker 1 but designed for a double roof-top tent. There are additional load racks and jerrycan mounts as well as the features of its smaller brother. All specs as per Tracker 1 but with a length of 3,5 metres.

JURGENS XPLORER

Africa's first off-road caravan is the Jurgens Xplorer. It fills me with dread to imagine the Central Kalahari turned into a caravan park, but, progress must go on. The Xplorer is a medium sized caravan with a steep departure angle and steel protective frame, fairly heavy duty chassis attached to a light duty, 1,6 ton axle.
It sleeps two adults and two children and is well equipped with kitchen goodies and is available with many extras.

The fact that the Xplorer has a 1,6 ton rubber torsion axle is a serious mistake in its design. Several local off-road trailer manufacturers have used rubber torsion axles on their trailers and all have regretted it. These axles fail in off-road use and

all who have used them, have suffered the same fate. Some Xplorers have been used successfully but it is only a matter of time before their axles fail. In my opinion, without an axle of at least a 2,5 ton rating with leaf springs, I would not take if off a tar road.
Few specifications were available from the manufacturer at time of printing. They are available from Jurgens, Gypsy and Sprint dealers.

FRONT RUNNER TRAILER

Front Runner design and build an off-road trailer in two styles - standard and Sherpa. From a distance the standard trailer is uninteresting to look at but far more interesting when looked at close up. What I like about it is its simplicity. Strong, light with a full-length chassis with leaf springs and shock absorbers. The tailgate opens and a slide which carries the entire trailer's load can be extracted allowing easy access to everything.
This was one of South Africa's first off-road trailers and is used by a number of professional safari operators, including the Afrika

FRONT RUNNER	
Loadbox height, width, length:	500 X 1200 X 1800 mm
Payload	±500kgs
Body:	Mild steel plate - 1.6mm. Body height can be lifted by 200mm
Chassis:	Steel channel
Unladen weight:	±250kgs
Wheels & Tyres:	'Prowhite' rims. RV180 215 R15. Wheel rims and tyres can be specified to suit vehicle.
Suspension:	Leaf springs and shock absorbers
Brakes:	optional
Track:	1520 mm
Axle rating:	2500kgs
Colours:	White standard. (duco or metallics can be specified)
Standard features:	Removable jockey wheel, solid hinged lid with rack suitable for roof top tent, gas helper struts, slide out rack.
Optional features:	Jerry and water cans and brackets. 50-ltre plastic water tank Roof-top tent and gas bottle brackets can be attached on lid.

Odyssey Cape to Cairo expedition. The trailer is rubberised underneath for rust and abrasion protection.
The Sherpa is similar but more fancy; more boxes, equipment, features are added to the standard trailer and with a yellow paint job it looks very good.

They are available from many off-road centres including most Safari Centre branches across the country. SsangYong dealers sell the Sherpa trailer from many of their big dealerships.

VENTER

South Africa's household name 'Venter' developed its first off-road trailer in 1996. I know of one operator using a sponsored Venter and his reports are favourable, although when looking at its design and construction I am doubtful as to its strength. There are three models to choose from, Bush Baby, Off-Roader and the Botswana Special.

Venter Bush Baby

This is a lightweight trailer of single box design without external boxes. The lid has a wood-slatted rack and the draw bar has a nose-cone.

Venter Off Road

The Venter Off-Road Trailer is a medium sized single loadbox trailer with a standard light-duty steel rack and leaf spring suspension but no shock absorbers It is simple and inexpensive.

JOHANN DU TOIT

Venter Botswana Special

The Botswana special, as its name suggests, is a heavy duty trailer designed for rugged trips. I am confused by the specifications as it appears to have a payload less than the Venter Bush Baby, though it is larger size. The loadbox has full-length lashings and the trailer comes retractable with rear stays. Jerrycan brackets, a nose-cone and roof rack are standard. Options include a spare wheel bracket as well as others to be specified when ordering. The chassis and suspension fittings appear to be under-engineered for off-road use.

Venter Savuti

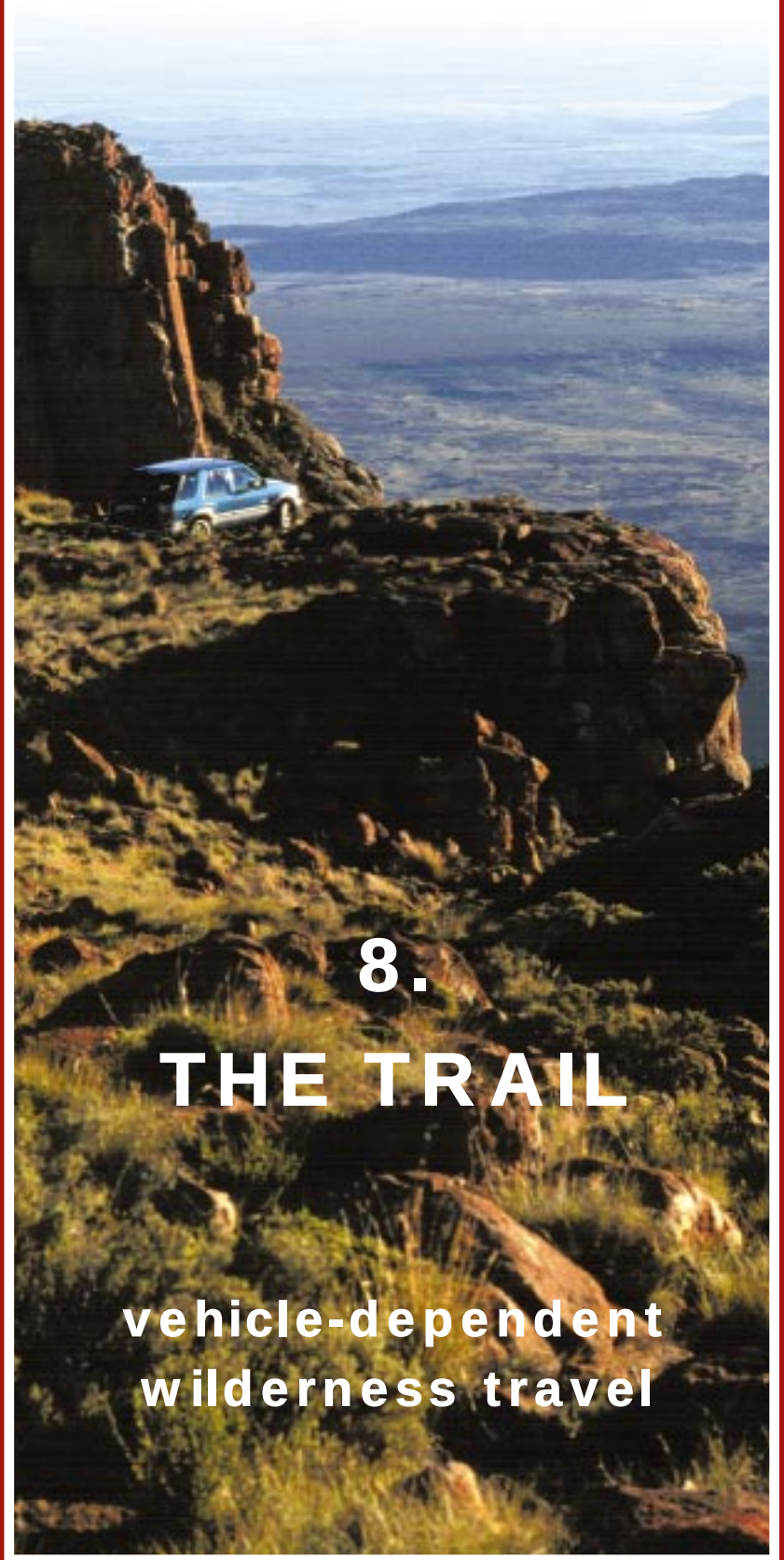
The report I wrote on the Venter Savuti trailer in the previous edition of this book caused an explosive reaction from the manufacturers. I was told on four separate occasions by four different people about one successful trip through Botswana by a Pajero diesel pulling a Venter Savuti. So, I will add no colourful adjectives to alter your perception as I decribe this trailer.

The Venter Savuti is the biggest civilian off-road trailer on the market. It weighs approximately 975 kilograms empty. Its chassis rails appear lightweight when compared to the load box's rigidity and strength. Wheels size is similar to vehicles like the Land Rover Forward control and a double jockey wheel is an indication of its size and weight. No expense has been spared in its construction. For example, the load box doors are secured closed by a one-inch solid steel locking bar and the doors are double-skinned steel plate. The designer changed from the original rubber torsion bar suspension to leaf spring which is not surprising considering rubber torsion axle's reputation off-road.

How heavy is it for a 4x4 to tow? Let's do some calculations: Consider its emply weight: 970kgs. Add a modest 400kgs of gear. That means the trailer weight is 1370kgs. Lets pull it with a Pajero diesel, at 2720kgs at maximum gross vehicle weight (fully loaded). Once the trailer's weight exceeds 70% of that of the towing vehicle the setup is entering the critical zone with regard to stability and safety. In this example 70% of the vehicle weight is 2079kgs - another 709 kgs and the trailer has become too dangerous to tow. The maximum trailer payload is therefore 759 kgs. When these calculations are made it doesn't look that bad.

The design in terms of ergonomics is odd. I don't know anyone who would want to hang shirts up in the bush, but then the Savuti fills a gap in the market for those who are a little eccentric or have spouses that don't know how to stop packing.

VENTER BUSH BABY / OFF ROADER	
Loadbox height, width, length:	500 X 1100 X 1800 mm (Bush Baby) 600 X 1100 X 2100 mm (Off Roader)
Payload:	490kg (Bush Baby), 1000kg (Off Roader)
Axle:	1400kg (Bush Baby), 2500kg (Off Roader)
Body:	1,6mm steel plate electro-galvanised
Chassis:	rectangular steel tube, draw bar: steel channel
Unladen weight:	n/a
Wheels & Tyres:	6.00x14" 8-ply tyres
Suspension:	8-blade leaf spring without shock absorbers
Brakes:	none
Track:	to match towing vehicle
Axle rating:	n/a
Standard features:	Non-removable jockey wheel, tailgate which can be used as a small table. Solid lid with gas helper struts, jerrycan brackets and nose-cone, stabilisers. Interior lashing rails
Optional features:	Jerry and water cans and brackets are among a range of extras.



8.
THE TRAIL

vehicle-dependent wilderness travel

VEHICLE PACKING

Efficient use of load space makes all the difference on safari. The speed at which a vehicle can be unpacked and repacked, the ease of finding equipment and having everything in its rightful place is one of the pleasures of off-road adventuring.

PRIMARY CONTAINERS

Large containers required to hold kitchen equipment, vehicle spares, tools, food, lighting or general camping equipment should be designed to do the job so that camping does not become a chore. For example, a single box containing kitchenware and food will be too awkward to pack and too heavy to load. A series of smaller containers are more practical and, if designed to fit efficiently onto a vehicle, while remaining accessible, can remain in the vehicle for the entire safari.
Many camping and vehicle equipment suppliers have devised their own fuss-free camping systems, such as ARC's vehicle-specific packing system. (as illustrated)

Primary containers can be compartmentalised for convenience and can be made from expensive 'camera case' aluminium or painted steel plate.

Vehicle packing systems greatly improve convenience and in most cases increase usable space by utilising all parts of the irregular packing space in the back of a vehicle.

CAMPING EQUIPMENT

This list is reprinted at the back of the book as a check list for you to copy and use when packing your vehicle.

- *Tent/s*
- *Mattresses*
- *Matches*
- *Paper plates*
- *Cutlery*
- *Chairs*
- *Dishwashing liquid*
- *Pot scourer*
- *Tea towels*
- *Wooden spoon*
- *Cutting board*
- *Frying pan*
- *Mosquito coils*
- *Toilet paper*
- *Gas tank keys*
- *Spare mantles*
- *Batteries*
- *Sponge*
- *Basin*
- *Small spade*
- *Tarpaulin*
- *Rubbish bags*
- *Fluorescent light & extension*
- *Sleeping bags*
- *Pillows*
- *Stove*
- *Gas tanks/Cooking Fuel*
- *Mugs*
- *Folding table*
- *Washing basin*
- *Dish cloths*
- *Egg lift*
- *Cutting knife*
- *Poitjie*
- *Cooking pot*
- *Insect repellent*
- *Paper towels*
- *Gas/Paraffin lamp*
- *Torch*
- *Cold water Omo*
- *Hand axe*
- *Brush*
- *Water purification kit*
- *Spare batteries*
- *Tie-downs/bungie cords*
- *Aluminium insulation blanket*

Containers, whether steel, plastic or cloth should have flat sides for ease of packing and lids must be water and dust proof. A good example is the small steel ammunition box with the clamp down lid found in army-surplus stores. They are 100% waterproof if the small holes in the bottom are sealed and are ideal for carrying breakable items such as torches and paraffin lamps and stoves, vulnerable items such as matches, fuel bottles and fire-lighters, and items which you hope you will not need such as tools and spares which can then be loaded onto a roof-rack or trailer and forgotten. Also, ammo boxes are inexpensive.

Large plastic boxes with clip-down lids are readily available from off-road suppliers and, although expensive, are popular. All containers, especially those made from metal must be lined with closed-cell high density foam to prevent damage to the contents - even tools, because the rubbing and chaffing steel-on-steel will soon produce iron filings.

Military containers are ideal for safari use because they are built to withstand abuse, but, because of the sensitivity of Third World road block attendants, they MUST be repainted, preferably white. Items such as military heavy-duty canvas bags or tarpaulins should be dyed black or blue.

Tying articles down inside the vehicle is also advisable if overland travel is anticipated. When a vehicle rides over an obstacle and drops down the other side, it seems to fall faster than the load inside it. The result is that when the vehicle rebounds and is coming back up, its load crashes down. The result is noise and breakages.

Dust and heavy vibrations are encountered on all worthwhile 4x4 outings. Attention must be paid to dustproofing and correct packing procedures.

Ideas

A basin has many uses such as bathing, washing clothes and dishes, draining oil and collecting water.

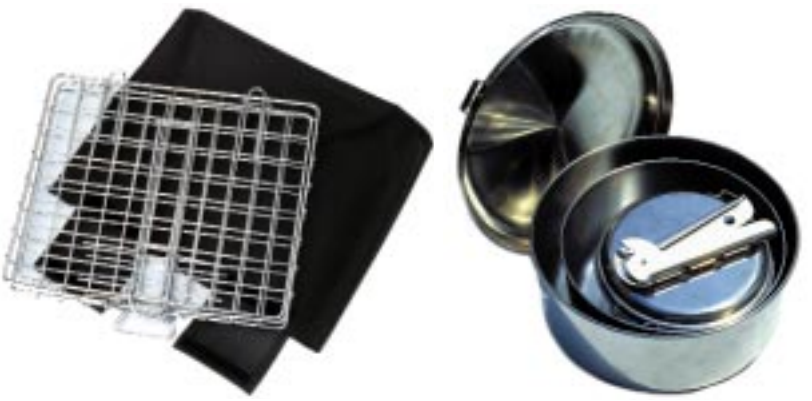
A cast iron pot, or potjie, can be used to cook almost anything and cooking in this way improves the flavour of canned meats and dried vegetables.

A small fold-away spade can be used for digging trenches around tents threatened by water, making a safe place to light a camp fire and for ablutions.

A large piece of plastic or canvas sheet/tarpaulin with eyes at each corner is a very useful item. It can be used for shade when strung between trees or vehicles, as a ground sheet for pitching tents on thorny ground, or for working under a vehicle, wrapping up sleeping bags on cold nights and collecting rainwater.

Make a protective canvas sleeve for the braai grid and stow it on the roof.

Pots should be designed to fit into one another to save packing space.



Efficient packing is common sense. Manufacturers that take packing into consideration produce such items as this fold-away braai grid and a series of stainless cooking bowls.

Although non-stick frying pans tend to get damaged on safari consider how cheap a small lightweight non-stick pan is. They do away with a major cleaning headache and are cheap enough to replace every couple of years.

A well-designed and practical hold-all for toiletries and medicines is a real convenience. Available from Outdoor Warehouse.

Items to help with roadblocks or border posts

Carry a few packets of cigarettes even if you do not intend to smoke them. Have them visible when approaching road blocks - soldiers manning road blocks may ask for a smoke. Obliging them aids with negotiations.

Items for low-key bribes are ball-point pens, T-shirts, pair of tackies. In some parts of Africa these are worth more than money and if offered as a gift are less likely to be construed as a 'bribe'.

Other bits and pieces:

- *Reading matter*
- *Pen knife*
- *Sunglasses*
- *Maps*
- *Paper and pens*
- *Passports and visas*
- *Cheque book*
- *Vaccination/health certificates*
- *Reference books*
- *Cash*
- *Driver's license/s*
- *Copy of vehicle registration papers*
- *Other licenses for the possession of special equipment such as radios or firearms.*
- *A handy passport pouch containing all important documents must be stored in an easily reached yet secure place in your vehicle. This one is available from Outdoor Warehouse.*

Food:

- *Powdered milk*
- *Frozen meat*
- *Onions*
- *Cheese*
- *Flour*
- *Tinned veg.*
- *Fruit*
- *Carrots*
- *Gem squash*
- *Vinegar*
- *Beverages*
- *Eggs*
- *Cooking oil*
- *Potatoes*
- *Biscuits*
- *Tuna*
- *Sweet corn*
- *Baked beans*
- *Cabbage*
- *Spices*
- *Sauces*
- *Coffee*
- *Margarine*
- *Pasta*
- *Cereals*
- *Tinned meats*
- *Dehydrated veg.*
- *Celery*
- *Lettuce*
- *Mayonnaise*
- *Sugar*

Food containers

The rattling and bouncing created when a vehicle travels on dirt roads and over rough ground will take its toll on inadequate food containers. Hard plastic is a better choice than glass. Brittle plastic containers such as those used for cooking oil bottles quickly develop cracks and the flip top lids pop open, allowing the contents to escape, creating a horrible mess. Small flexible plastic Tupperware type containers are ideal for storing most foodstuffs as well as condiments such as spices, mayonnaise, vinegar, oil, sauces and food leftovers.

Fresh foods such as onions, carrots, potatoes, cabbage and gem squash will stay fresh for some time as long as they are protected from being crushed. Eggs stay fresh for weeks but should be well packed. On a 10-day safari into the Kalahari we broke all of our eggs into a Tupperware container and simply poured them out as needed. After days of very rough conditions, of the 36 eggs, only one yolk had broken.

Your kitchen should include a wooden spoon, cooking pots, an egg lift, a sharp cutting knife, a chopping board and sealable containers for salads and fresh foods.

Shrink wrapped meat lasts very much longer than unwrapped meat even if it is not refrigerated.

Packing a roof-rack

Roof-racks must be considered as light-duty carriers and all heavier equipment must be carried inside the vehicle and only light-weight bulky gear on the roof. This will keep the centre of gravity low and will aid stability. Heavy roof-racks are dangerous. Keep all heavier articles as far forward as practical so as to lessen the load on the rear axle and distribute the weight evenly.

In heavy sand excessive load over the rear wheels will cause the rear axle to sink into the sand while the front wheels spin hopelessly on the surface. Remember that on a rough road, when the vehicle is being thrown about, the roof pillars will be taking an enormous amount of strain supporting a loaded roof-rack and it is the front pillars that bear much of the stress. Poor weight distribution will have an adverse effect on stability, mechanical and tyre wear, fuel consumption, on-road handling and off-road performance.

One of the best methods of tying items onto a roof-rack is with a hammock spread over the load held down with a number of elastic tie-downs. Bungy cords or rubber straps made from inner tube rubber, with heavy wire hooks attached at the ends, also make excellent tie-downs that will not perish in the sun.

When packing jerrycans on a roof-rack make a broad rubber band from old inner tubes and wrap each can with the band. This prevents metal-to-metal contact that results in excessive static built up and damage to the cans.

A hammock makes an ideal roof-rack tie-down.

ROOF-TOP TENTS

Unless it is housed in a hard case, the convenience of a roof-top tent comes when erecting it, not when packing it away. When they are covered by a waterproof polyurethane bag, packing it away is a tiresome chore almost as time consuming as a regular dome tent. It is also quite strenuous to pack away because it is normally done while trying to balance standing on one of the rear tyres. Technitop make a tent in a fibreglass case and with Eezi Awn the case is alloy. The extra expense is worthwhile if your primary reason for having a roof-top tent is speed and convenience. However, the most

significant benefit of a roof-top tent is that mattresses, sleeping bags and pillows remain in the tent. The space saving can even be enough to sway a decision from buying a roof-rack over a trailer.

When choosing a roof-top tent look for sturdy construction. Those built with very light poles, for example, move around a lot in windy weather and because the tent is held aloft, are more susceptible to wind. Manufacturers are trying to make their products lighter but few have succeeded because these light-weight products don't last. Another advantage of tents housed in rigid cases is significantly reduced wind resistance. Poly bags tend to fill with air and balloon once the vehicle reaches about 80 kph. Eezi Awn's new tent has elastic ties fitted inside the tent to assist packing away. With the alloy case it is extremely quick and easy. A disadvantage of a rigid housing is that they are more difficult to get in and out of because of the lip of the case. Before you purchase a tent be sure to climb all the way in and out and have the entire family do the same. Disappointments come when the tent is taken on a safari and only then is it realised that they are difficult to climb out of or are too small. Select the widest available. Two smallish people often find the narrow tents cramped. Rigid cases also fill up with water. Drain holes do not come standard with some makes - they need to be modified, or perhaps ask your supplier to do it for you. The holes need to be capped to prevent dust ingest when the tent case is closed.

Top:Eezi-Awn roof-top tent. Right:Technitop roof-top tent is protected by a streamlined fibreglass case.

CAMP FRIDGE / FREEZERS

Being able to keep foodstuffs and beverages cold on a safari is a real luxury. Once you have used a fridge or freezer on safari you will never be able to do without one.

The first 12-volt compressor fridges available in South Africa were built with a 220-volt compressor and an inverter to convert 12-volt vehicle power to 220-volts to run it. It was an inefficient system and unpopular. The only alternative was the well established heat-exchange fridge/freezers whose claims to be able to freeze in high ambient temperatures were simply not true.

Today, both heat-exchange and compressor fridge/freezers are much more efficient.

For example, I tested an Engel compressor freezer and broke all the recommended rules regarding setting it up, not pre-cooling the foodstuffs and using a tired old battery to power it overnight, in a deliberate attempt to push it to the limit. The only thing I did ensure was that the wiring and electrical connections were good. It was a 39-litre unit filled to the brim with food and Cokes wrapped in plastic. At 4am we switched it on and headed out for a weekend up the Cape West Coast. By the time were had arrived at Clanwilliam for breakfast, about three hours later, I opened the Engel and the Cokes were close to freezing. That evening, powered by my seven-year-old Willard battery which was past its best, I turned the Engel to 2,5 on the scale of 1 to 5 and left it overnight. In the morning the food and cokes were still icy and the battery turned the engine over without any problems.

New technology used in modern fridge/freezers has created units that are efficient and live up to their claims that they can freeze food - and keep it frozen on safari. They are powered by one of two systems; compressor or heat-exchange. A third system called thermoelectric is used in coolers which are also able to heat up.

Compressor fridges

All portable compressor fridges are electrically-driven and all work on 12-volts. Some can also run on 220-volts. Because they are controlled by an adjustable thermostat, current draw is very efficient maintaining the fridge and its contents at operating temperature. The colder the setting, the higher the current consumption both in attaining the desired temperature and maintaining it.

In comparison with heat-exchange fridges, compressor fridges cool down very much faster. Because current draw only becomes efficient once the fridge has cooled and is simply maintaining a temperature, it is important that the fridge be run for some time before the engine is switched off and battery charging ceases, otherwise the compressor will run for a long period draining the battery to reach operating temperature.

Unlike heat-exchange types, they do not need to be levelled to work efficiently and are therefore more suitable for use in a vehicle. Compressor fridges are virtually maintenance free.

Heat-exchange fridges/freezers

Heat-exchange fridges are powered by LP gas and by 12-volts or 220-volts electricity.

The heat-exchange fridge's biggest advantage is that it is very versatile and can be powered with electricity and gas. That's especially advantageous if they remain in one location for a long period when battery charging is not possible or practical. Although they work when in a moving vehicle or trailer under electric power, they do lose some efficiency and depending on outside influences, may not freeze. When set up in a fixed location they must be levelled.

Heat-exchange types come into their own when camp is set up for more than three days when they should be removed from the vehicle and installed in a trailer or caravan where they can be levelled and worked off gas. In this situation they are efficient and will freeze easily.

To solve the problem of wiring and switches some are tempted to operate a fridge on gas when travelling. This is dangerous and impractical for the following reasons:

- *If an accident should occur, a naked flame in the vehicle or trailer could be the cause of a fire or explosion.*
- *When refuelling the flame must be extinguished. If this procedure is forgotten the results can be catastrophic.*
- *If the fridge is inside the vehicle the burnt fuel gas is a health risk and it smells.*
- *If the fridge is in a trailer the flame is easily extinguished by drafts.*

Maintenance

Check that the flame is centred under the chimney tube and the regulator is set at precisely the manufacturer's specified pressure. A yearly service of the heat-exchange mechanism should include cleaning soot from the chimney tube. Also, shake the fridge around or preferably invert it after disconnecting the gas and electricity, and leave it that way for 24 hours.

Thermo-electric coolers

Thermo-electric coolers run on the Peltier principal that if a current is passed through a special metal element it becomes cold and if the current direction is reversed the element gets hot. So thermo-electric can also be used to warm up food. Apart from a small fan, thermo-electric fridges are solid state and very quiet but will not freeze and are slow to cool when compared to compressor fridges. They run off 12-volts and are not thermostat-controlled - meaning that they are inefficient in terms of current consumption. Get one if you will be satisfied with drinks that are cool and not cold.

TIPS AND TRICKS TO EFFECTIVE PORTABLE REFRIGERATION

Setting up

Inadequate wiring caused by a combination of cheap connectors and thin cabling are the most common causes of problems with freezer installations. Although the current draw of compressor

fridge/freezers is less than that of heat-exchange types, the wiring system is no less important.

When the compressor starts up, the current draw, albeit only for a second or two, far exceeds that of a heat-exchange freezer. Some models can soar to 15 amps. Use the best quality connectors you can find.

The following calculation can be used to determine the cable core thickness when wiring up a freezer. Divide the length by 1000, for example, if the cable length is 3 metres (3000mm) then the minimum cable core thickness is 3mm and if the length is 4 metres then a 4mm cable is required, and so on. This will ensure adequate current flow along the length of cable, no matter how long it is.

Dual battery split-charging systems

When a fridge/freezer is powered from the vehicle's primary battery, there is a risk that it will be flattened overnight or during an extended stay. In the bush this could lead to a serious problem in that the vehicle would have no power to start. Dual battery split-charge systems solve this problem by enabling a second battery to run the fridge while the vehicle's primary battery remains unaffected. This second battery must be a deep cycle type, designed to cope with total discharge, which ordinary vehicle batteries are not. As a result, compressor and thermo-electric types are not suitable for permanent or semi-permanent installations where 220volts is not available or 12-volt battery recharging is not possible. The best systems are the auto-relay or manual switch systems. Diode systems are made by manufacturers such as Warn but I have yet to see one work satisfactorily.

Calculating electric current draw

Assuming that a deep-cycle battery is fitted a simple calculation can be made to establish for how long your freezer can run before it flattens the battery.

The average current draw of a heat-exchange freezer is an uninterrupted 7 amps (ampere per hour). Establish the capacity of the battery: large deep-cycle batteries have a typical rating of ±96 amps. This means that the battery can deliver one amp for 96 hours. At seven amps (96 divided by 7) the battery will keep the freezer running for 13,7 hours. Although this sounds like enough for an overnight camp, in reality, batteries can only deliver optimum current under ideal charge and temperature conditions, and dropping a deep-cycle battery to less than 30% of its charge will cause permanent damage. Heat-exchange freezers do not have auto-cut-off devices and will drain a battery to 0%.

Calculating consumption of a compressor freezer is more difficult in that although current draw is ±4- amps, it is interrupted by a thermostat. So, current draw reduces significantly after the operating temperature is reached. Current draw is now dependent on thermostat setting, quality of insulation, outside temperature and how many times the fridge is opened. Most compressor fridges are equipped with an auto-cut-out switch preventing battery drainage dropping below 30%.

Preparation: (particularly important for heat-exchange types)

- *Cool down everything in your household fridge before packing the vehicle freezer.*
- *Remove the plastic cling wrap around canned beverages, otherwise the plastic will inhibit air flow and reduce cooling efficiency.*
- *Liquids should be in metal containers as plastic does not conduct heat well.*
- *Over-filling the freezer will also have a detrimental effect on the cooling efficiency.*
- *Have a clasp to keep the lid tightly closed to prevent it bouncing open off-road.*
- *By keeping the amount of time the freezer is opened limited, the freezer will consume less current and the temperature has a better chance of remaining frozen no matter what the outside temperature (compressor types).*

Fitting fridge/freezers into trailers

Freezers often get damaged when fitted inside trailers. The excessive vibration tends to fatigue the copper piping. This is especially relevant to compressor types. Heat-exchange types are more robust and some makes can take the punishment of being in a trailer. When they are, it is essential that they are secured with non-stretch attachments such as steel cables and turnbuckles. They must have ventilation apertures which must be opened when the freezer is powered by gas in camp at night when the trailer lid will be closed. Heat generated above a gas freezer can damage the trailer lid so an aperture must be fitted above the vent pipe as well as at the base near the burner. These apertures must be dust-tight and closed when on the road, when the freezer must be run on the vehicle's 12-volt system.

Batteries

Suitable batteries and split-charging systems are discussed in chapter 3.

12-VOLT COMPRESSOR FREEZER - BUYERS' GUIDE

Only 12-volt compressor freezers are featured here because of their popularity with 4x4 users. They are in most cases the most suitable types for use in a vehicle.

Guide to buyers' guide:

- *Control indicates operating temperature range.*
- *Baskets improve ease of packing.*
- *Low-voltage cut-out prevents a battery voltage from dropping to a level which could cause damage. Even a deep-cycle battery can be damaged in this way.*
- *Tie-down handles ensure that the unit can be well secured which is essential for travel in rough country.*

Engel

The Engel range of portable cfc-free compressor fridge/freezers boasts a unique 'swing motor' claimed to be the world's most efficient AC/DC compressor which operates at peak efficiency at grades of up to 30°. Features include tie down handles on the larger models, deep storage bins suitable for tall bottles, steel outer casing and a wrap-around evaporator for very rapid cooling. For working in cramped vehicles, the removable lid is a very nice feature.

The Engel appears to be the most efficient fridge/freezer on the market in terms of size and current consumption. However, efficiency measured over a longer period in high ambient temperatures may prove inferior to other brands because of thinner and less efficient insulation. Engel also make a chest freezer for caravans.

Desert Cool

Desert Cool is an Engel in a different colour.

ENGEL / DESERT COOL	
Type	compressor fridge/freezers
Available sizes & weights	13lit/11,5kg, 21lit/16kg, 29lit/21kg, 39lit/23kg, 60lit/33kg
Voltage requirements	most models are 12, 24 and 220-volts
Max. current draw 12-volts	3,9 amps(13-lit), 3,5 amps(15,21,29,31,39-lit), 5,5 amps(60-lit)
Control	thermostat dial controls from +10°C to -18°C or -12°C depending on model
Baskets	1
Low-voltage cut-out	yes
Tie-down handles	yes
Manufacturer	Sawafuji Electric Co. Ltd. Japan
South African agent	Desert Cool cc, (011 454 2875). Sold by all major 4x4 equipment outlets

MINUS 40	
Type	compressor fridge/freezers
Available sizes & weights	40lit/25kg, 60lit/35kg, 115lit/48kg, 150lit/60kg.
Voltage requirements	12-volts. 220-volts optional (24-volt models available)
Max. current draw 12-volts	5 amps
Control	thermostat dial controls from +10°C to -25°C
Baskets	40lit-1, 60lit-2, 115lit-2, 150lit-4.
Low-voltage cut-out	yes
Tie-down handles	yes
Manufacturer	Minus 40
South African agent	Minus 40 (021 386 2290). Sold everywhere.

Minus 40

South Africa's longest-established manufacturer of 12-volt cfc-free compressor freezers produce a range from 40-litres up to a massive 150-litres in both portable box and chest models. Features include tie down handles, deep storage bins suitable for tall bottles, no visible evaporator pipes to clutter the load bin and load baskets. Insulation is excellent.

Kwik-Freeze

South African manufactured range of fridge/freezers from 40 to 120 litres powered by 12 and 220 volts. All feature trommel type handles, fan-cooled compressor, lockable lids and concealed condenser pipes and baskets. They are not as well respected as either the Engel or Minus 40.

KWIK-FREEZE	
Type	compressor fridge/freezers
Available sizes & weights	40lit/18kg, 80lit chest/26kg, 80lit low-profile/26kg, 120lit/30kg.
Voltage requirements	12-volts and 220-volt. All models also available in 220-volt-only models.
Max. current draw 12-volts	5 amps
Control	thermostat dial controls from +10°C to -25°C
Baskets	yes
Low-voltage cut-out	no
Tie-down handles	yes
Manufacturer	Margot's Manufacturers, East London
South African agent	Margot's Agencies (01431 46 1096)

Tropical Freezers

Tropical make a wide range of compressor freezers all fitted with digital thermometers. They are not common and I could find nobody with experience of this product that could be shared with me. The importers were also of no assistance in compiling information.

COOLER-BOXES

There are many types of cooler-boxes on the market these days. Choosing one is simple - you get what you pay for. Cheap cool-boxes will keep food and drinks cooler for shorter periods. It is as simple as that. However, there are some tricks that can improve the insulation qualities of even the most inexpensive cool-box.

If you wish to carry ice, sandwich the ice between numerous layers of newspaper and place inside a few small cooler boxes during the cool hours. Seal each box with tape. To consume the ice, open one box at a time. If the cooler box remains unopened and perfectly sealed, ice will remain solid for up to a week!

Seal the lid with tape. Even the expensive model's lids seldom have a 100% seal. Open cooler-boxes as seldom as possible. Whenever the cooler-box is opened, the inside temperature increases dramatically.

Cooler-boxes are often used in conjunction with freezers to keep food fresh. Place frozen foods once they have been removed from your freezer in your cooler-box. In this way, energy used to freeze is recovered in an useful way.

CAMPING

Sleeping inside the vehicle

In hot climates, mosquito netting cut to size and attached to the windows with Velcro will allow the windows to be opened at night. If the vehicle has to be emptied, all foodstuffs must be stored in very strong boxes (preferably steel) to resist attempts by animals such as hyena to gain access.

Sleeping on vehicle roof-racks, whether in a tent or in the open, is ideal because being well away from the ground is a safe refuge from snakes and scorpions. In the dry season, sleeping in the open on a roof-rack is a pleasure - except for attacks by mosquitoes, which can be dealt with by constructing a simple mosquito net which covers the part of the body that is exposed. Alternatively, burning mosquito coils all night will help.

Camp cooking equipment and techniques

LP Gas is the most common fuel used on the safari although it is less efficient than many other fuels. The convenience of gas and the wide range of accessories is its biggest advantage. Alternatives such as multi-fuel stoves are smaller, lighter and more fuel-efficient.

Cast iron pots are very useful on safari. I find that three legged iron pots are awkward to pack and are less versatile than flat-bottomed types. We have used a flat-bottomed pot with great success in baking bread, rolls of meat, potatoes and even chocolate cakes on an ordinary wood fire. The trick to baking in such a pot is to build the fire in a shallow hollow on a flat rock. Before cooking remove ALL coals from the rock and position the pot on the rock, placing hot coals around, but not touching the pot. Then place a few hot coals on the lid. Rotate the pot from time to time. After a little practice baking will become very easy indeed.

Lighting fires

If you find your matches wet and you don't have a lighter, use a magnifying glass from a penknife or a lens from a binocular to

burn dry grass. Dry grass is better for lighting fires than newspaper, but start with only a small clump otherwise the fire will be smothered and will smoke excessively.

If all the wood is wet and smokes instead of burning, line the base of your fire with tin foil. This insulates the fire from the damp ground and the heat reflected by the foil accelerates the burning.

Keeping warm at night

Hot water bottles are a good idea for cold winter nights. Another solution is to take a rounded rock, about ten inches in diameter and place it next to the camp fire with one side of it over the coals. Rotate it periodically during the evening. Fifteen minutes before retiring for the night take the rock and wrap it in a towel. Do not let the rock get too hot otherwise you may scorch the towel. Place this warm bundle inside your sleeping bag. It will provide a substantial amount of heat for most of the night.

But beware: if you are the type that thrashes about while fast asleep you may wake up suffering from bruises or even burns. However, do not rely on finding suitable rocks in desert and semi-desert regions. Parts of the Kalahari, for example, are without rocks.

A multi-tool or penknife in a belt pouch is a worthwhile investment for the camper. Having looked closely at the broad range of multi-tools, I decided on the Leatherman Wave. Available from Outdoor Warehouse.

Camp lighting

Some lamps are noisy and others are quiet. Some give a very blue light, and others nothing much more than a warm, golden glow. The colour temperature of a light source, be it blue or gold, differs greatly, and although not always apparent to the eye, affects the eye's ability to compensate to darkness when the light is extinguished. Briefly, the bluer the light, the slower the eyes will compensate. After being exposed to bright gas or fluorescent lights, the eyes will take a very long time to compensate, while the effects of low intensity electric light or fire light may only take a minute to disappear.

In order from blue to red, the list of camp lights is as follows: fluorescent; high pressure paraffin/gas; electric incandescent; paraffin/candle/firelight. The light intensity, or brightness, will also affect the eyes' ability to compensate. Ideally, the light source should be a low intensity warm light. It should also be quiet.

If using LP gas lighting, as most campers do, run at half power. The light will be warmer and therefore kinder to the eyes. It's very much quieter and is far more fuel efficient at this level. At first, running lights at half power will appear dull but you will be surprised how well your eyes will compensate and become accustomed to it.

I use a number of 12-volt 2-watt torch bulbs on a long extension for exterior camp lighting. They are silent, give a low intensity warm light and consume very little current. I have a Coleman paraffin light for use when a brighter light is needed, eg. when

KEY TO PHOTOGRAPHS

A. Wind screen. 6metres long, 1,6 metres high. 5 poles with guy ropes & pegs. Supplied in light-weight bag. Available at Makro.

B. Vehicle packing rack. See page 248. Available from ARC.

C. Fold up camp chairs with armrests. Must be rattle-resistant, compact to pack and comfort able. These ones come from Makro.

D. Dome tents are ideal for safari use. Should have sewn in ground sheet with added fly sheet and canopy. Very quick to erect. Available from all good camping stores.

E. Roof-rack bag. Welded seams sealed with zip and velcro. Water and dust-proof. Makro.

F. Clean air, clean water, lots of animals etc.

G. Portable commode. An adapted camp chair for use in private. Practical, light. Makro.

H. Folding table. This is a Coleman. Not overly strong but very lightweight and therefore good for packing on a roof-rack. Makro

I. Off-road shovel. This is the author's purpose-built off-road shovel. Also good for camp chores. See chapter 6. Available from Safari Centre.

J. Folding, self-standing washing basin. Makro.

K. Eezi-Awn roof-top tent. Available with plastic and aluminium cases from 4x4 stores.

L. 12-volt fluorescent light. Ideal for camp chores. Available from most camping stores.

M. 3-way fridge/freezer. Available from Makro and caravan suppliers.

N. Engel freezer is a good choice of compressor freezer. There are many good similar freezers to choose from. See buyers' guide earlier in this chapter.

O. Wolffpakk - plastic 'ammo boxes'. Efficient, economical packing system. Makro and some 4x4 equipment outlets.

P. Raylight long-life rechargable torch. See page 266. Makro.

Q. Bush-Lite hanging candle lantern. see page 265. Available from Outdoor Warehouse.

R. Shower or toilet tent. Simple, quick, robust and private. Complete with ground-level wind deflector and hanging bag for soap etc. Simple and sensible. Makro.

S. Shower head. Collapsible and light.

T. Coleman cooler box. All good camping stores.

U. A very good 4x4 trails book. Available at Safari Centre, AA stores, Exclusive Books, PNA, Outdoor Warehouse, 4x4 Warehouse and some CNA stores. See page 281.

V. Coot. Available at most water holes.

kitchen duties such as food preparation and cooking are being performed, and a fluorescent tube on an extension that can be plugged into vehicle power points for demanding tasks such as working on a vehicle, when anything but good lighting makes the job that much more frustrating.

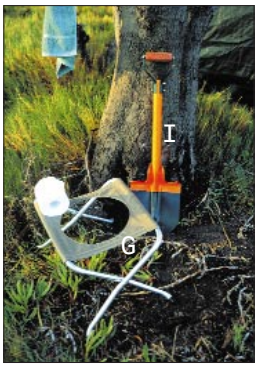
If you are carrying liquid fuel such as kerosene use unbreakable metal bottles with good leak-proof caps. Purpose-built commercially available fuel bottles which come in sizes ranging from 250ml to 1-litre are best.

Candles

The warm glow of a candle is impractical in the bush unless it can be protected from the wind. The Bush-Lite candle lantern does just that. A single candle lasts all night and the lantern can also accommodate a mosquito pad

Torches

I would not have believed that a torch could be too bright until I acquired the rechargeable Maglite torch (Magcharger). This torch cannot be used in the middle of the night inside a tent as it is so bright that the effect is the same as switching on a 220 volt, 100-watt incandescent bulb at home. It takes minutes for one's eyes to adjust.



They are however wonderful outdoors, the battery pack giving about 30 minutes of the brightest most penetrating hand-held torch-light I have ever seen. In fact it compares only marginally unfavourably with a Coleman 500 000-candlepower spotlight. All Maglites are made of heavy-duty aluminium, are water-resistant and very rugged. In short - they are unbeatable for ruggedness. I bought my first Maglite in 1982 and still use it regularly.

Another torch which I find very useful is a Raylite long-life rechargeable. It is based on a miner's lamp and is the most versatile, if heavy, torch I have used. The battery is 4-volts and powers the standard beam head and an optional fluorescent lamp which can be connected independently. The best part about the battery is that it will run any one of the lamps for 16 hours. When camping I use it as a portable light source for outdoor cooking and then as a night-light for my children. The charging time is equal to the time a single light is run, ie. 16 hours for a totally flat battery.

Bulbs and batteries

There are two types of bulbs to chose from: regular incandescent and high-intensity krypton. Regular incandescent are cheap and drop-resistant but do not perform well. Krypton bulbs deliver a much brighter and whiter light for a similar current draw. Krypton bulbs come in two distinct price ranges: moderate and expensive.

The most expensive krypton bulb can be identified by the integral magnifier. As the moderately expensive types fail with monotonous regularity and are poor value, I recommend the most expensive bulbs as they are very long lasting and appear to be able to withstand a lot of abuse.

Alkaline types show their mettle when used in a constant current draw situation, whereas zinc carbon batteries are better suited to intermittent use during a limited period. The shelf life of alkaline batteries is very much better than zinc carbon batteries.

Insect repellents

Mosquito coils are very effective as long as there is no wind. What is more, they work even better if burnt close to the source of light. Insects first fly to the source of light and then they buzz around looking for targets.

Insect repellents come in many different forms. Spray-on and stick repellents such as Peaceful Sleep and Tabard are best applied to ankles and socks as well as to exposed skin. This will prevent ticks from crawling up the leg. Repellent lotions are also available, and all of these products are toxic. Contact with sensitive skin, on the lips and eyelids will cause irritation. Some repellents may cause a skin reaction with certain people and if a new brand is taken on safari it is advisable to test it on the skin before departure. Mosi Wipes, wet-wipes impregnated with repellent, work very well.

I once witnessed the agony of a visitor from the United States, who, on his first night in the bush, thought he had caught a dreaded bush disease when his skin turned a fiery red interrupted by

numerous bluish blotches scattered over his body. He had not kept it a secret that he was worried about the malaria threat and the possibility of picking up ticks, so whenever he ventured out of his reed hut he doused himself in a protective layer of repellent. No more that five minutes in the open brought on an attack of red skin and blotches. His reaction was to shower which he said gave temporary relief, but then he would put on more repellent immediately afterwards. It took two whole days for him to realise that it was the repellent that was attacking his skin - not insects!.

Other less orthodox methods of discouraging mosquitoes are found in repellent arm bands, repellent bars and vitamin B12 which perhaps is the most unusual. I am assured that a course of vitamin B12, started two weeks before departure and continued during exposure, makes mosquitoes think twice about biting. Arm bands impregnated with insecticide are also very effective and if worn around the ankles would also be very effective against ticks. I am told that in some areas, a few ripe tomatoes cut open repel mosquitoes. I tried this on two occasions and it had no effect.

Refuse and ablutions

Some conservationists abroad advise burying rubbish. In Africa this is contrary to all proper thinking. Animals, namely baboons, jackal and hyena dig it up and spread it around.

Burn it or take it with you. To aid in the processing of refuse and to make it easier to carry, I suggest the following:

- *Use paper plates and burn them in the camp fire.*
- *Do not burn plastic - it melts down but still constitutes litter.*
- *Use a four pound hammer and a wooden block (or the jacking plate from your high-lift) to crush beer, soft drink and food cans. This will reduce the bulk of your rubbish.*
- *Carry some large sized heavy duty plastic bin bags in your safari kit. Rubbish in bags strapped to a roof-rack will prevent smells inside the vehicle and can be easily discarded when a town is reached.*
- *Use bleach-free toilet paper and if possible burn it before burying it. Dig a hole as deep as possible - at least 30 cms.*

Hiring camping gear

Camping Africa, owned by well known outdoor expert Charlotte du Toit, runs an excellent service advising on the purchase and use of camping and safari gear. She also runs an equipment hire service from Johannesburg. Camping Africa: 082 555 3287, email: campafrica@icon.co.za

SAFARI CLOTHING

Perhaps the single most important item in the safari wardrobe is a good hat. Wide brimmed hats are better than caps as they keep the sun off the neck as well as the face. Like the hat, other clothing should be chosen to protect the body against the elements and to blend in with the surroundings.

Daytime:

Camouflage against animals is not dependent on colour, since most animals are colour-blind. Interrupted patterns that break up the human shape work best. Even bright blues and red cannot be seen by animals - in fact, pure blues are better than any other colour for animal camouflage. Long baggy trousers are the best protection against snakes and are most comfortable when walking through tall grass.

Night-time:

Never underestimate how low temperatures can fall during darkness. Wherever and whenever you go on safari, take along a warm jersey and a windcheater.

Footwear:

If you intend to walk, wear boots or tackies. Sandals and flip-flops are totally inadequate - they allow grass to cut the feet and are no protection against biting insects or snakes. At night, boots or tackies are also recommended, as snakes and scorpions are largely nocturnal.

FIRST AID

You will need a basic kit for emergencies or to tide you over until medical help is found. This is something to discuss with your family doctor. You should also mention drugs that will be carried to combat common illnesses; diarrhoea, vomiting and allergies as well as the carrying of needles and syringes should an injection be required in a situation where sterility is dubious.

A first aid kit should include:

- *Analgesic ear drops.*
- *Antihistamine ointment and oral preparation.*
- *Anti-inflammatory gel.*
- *Anti-emetic preparation.*
- *Antiseptic concentrate, ointment or powder*
- *Cotton wool*
- *Crepe bandages; large and small*
- *Gauze swabs*
- *Paracetamol for fever or pain*
- *Paracetamol plus codeine for stronger/adult analgesia*
- *Rehydration powder or tablets*
- *Scissors*
- *Sling*
- *Splints*
- *Sticking plaster*
- *Sunblock*
- *Thermometer*
- *Wound closure strips*

Snake bite kits

The value of a snake bite kit in the bush is questionable. Seldom is the small amount of antivenom carried in a kit sufficient to help

the patient in any way. More importantly, due to the toxicity of antivenom, it should only be administered by a medically qualified person in a situation where appropriate action can be taken to counteract the severe life-threatening allergic reactions which can occur.

Thorns and narrow bush tracks

Keep windows wound up at least to eye-height when travelling along narrow bush tracks. The dangers of eyes and faces being spiked by thorns is then kept to a minimum. This is particularly necessary with children who love to hang their heads out and feel the fresh air on their faces.

Stings and bites - First Aid

The effects of stings and bites from insects, scorpions and snakes can be partially relieved with the use of a suction device called Aspivenin. The kit consists of a special syringe and a range of suction nozzles of varying sizes. If applied immediately after a bite or sting, the Aspivenin will suck a quantity of poison, relieving pain and helping to reduce swelling.

Phutsi fly

This annoying insect is found throughout Southern Africa and is particularly prevalent during the wet months. It lays its eggs in damp clothing that has been hung out to dry. Then, when the clothes are worn the eggs hatch and the worms burrow into the skin causing severe irritation. Spread a liberal layer of Vaseline jelly over the infected area and cover with a sticking plaster to starve the worms of air. To prevent Phutsi Fly, all washed clothing must be ironed.

WATER AND SURVIVAL

Do not underestimate the importance of water and the maintenance of proper water intake by the members of your group of travellers.

In May 1998 I got a vehicle bogged down on Sowa Pan. Two of us were travelling in a single vehicle. The day before I had spent about three hours in the sun shooting pictures and by evening I realised that I was dehydrated. I began a program of drinking large amounts of water over a prolonged period. By the time we got bogged down the following day I thought I had recovered. After 30-minutes in the scorching heat on Sowa Pan the symptoms returned in a form which spelt danger. Initial symptoms of dehydration is a headache and tiredness. Advanced dehydration comes in the form of nausea, light-headedness while sweating seems to stop. It can also be accompanied by a rise in body temperature probably because the body's cooling mechanism is failing.

This is what happened to me. It was our last day before our return leg and we had only 15-litres of water remaining. The heat was intolerable, the sun and white surface of the pan unbearable and our vehicle, which had overheated, was deep in a mire of

thick black mud. Already dehydrated, with not enough water, miles from nowhere and with an immobile vehicle - it was a scary situation. Knowing the dangers of crossing the pans and having got myself into this predicament I wanted to turn around and give myself a swift kick in the backside for my foolishness. I decided that we should have one attempt to get the vehicle out but that our preparation would be thorough. If the recovery attempt failed we would construct a shelter and rest until nightfall.

Having donned a long sleeve cotton shirt and long trousers for protection we began to work. One hour later, with rests every five minutes, we made our first attempt and succeeded. Things could have been very much worse.

Carrying water

Water consumption should be calculated at no less than six litres per person per day in summer, and four litres per person per day in winter. This includes washing and drinking. Additional water requirements must also be catered for.

These are:

- *Vehicle requirements: radiator refills, windscreen washing, cracked pipes and leaks.*
- *Tyre repairs: soap and water is needed for lubricating tyre levers.*
- *Evaporation and spillage.*

On extended trips, water stored in a translucent container will eventually turn green. Black, light-proof plastic containers are therefore best for water storage.

Water cans with a plastic tap at the base are very convenient, but because the taps are easily broken, remember to remove the tap and replace it with a plug when travelling. I prefer heavy plastic water cans with handles. I decant water from these cans into a smaller insulated water container with a small tap at its base. This keeps the water easily accessible and cool at the same time. The light weight of the small container also means that it can be moved around with ease.

Steel water cans can give the water a metallic taste and rust can make the water undrinkable. If you wish to carry water in steel jerry cans, paint them white to avoid possible confusion with fuel cans. The white surface will also help to keep the water cooler.

Wine bags (the silver bags found inside 5-litre boxed wine) make excellent water carriers. When frozen solid and then placed in a cooler-box, they make excellent space and weight savers - when they thaw, you have 5 litres of drinking water, and when empty they can be folded up and put away.

Water carried in goat skin or canvas cooler bags is a way to keep water cool for drinking but the substantial water lost due to evaporation must be taken into account. Although hanging a cooler bag on the front of the vehicle cools the water very quickly, the bag must not simply be hung on the string handle as the abrasion caused by a rocking vehicle quickly damages the bag and the string handle soon breaks.

Be sure to disinfect water bottles once they are more than a year old by filling with water and adding a teaspoon of chlorine. Leave

for a couple of days and then rinse thoroughly.

Vehicle water tanks

The golden rule when carrying water is: never carry all of your water in one container. Should a fitted tank split while travelling and all the water run out, you may find yourself in a situation where you are left with no water at all. Carry a quantity of water in a container that is transported inside the vehicle. This must be regarded as your emergency supply and must not be decanted into the vehicle's auxiliary tank.
The fitting of auxiliary water tanks is covered in chapter 3.

Camp showers

Portable camping showers consist of a heavy duty plastic bag, black on the one side, transparent on the other. A short hose, tap and rose are attached to the bottom. It is filled with water and left in the sun with the clear side exposed. After about three hours, it is ready to give a delightful hot shower. Left in the midday sun for five hours it will produce water hot enough for a cup of tea, although this is not recommended by the manufacturers.

These showers hold between 10 and 15 litres, are inexpensive and are available in most camping stores. Alternatively, use the cooler times of the day to view game and enjoy your surroundings, and during the midday heat when all the animals are resting in shady places, enjoy a cold shower.

Washing clothes

For very long trips into the wilderness a bucket with a sealed lid is useful. Put in the soiled clothes, a tablespoon of washing powder and hot or cold water. Now drive for a while over some rough ground. The harder your suspension, the cleaner your washing will be. The bucket is also useful for many other camp duties.

WATER PURIFICATION

Iodine and chlorine

In an emergency Iodine is very useful to the traveller for purifying water because it is readily available in most towns. It is also available at mission hospitals and clinics. Chlorine tablets are available as a water purification agent, but like iodine, are rendered inactive by pollutants in the water. It is therefore necessary to filter the water through gauze or cloth before the chlorine or iodine is added. Beware of overdosing - iodine and chlorine are poisonous in high quantities.

It is far better to equip yourself with one of the better suited water purification systems available from most camping stores. Good examples are Chlor-Floc purifiers and Katadyn water pumps.

Chlor-Floc

This is perhaps the best tested chemical field purification system available and is called 'Syn. Aquacure' in Britain. Its name is derived from what it does; 'Floc', means flocculation: the removal of debris, and 'Chlor', means that it chlorinates the water. Ingredients in each tablet cause the sediment to coagulate and

Camping in waterless, barren and unpopulated areas is the final reward of off-road adventuring. This is one such place - Kubu Island on Sowa Pan, Botswana.

separate. This sediment can be removed by pouring the water through a cloth strainer. No special equipment is necessary and purification can even be done by making a hole in the ground next to a raw water source.

Filtration

Unless filtered through ultra fine membrane filters, filtering without chemical purification will not make the water drinkable. It will only serve to make it more pleasant to look at, since harmful bacteria and viruses will pass through all but the finest of filters. Filtration should take place before purifying with iodine or chlorine, and afterwards when using Chlor-Floc. A cloth filtration bag available at camping stores will make the job easier.

Filter pumps

I have had first-hand experience of Katadyn water filter pumps. These devices require no chemical additives whatsoever, and although expensive, are unequalled in their efficiency and ultimate safety - in fact they are so safe that the source water can be ridden with typhoid, dysentery, cholera and the purified water leaves the pump crystal clear and ready to drink. Not only is the water cleared of harmful bacteria and viruses but of pesticides, herbicides and harmful chemicals as well. In some models the water produced is pharmaceutically sterile. Katadyn are standard issue to the Red Cross throughout the world.

It works in this way: the inlet pipe is lowered into the source and the water is first filtered through an open cell foam filter housed in a wire cage, thereby preventing the ingestion of large particles. Then the water is pumped under pressure through a special ceramic filter. Katadyn is Swiss, beautifully made and very durable. The filters do need periodic replacement but this is at surprisingly long intervals - the Pocket pump can filter 50 000 litres and the Mini Pump 7000 litres before the filter needs renewing. Katadyn products are available via mail order from good camping stores.

Even if you think you may never need it, buy a purification kit or filter pump and stow it in your vehicle. Be prepared for the unexpected.

Boiling the water

Boiling water will kill many, but not all, of the bugs in water that could make you ill. There are many hardy viruses that will not be killed, so additional purification methods should be used especially if the water is taken from areas close to human habitation and therefore prone to disease-carrying bacteria. If boiling is the only method used, boil for a minimum of 12 minutes.

WILD ANIMALS

Before you set up camp, look closely at the area you are considering. Game tracks look like people tracks - flattened paths that snake their way through the bush often to and from water. If a hippo or a herd of elephant use this track on a regular basis and you set up camp in their path, it could lead to an unpleasant confrontation. It is imperative that you never sleep with food stored inside your tent. You are very safe inside a tent, even against lion, hyena, hippo and elephant, as long as you follow this advice.

If you camp close to water, remember that game will want to drink and therefore you should ensure that there is easy access for the animals, especially if you are camped in an arid area. Animals made skittish by your presence may be too scared to drink and could die. Do not approach wild animals on foot unless you are accompanied by an experienced guide.

Washing and swimming in pools frequented by crocodiles and hippo is dangerous and should only be done once the area has been thoroughly looked over and there is somebody keeping constant watch. If you are going to swim, I strongly advise making the swim as brief as possible.

In many areas where animals are accustomed to the presence of humans, hyena, baboons and monkeys will raid your camp when your back is turned. It is important not to allow these animals access to your food. They will eat anything they can reach, and if they succeed they will become versed in the art of stealing which will only encourage them to try again.

NEVER, FOR ANY REASON WHATSOEVER, FEED A WILD ANIMAL

Once, while camping at Serondela in the Chobe Game Reserve in Northern Botswana, I placed two full 20-litre jerry cans on the lid of my cooler-box to prevent the baboons from getting inside. I walked about 20 yards away to do some fishing. After about five minutes I heard the clang as one jerry can hit the ground. I turned and ran towards camp. By the time I got there the lid was open and three rolls of Kodak film had been stolen. The baboon, more used to stealing citrus fruit, obviously thought that if it was yellow, then it must be tasty. I seethed as I watched the baboon climb the trees above the water, tear open the boxes, undo the plastic containers and drop my films into the river. Since that trip to

Serondela, dozens of resident baboons have had to be destroyed because they became talented at tearing open tents. All this could have been avoided had they never been fed, or been allowed access to campers' foodstuffs.

Scorpions

An easy way to identify a harmless scorpion from a dangerous one is by the size of its pincers - the smaller the pincers, the more dangerous the sting. Scorpions with large pincers have less need for a highly toxic venom and hence the sting will be no worse than a wasp. Scorpions armed with small pincers will be armed with a more potent toxin in their sting, and a thicker tail. The venom is neurotoxic and the sting can result in cardiac or respiratory failure, or both. Some scorpions can spray their venom and envenomation of the eyes can result. It is therefore very wise to treat a scorpion as if it were a snake. Do not get too close, do not antagonise a scorpion or pick up a dead one. Scorpions seem to be attracted to camp sites and you may find one under a tent ground sheet when the tent is packed up, or under a jerry can or cool-box left sitting on the sand. They also like living in cracks in dead wood, and the risk of being stung while collecting fire wood is very real. Shake out your clothes and shoes before putting them on in the morning. Because scorpions and many snakes are nocturnal, do not walk barefoot at night.

Snakes

Knowing about snakes, where and how they live, will go a long way in helping to avoid an unpleasant confrontation.

Most snakes depend on camouflage to protect themselves and unless they are moving they can become very difficult to see, even at close range. Fortunately snakes for the most part prefer to flee and will only attack in self defence. This is why more than 90 percent of recorded bites have occurred in people handling snakes. (Source: A Field guide to Animal Tracks - L Liebenberg) The puffadder on the other hand remains motionless when approached. This is why this highly venomous snake features very prominently in the list of recorded bites, as most are unwittingly stepped on and the snakes have retaliated by striking.

Here are a few simple rules:

- *Wear calf length boots and long loose fitting trousers when walking in the bush. If a snake strikes, it may bite into the loose trousers and miss the victim's flesh altogether.*
- *Step onto rocks and logs and not over them. A snake resting on the other side or under a log will not be seen, and a step onto and a glance over the log may reveal a snake which may otherwise have been stepped on.*
- *Avoid walking in very long grass where the visibility of the path is restricted.*
- *If you are picking up rocks or logs, do so by lifting or rolling them towards you, thereby allowing a path for a snake to escape by moving away from you.*

- *Never put your hand into a place in which you cannot see, like a burrow or a hollow tree trunk. A snake may have made it a home and will have nowhere to run to if it feels threatened.*
- *Do not walk around at night without a good torch - many snakes are nocturnal.*
- *Should you encounter a snake at close range, remain motionless until the snake retreats. Alternatively, withdraw very slowly - snakes have very poor eyesight and will strike at what they perceive to be threatening them. A sudden movement may induce a strike.*
- *Do not pick up a 'dead' snake unless you are absolutely sure it is dead. The rinkhals shams death when threatened and if it is touched will immediately strike.*
- *Do not approach snakes to get a better look unless you know what you are doing. Some species like the Mozambique spitting cobra and the rinkhals are able to spit their venom up to three metres and should the venom enter the eyes, thorough and continuous cleansing with water will be needed if the victim is to avoid permanent eye damage. Wearing sunglasses gives good protection against spitting snakes.*

Ticks

Because ticks carry disease, some of which can be fatal, it is important to know how to avoid being bitten. Wearing boots with long trousers and applying insect repellent or paraffin to your socks will prevent them climbing up your legs. Ticks often sit on the ends of long blades of grass and wait patiently for a host to pass by. If you walk through long grass, inspect yourself thoroughly afterwards. If you find a tick, do not pull it off as it may leave its head behind. Smearing Vaseline, grease, disinfectant or alcohol onto the tick will make them release their grip. Some tick species bury themselves under the surface of the sand and lie in the shade of a tree waiting for a host to use the shade as a resting place.

Ostrich

We have encountered ostrich on many occasions on our travels and at no time have I felt comfortable with them when they have been bold enough to approach us and stay close by. In the Qwaqwa National Park there are semi-tame ostrich which are frankly a nuisance and can become aggressive without provocation. These birds will run for kilometres alongside a vehicle and get uncomfortably close. I have been told by reserve staff that they are not to be trusted.

When protecting its nest an ostrich becomes very dangerous, so never approach an ostrich nest even if it appears to be unguarded. This rule applies to every wild animal - threatening young offspring will produce a fearless defence from almost all animals, big and small.

Hippo

The hippopotamus accounts for more injuries and death than any other wild animal in Africa. They do not mock charge. Because of their poor eyesight a charge is normally wild and without direction.

Moving sideways or climbing trees is the only escape route as outrunning a hippo is impossible for even the fastest athlete.

To avoid confrontation with hippo:

- *Do not camp on or too close to game paths leading to water.*
- *Do not shine bright lights at hippos, even if they are in the water. They have been known to charge at the headlights of a vehicle - so do not drive around at night in hippo country. This is one of the reasons why driving at night is forbidden in most game reserves in Southern Africa.*
- *Do not get between a grazing hippo and the water from which it has come - you will be cutting it off from its place of sanctuary and it may charge.*
- *If a hippo should rise up under and tip your boat, the best course of action - probably the only course of action - is to jump into the reeds and hide. And pray!*
- *If you are in a boat, keep at an extra distance if the hippo are with young. In this situation they can become very aggressive and will attack the moment they feel threatened. Hippo move with astonishing speed under water and a charging hippo may only be seen when it is too late.*

Lion

Like most animals, lions will usually move off when they become aware of approaching humans. The danger occurs when walking down-wind and the lion fails to notice your approach. Lions, especially when feeding or when they are with cubs, can become very aggressive and charge. The best course of action if you find yourself close to a lion or lioness is to remain motionless staring directly into the lion's eyes. If you turn and run, the lion's instinct may take over and you will be chased and brought down, whether the lion is hungry or not. If the lion charges, stand your ground, stare hard and shout at the top of your voice. Avoid high pitched screaming as this may be construed as fear. Throwing sticks towards the lion will help. The lion, realising that you have no fear of him will back away. Happily, I give this advice without first hand experience, but it comes from those who have.

Leopard

Shy and reclusive, leopard will more often than not move away when approached by humans. They can however become a threat if they are suddenly disturbed. In this situation, eye contact with the leopard should be avoided as this will let the leopard know that it has been seen which will promote a response, in most cases a quick withdrawal. The other alternative is that the leopard will charge. Leopard do not mock charge and unlike a charge by a lion, shouting at it will have little effect. In short, if you come across a leopard that is uncomfortably close, do not look directly at it and immediately move away to a safe distance before you do so.

Tracking leopard is dangerous, especially if the leopard is injured or sick. Leopards have been known to back around their trackers and attack. Leopards are not a danger to people camping out in the open and only in very rare cases have leopards been known to attack humans for food.

Elephant

When on foot always establish in which direction the wind is blowing and walk into the wind. This rule applies to all wild animals if you wish to approach them safely and to a distance close enough to get a good look without their taking fright and moving away. This is particularly important when approaching elephant because, unlike most animals, elephant will not always turn and move away - they may not wish to have you around and may move towards you and chase you. Elephants use their trunks to smell and will raise them above their heads and point toward you. If they do this you can be pretty sure that they have smelt you - if they do not move away it is unlikely that they will be happy with the existing arrangement. This is a good time for you to retreat. Make sure that you then remain downwind until you are at a safe distance. Do not wait until the last minute to retreat. Elephants often mock charge. They do this with their ears flapping and they often accompany this performance by trumpeting. They may only mock charge once. The next may be for real and elephants do this with their ears held back. You will not outrun an elephant and climbing trees is of little use. If you are forced to run, run downwind. If you manage to get out of sight, hide in the thickest undergrowth you can find. Elephants have poor eyesight and rely on their acute sense of smell to locate their enemies. Elephants in a herd with young are the most likely to become aggressive. Elephants found in hunting areas are often very wary of humans and they should be kept at a good distance whether you are on foot or in a vehicle. Unlike buffalo, lone bulls are normally placid.

Buffalo

A lone buffalo is perhaps the most unpredictable of all African wild animals and will often charge without warning. They rarely mock charge. If you are on foot and come across a single, or a small group of buffalo, immediately look for a suitable tree to climb. Do not wait for a charge before looking for a tree because if it should charge, time wasted in finding a suitable tree could mean the difference between life and death. Large herds of buffalo are not dangerous - but if you do not spot a lone straggler and you get too close you could find yourself in trouble.

Rhinoceros

Like the elephant and buffalo, rhinoceros should be approached into the wind and never too close. The black rhinoceros is far more dangerous than the white, and is a particularly nervous and unpredictable animal. They have poor vision but an acute sense of smell and good hearing. Rhinoceros will mock charge, but this is often followed very quickly by a genuine charge. It will do this with its head held up for improved vision and it will only lower its head at the last moment. Climbing a tree is the best course of action. If there are no trees, do not run away but move sideways always staying downwind. Hide in dense undergrowth and remain motionless until the rhino loses interest.

An interesting fact about the white and black rhinoceros is that although the black is the more feared, there are more cases of

white rhino charges than black. There are two reasons for this: the white rhino is more common and people know the dangers of the black rhino and respect it as a dangerous animal. The white is regarded with a casual attitude and people tend to get too close.

Hyena

Two species of hyena occur in Southern Africa - the brown and the spotted. The brown hyena is a timid animal and not aggressive, normally keeping away from humans. The spotted hyena however is a bold and resourceful animal. Although hyenas move off when approached on foot, they become dangerous and destructive when everyone is asleep. They can do damage to any food container left in the open at night. The jaws of the hyena are incredibly powerful and they put them to good use in getting at campers' foodstuffs. They will tear open a fridge or cooler-box with ease. They also attack plastics and rubber and there have been cases of them chewing and puncturing vehicle tyres. Covering tyres with thorn bushes will serve to discourage this practice.

In areas where hyenas have become accustomed to the presence of humans, they are an even greater source of annoyance - aeroplane wings and tyres have to be guarded by piling up heaps of thorn bushes overnight.

In 1991 when running a camp in the Okavango, I attempted to discourage a spotted hyena from raiding our kitchen - which it had been doing regularly over the previous two months - by placing chicken bones on a plate flavoured with strong spices. The recipe included an entire bottle of Tabasco sauce, a tablespoon of curry powder and a tablespoon of hot English mustard powder. In the morning the metal plate on which this 'nouvelle cuisine' was served was licked clean! The spotty was back the very next night to take his revenge by tearing open a fridge, which strangely contained nothing other than green lettuce, cucumber and tomatoes. The hyena ripped out the plastic door lining, a quarter of which he ate!

The presence of spotted hyena is the most convincing reason why sleeping on the ground in the open is ill advised. There are some dreadful stories of hyenas attacking sleeping humans and with their powerful jaws they can easily take a life.

All wild animals should be treated with the greatest respect. Remember that you are the visitor in their world and they should never be interfered with. Animals like cheetah and wild dog, although carnivorous and potentially dangerous, will retreat and can easily be driven off a kill. In situations where the food source is scarce, an approach too close to a kill could result in cubs going unfed, and prides breaking up. The nocturnal honey badger, although relatively small, can become very aggressive if approached too close. It will attack with little provocation. There is one account of a honey badger bringing down a wildebeest! (Animals tracks of Southern Africa - Louis Liebenberg) Antelope such as roan, sable, gemsbok and bushbuck will defend themselves if cornered and their horns can inflict fatal wounds.

GAME VIEWING AND PHOTOGRAPHY

The best time for both of these pursuits is in the early morning and late afternoon, when the animals are active and when the light is at its best. Lenses for landscape photography must include a wide angle of about 28mm, or my preference, a 24mm. Professionals shooting landscapes often use longer focal length lenses to do this - a 135mm is ideal. For photographers keen on game, 180mm and 300mm lenses are ideal.

For successful bird photography you will need a focal length of 400mm or more. Remember that when using this type of lens, a tripod or some means of supporting the lens will be necessary. A film rated at an ASA of at least 200 will be required when using long focal length lenses because high shutter speeds will be needed to prevent camera shake from spoiling pictures.

If you are shooting pictures from inside a vehicle and are unable to use a tripod, have a small canvas bag filled with sand handy. Wind down the side window and place the sand bag on the edge of the door. Now you have a steady support which can be moulded and shaped for the lens, and the window can be raised for best viewing comfort.

Keeping your film in the refrigerator or cool-box is a good idea if the ambient temperatures exceed 35°C. Film rated at 100 ASA or lower can be stored for short periods up to 40°C without harm but film rated at above 100 ASA will be damaged very quickly if it is allowed to do so. The result of over heating a film emulsion will be a colour shift, in the case of transparency film, often towards the cyan-blue.

Do not photograph government buildings or employees. Do not even point your camera at a military installation or vehicle. Keep your photographic equipment packed away, but within easy reach when passing through border posts or road blocks. At some border posts you may need to declare your camera equipment and it is a good idea to have a list of each piece of equipment and its serial number from which you can copy the information down onto the declaration document. Never photograph a soldier in uniform or you may find yourself being interrogated as a spy.

Photographic safari list:

- *Camera body/s*
- *Std./zoom lenses*
- *Close-up attachments*
- *Wide-angle lens*
- *Telephoto lens*
- *Tripod/monopod*
- *Film*
- *Plastic bags*
- *Flash gun*

- *Grain sack*
- *Flash batteries*
- *Lens brush*
- *Camera batteries*
- *Compressed air*
- *Lens tissue*

SPECIALIST 4X4 MAPS

From November 1999 to November 2000 a series of specialist 4x4 maps will become available. They are highly detailed with GPS coordinates, 4x4, 4x2 and vehicle/trailer suitability complete with fuel and accommodation availability.

Map titles and due dates:

RICHTERSVELD - NOVEMBER 1999
NAMIBIA AND KAOKOLAND - JANUARY 2000
LESOTHO - APRIL 2000
NORTHERN NATAL/SOUTHERN MOZAMBIQUE - JUNE 2000
TRANSKEI - NOVEMBER 2000
ZIMBABWE - NOVEMBER 2000
For mail order and trade enquiries call: +27 021 785 575

LISTS

Copy these check lists and use them on your travels.
Tick the first block if needed. Tick the second when packed.

TENTS

Tent 1	❒ ❒	Tent 2	❒ ❒
Guy ropes	❒ ❒	Mallet	❒ ❒
Ground sheet	❒ ❒	Fly sheet	❒ ❒
Poles	❒ ❒	Tent brush	❒ ❒
.....	❒ ❒	.....	❒ ❒

BEDDING

Foam mattresses	❒ ❒	Folding mattresses	❒ ❒
Stretchers	❒ ❒	Duvet	❒ ❒
Sleeping bags	❒ ❒	Pillows	❒ ❒
Mosquito net	❒ ❒	Hot water bottles	❒ ❒
.....	❒ ❒	.....	❒ ❒

LIGHTING

Paraffin lamp	❒ ❒	Gas lamp	❒ ❒
Fluorescent strip	❒ ❒	Methylated spirits	❒ ❒
Spare mantles	❒ ❒	Matches	❒ ❒
Candles	❒ ❒	Torch	❒ ❒
Recharger	❒ ❒	Torch batteries	❒ ❒
Torch bulbs	❒ ❒	Spot light	❒ ❒
.....	❒ ❒	.....	❒ ❒

COOKING

Braai grid	❒ ❒	Fire lighters	❒ ❒
Charcoal	❒ ❒	Small stove & benzine	❒ ❒
Potjie	❒ ❒	Flat iron pot	❒ ❒
Cooking pots	❒ ❒	Frying pan	❒ ❒
Kettle	❒ ❒	Gas bottles	❒ ❒
Gas bottle keys	❒ ❒	Spare jets & washers	❒ ❒
Gas extension tube	❒ ❒	Gas rings	❒ ❒
Smoker cooker	❒ ❒	Cutting board	❒ ❒
Alluminium foil	❒ ❒	Cling wrap	❒ ❒
.....	❒ ❒	.....	❒ ❒

CLEANING

Dust pan & brush	❒ ❒	Bucket and lid	❒ ❒
Basin	❒ ❒	Dishwashing liquid	❒ ❒
Dish cloths	❒ ❒	Dish towels	❒ ❒
Scouring sponges	❒ ❒	Bottle brush	❒ ❒
Sink plug	❒ ❒	Swipes	❒ ❒
Paper towels	❒ ❒	Serviettes	❒ ❒
Washing powder	❒ ❒	Miltons	❒ ❒
Disinfectant	❒ ❒	All-purpose cleaner	❒ ❒

CUTLERY

Knives	❒❒	Paring knife	❒❒
Forks	❒❒	Utility knife	❒❒
Spoons	❒❒	Vegetable peeler	❒❒
Tea spoons	❒❒	Grater	❒❒
Serving spoons	❒❒	Tin opener	❒❒
Bread knife	❒❒	Wooden spoon	❒❒
Carving knife	❒❒	Egg lifter	❒❒
Bottle opener	❒❒	Cork screw	❒❒
Soup ladle	❒❒	Salad servers	❒❒
Potato masher	❒❒	Braai tongs	❒❒
Colander	❒❒	.....	❒❒

CROCKERY

Plates	❒❒	Paper plates	❒❒
Bowls	❒❒	Kid's bowls	❒❒
Mugs	❒❒	Wine glasses	❒❒
Tumblers	❒❒	Containers	❒❒
Toothpicks	❒❒	Tea pot	❒❒
Thermos flask	❒❒	Tupperware salad bowl	❒❒
Plastic containers & lids	❒❒	Tupperware jug & lid	❒❒
.....	❒❒	.....	❒❒

MEDICAL

Antibiotics (infection)	❒❒	Antibiotic cream	❒❒
Antipyretics (fever)	❒❒	Antiseptics	❒❒
Anti-inflammatories	❒❒	Analgiesics (pain)	❒❒
Anti-emetics (vomitting)	❒❒	Bandages	❒❒
Cortisone cream	❒❒	Eye drops	❒❒
Interflora	❒❒	Plasters	❒❒
Medical bag/box	❒❒	Malaria prophylaxis	❒❒
Mosquito repellant	❒❒	Insect spray	❒❒
Water purification system	❒❒	Survival blanket	❒❒
.....	❒❒	.....	❒❒

LIBRARY

Birds	❒❒	Mammals	❒❒
Reptiles	❒❒	Insects/Butterflies	❒❒
Trees	❒❒	Stars	❒❒
4x4 Trails book	❒❒	4x4 Guide book	❒❒
Magazines/novels	❒❒	Children's book	❒❒
.....	❒❒	.....	❒❒

CAMP

Shovel	❒❒	Axe	❒❒
Water containers	❒❒	Clothes pegs	❒❒
Fire extinguisher	❒❒	Chairs - adult	❒❒
Table - catering	❒❒	Chairs - children	❒❒

Table - other	❒❒	Table cloths	❒❒
Shade cloth	❒❒	Taupaulin	❒❒
Catapult	❒❒	Pen knife	❒❒
Leatherman	❒❒	Bin bags (black)	❒❒
Newspaper	❒❒	Solar shower	❒❒
Coolbag	❒❒	Coolbox	❒❒
Ice bricks	❒❒	Engel	❒❒
.....	❒❒	.....	❒❒

CHILDREN

Games and toys	❒❒	Stationary & crayons	❒❒
Underwear	❒❒	Vests	❒❒
T-shirts	❒❒	Tracksuits	❒❒
Jeans	❒❒	Jerseys	❒❒
Jackets	❒❒	Balaclava	❒❒
Gloves	❒❒	Hats	❒❒
Pyjamas	❒❒	Boots	❒❒
Shoes	❒❒	Sandals	❒❒
Water wings	❒❒	Swimming costumes	❒❒
Rain wear	❒❒	.....	❒❒

TOILETRIES

Bath plug	❒❒	Toilet rolls	❒❒
Soap	❒❒	Shampoo	❒❒
Aqueous cream	❒❒	Toothpaste	❒❒
Tooth brushes	❒❒	Cotton wool	❒❒
Deodorant	❒❒	Nail set	❒❒
Razor and blades	❒❒	Hair brush & comb	❒❒
Sanitary towels	❒❒	Lip balm	❒❒
Tissues	❒❒	Makeup	❒❒
Sunblock	❒❒	Lens cleaner, saline etc.	❒❒
Contraceptive pill	❒❒	Condoms	❒❒
Towels	❒❒	Moisturiser	❒❒
.....	❒❒	.....	❒❒

DOCUMENTS & MAPS

Passports	❒❒	ID book/drivers license	❒❒
Visas and permits	❒❒	Travellers cheques	❒❒
Cash	❒❒	Credit cards	❒❒
Car registration	❒❒	Triptique (Zimbabwe)	❒❒
Cheque book	❒❒	Booking receipts	❒❒
Vehicle registration	❒❒	Trailer registration	❒❒
ContiMaps	❒❒	AA maps	❒❒
Shell maps	❒❒	.....	❒❒

FOOD - CONDIMENTS

Salt and pepper	❒❒	Sugar	❒❒
Sweetener	❒❒	Mayonnaise	❒❒
Tomato sauce	❒❒	Vinegar	❒❒

Olive oil	❒❒	Soy sauce	❒❒
Sun flower oil	❒❒	Spray and cook	❒❒
Herbs and spices	❒❒	Salad dressing	❒❒
Chutney	❒❒	Mustard	❒❒
Marmite	❒❒	Peanut butter	❒❒
Jam	❒❒	Honey	❒❒
Stock cubes	❒❒	Tomato paste	❒❒
.....	❒❒	.....	❒❒

FOOD - GENERAL

Tea	❒❒	Coffee	❒❒
Milk	❒❒	Powdered milk	❒❒
Bread	❒❒	Bread rolls	❒❒
Flour	❒❒	Bread mix	❒❒
Mealie meal	❒❒	Rusks	❒❒
Eggs	❒❒	Fruit	❒❒
Potatoes	❒❒	Onions	❒❒
Rice	❒❒	Pasta shells	❒❒
Spaghetti	❒❒	Sun flower seeds	❒❒
Tinned tomato & onion	❒❒	Cabbage	❒❒
Baked beans	❒❒	Sweet corn	❒❒
Tinned fruit	❒❒	Cake mix	❒❒
.....	❒❒	.....	❒❒

FOOD - BREAKFAST, SNACKS AND DRINKS

All bran	❒❒	Coco Pops/Cork flakes	❒❒
Muesli	❒❒	Jungle Oats	❒❒
Chips	❒❒	Nuts	❒❒
Sweets	❒❒	Popcorn	❒❒
Chocolate	❒❒	Biltong/dry wors	❒❒
Marshmallows	❒❒	Fruit juices	❒❒
Tab/diet drinks	❒❒	Cokes/sodas	❒❒
Beer	❒❒	Wine	❒❒
Liquor	❒❒	Sherry/port	❒❒
Oros	❒❒	.....	❒❒

FOOD - LUNCH

Tinned ham	❒❒	Tinned Tuna	❒❒
Tinned mussels	❒❒	Tinned corned beef	❒❒
Cheese spread	❒❒	Provitas	❒❒
Sandwich spread	❒❒	Cheese wedges	❒❒

FOOD - COOLBOX/FRIDGE

Margarine	❒❒	Cheese	❒❒
Cold meats	❒❒	Yoghurt	❒❒
Cottage cheese	❒❒	Feta cheese	❒❒
Lettuce	❒❒	Tomato	❒❒
Cucumber	❒❒	Spring onions	❒❒
Avocado	❒❒	Carrots	❒❒
.....	❒❒	.....	❒❒

FOOD - FREEZER

Chicken pieces	❒❒	Kebabs	❒❒
Lamb chops	❒❒	Steak	❒❒
Pre-prepared meals	❒❒	Mince	❒❒
Sausages	❒❒	Ribs	❒❒
Ice cubes	❒❒	Freezer blocks	❒❒
.....	❒❒	.....	❒❒

TRAILER, ROOF-RACK AND RECOVERY GEAR

License	❒❒	Padlock & keys	❒❒
Full gas bottles	❒❒	High-lift jack	❒❒
Full water tanks	❒❒	Battery secure	❒❒
Kinetic strap	❒❒	D-shackles	❒❒
Bow-shackles	❒❒	Chain	❒❒
Anchor/tree strap	❒❒	Snatch block	❒❒
Gloves	❒❒	Winch controller	❒❒
Anchor	❒❒	Stakes	❒❒
Tie-downs/rope	❒❒	.....	❒❒

CLOTHING

Sun hats	❒❒	Balaclavas	❒❒
Sunglasses	❒❒	T-shirts	❒❒
Jerseys	❒❒	Jackets	❒❒
Underwear	❒❒	Shorts	❒❒
Jeans	❒❒	Tracksuit	❒❒
Socks	❒❒	Spare laces	❒❒
Tackies	❒❒	Boots	❒❒
Mud boots	❒❒	Slops	❒❒
Gloves	❒❒	Pyjamas	❒❒
Swimming costumes	❒❒	Rain gear	❒❒
.....	❒❒	.....	❒❒

MISCELLANEOUS

Cell phone & charger	❒❒	Inverter	❒❒
Chargers	❒❒	Compass	❒❒
GPS	❒❒	Fishing tackle	❒❒
Sewing kit	❒❒	Two-way radios	❒❒
.....	❒❒	.....	❒❒

VEHICLE MAINTENANCE

Tool box	❒❒	Funnel	❒❒
Tyre pump/s	❒❒	Tyre repair kit	❒❒
Spare inner tube	❒❒	Spark plugs	❒❒
Workshop repair manual	❒❒	Globes	❒❒
Second spare wheel	❒❒	Fan belt/s	❒❒
Distributor cap	❒❒	Fuses	❒❒
Q-20 or equivalent	❒❒	Rotor arm & points	❒❒
Condenser	❒❒	Jerrycans	❒❒
Plug suppressor/HT lead	❒❒	Coil	❒❒

Hand cleaner	❒❒	Electrical wire	❒❒
Various nuts and bolts	❒❒	Spare keys	❒❒
Galvanised wire	❒❒	Radiator cap	❒❒
Gasket cement	❒❒	Epoxy putty	❒❒
Quick set epoxy glue	❒❒	Gearbox oil	❒❒
Exhaust sealing tape	❒❒	Hydraulic fluid	❒❒
Insulation tape	❒❒	Engine mount	❒❒
Locktite thread fastener	❒❒	Fuel hose	❒❒
Automatic transmission fluid	❒❒	Engine oil	❒❒
Medium and fine water paper	❒❒	Fuel filter	❒❒
Various electrical connectors	❒❒	Jump cables	❒❒
.....	❒❒	.....	❒❒

BEFORE GOING AWAY

Cancel deliveries	❒❒	Turn off geyser/s	❒❒
Fish, plants and animals	❒❒	Disengage immobiliser	❒❒
Inform next of kin	❒❒	Domestic workers	❒❒
Engage light time-switches	❒❒	Inform security	❒❒

VEHICLE ..... REG. no. .....
Chassis no. ..... Engine no .....
TRAILER ..... REG. no. .....
Camera and valuables - serial nos. .....
....
....

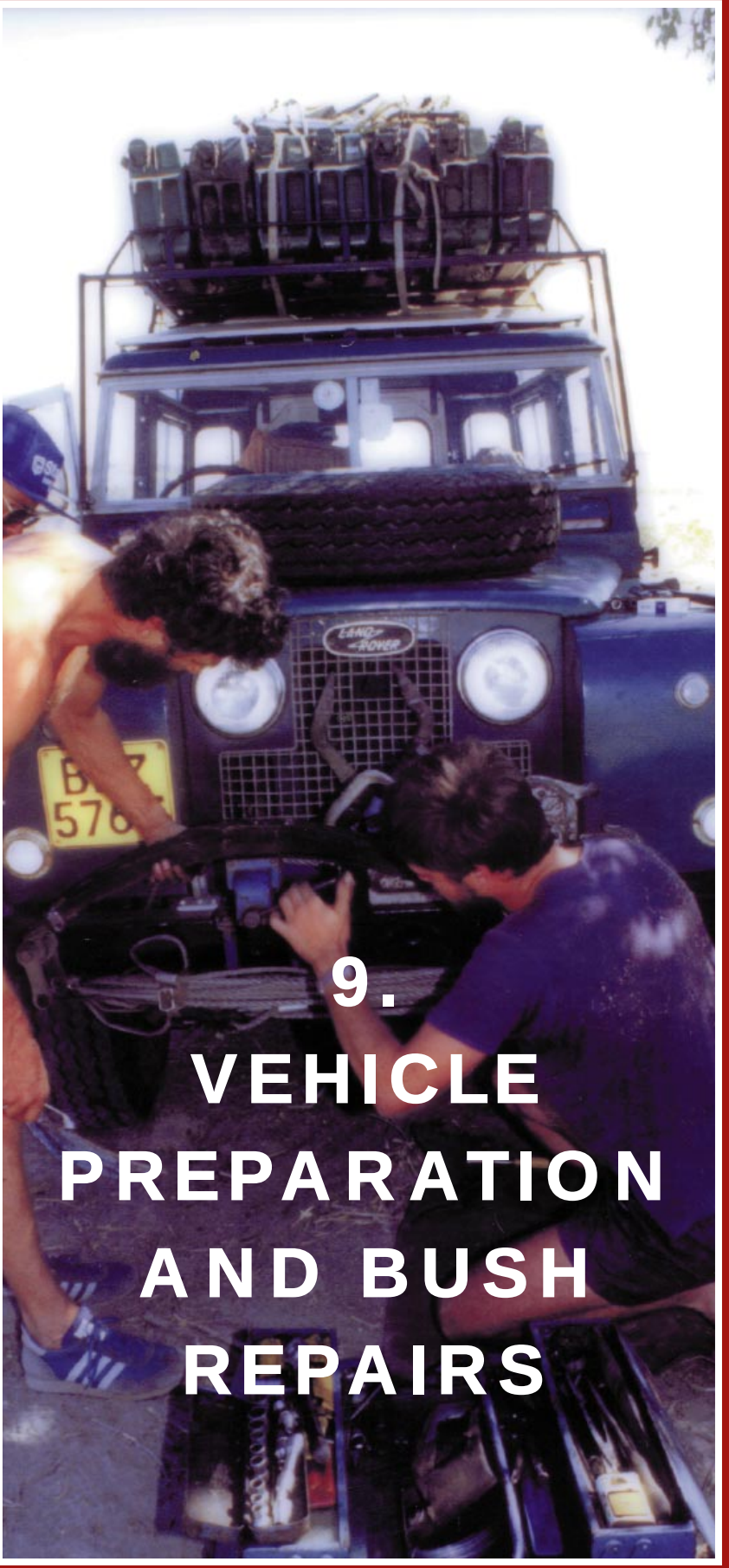
(This packing list printed courtesy Mark and Cheryl Eltringham of Fourways)

CONVERSION TABLES

VOLUME:	1 pint	600 ml	1 imperial gallon	4.54 litres
	1 US gallon	3.78 litres	44 Imp. gallons	200 litres (one fuel drum)
	1 litre	1 kilogram	20 litres	4.4 gallons (one jerrycan)
	1 litre	1.76 pints	500 ml	.9 pint
DISTANCE:	1 inch	25.4 mm	1 foot	0.305 metres
	1 mile	1.6 kilometres	1000 feet	305 metres
	100 metres	328 feet	1 kilometre	0.63 miles
	km	miles	km	miles
	5	3.1	70	37.5
	10	6.3	80	50
	20	12.5	90	56.3
	50	31.3	100	62.5
MASS:	1 kg	2.2 lbs	1 ton	1000 kilograms = 2200 lbs

TEMP: To convert celsius to fahrenheit - double it, subtract 10% and add 32.
TYRE PRESSURES: Kg/cm2 and PSI from 0.5 to 3.4 kg/ cm2
FUEL CONSUMPTION:

Miles/gallon	km/litre	Litres/100 km	Miles/gallon	km/litre	Litres/100 km
10	3.5	28.5	21	7.4	13.5
11	3.8	26.3	22	7.7	12.9
12	4.2	23.8	23	8.1	12.3
13	4.6	21.7	24	8.4	11.9
14	4.9	20.4	25	8.8	11.3
15	5.3	18.8	26	9.1	10.9
16	5.7	17.5	27	9.5	10.5
17	6.0	16.6	28	9.8	10.2
18	6.4	15.6	29	10.1	9.90
19	6.7	14.9	30	10.6	9.43
20	7.1	14.0	31	10.9	9.17



9. VEHICLE PREPARATION AND BUSH REPAIRS

Following your vehicle manufacturer's service handbook recommendations when doing maintainance will get you going in the right direction. Get yourself a good workshop repair manual and carry it in the vehicle particularly when on a trail. This chapter gives advice on proper maintenance guidelines and how to avoid common mistakes as well as remedies for common vehicle breakdowns far away from home.

MAINTENANCE

VEHICLE LUBRICANTS - THE KEY TO RELIABILITY

Engine oils contain additives that make them specific for use in internal combustion engines. These are: alkalis to neutralise acids created by the combustion process, anti-foam agents to prevent air becoming trapped in the moving oil, anti-oxidants to prevent varnish deposits in the engine, and emulsifiers to keep any water contaminants suspended in the oil.

Automatic transmission fluid can be used as engine sump oil in an emergency. It should not be mixed with other oils and should be replaced with engine oil as soon as possible.

Gear oils are labelled hypoy, hypoid or EP. Medium to heavy duty gear oils are specified GL 4 or GL 5. GL 4 oils are normally SAE 80 or 85/90. They have limited extreme pressure (EP) additive and are suited to gearboxes, transfer gearboxes and some hypoid differentials. GL 5 oils are suited to heavy duty uses such as hypoid differentials and swivel pin/CV joint houses. The EP additive in GL 5 oils reacts with bronze synchronisers in main gearboxes and should not be used as the additive is so effective that it negates the friction required for synchronisers to synchronise gear changes. EP additives in GL 4 oils are often insufficient to handle the gear tooth loads in hypoid differentials.

Borate oils are superior gear oils containing boron additives. They offer superior performance to EP oils. They are however costly and are very sensitive to water contamination which severely degrades their performance. These oils are used in transfer gearboxes and differentials, areas that are vulnerable to water ingestion when wading, so they are not well suited to a working 4x4.

Oil changes

Cheap oils are the cause of a great many serious engine breakdowns. Although the manufacturers of cheap oils can give accurate information about the lubrication properties of their oils, seldom do they detail the cleaning and anti-sludge additives in their products. To make matters worse, rarely do the engine problems occur while the cheap oil is in the sump, and this is why: a cheap oil is run for one or more service intervals of let's say 10 000 kilometres. Then the vehicle is treated to a high quality oil either by the service centre or the owner who now has a little more to spend. Now, the excellent cleaning properties of the expensive oil have to do the work of the many kilometres run with the cheap, non-cleaning oil.

The sludge is cleaned from the engine and is filtered by the oil filter, which soon clogs up. If there is enough sludge to block the

filter the engine's lubrication system fails and the engine seizes. This is then blamed on the new oil or the service mechanic. Oil is the life blood of your vehicle. Buy the best.

After deep water wading, water ingestion into gearboxes and axles can do hidden damage. Be sure to check for cloudiness in the oil - the first sign of contamination by water.

SERVICE INTERVALS

Many 4x4s are part-time and therefore low mileage vehicles. Engine lubricants degenerate even if the vehicle is not being used, whereas gear oils less so. Acid, oxidation and sludge formation are the chief villains. Six month intervals for engine oil changes and 18-month intervals for transmission oil changes should be adhered to.

When a vehicle is being operated in severe conditions, service intervals indicated in the handbook may have to be revised. For instance, if the vehicle is doing a lot of wading, water contamination of the axle and gearbox oils could mean that oil changes are required weekly. Heavy dust will mean that air and fuel filters will need to be changed frequently. Cleanliness of oils, filters and vehicle components has a direct effect on a vehicle's working life.

Service intervals and diesel engines

Diesel engines require servicing more often than petrol engines. I am told this is more the case in Africa than in First World countries due to the relatively poor quality of the diesel fuel and the quantities of dust in the atmosphere. If you have a diesel engine and want it to last more than 300 000 kms, as they frequently do in Europe, it is recommended that the sump oil and filter are changed every 5000 kms.

BREAKDOWNS

Most breakdowns in the bush can be handled with a good tool set and spares such as fanbelts, rotor arm, points, spark plugs, gasket paper, silicone sealant, a packet of odd nuts, bolts and screws and a length of wire.

Don't start taking complicated components apart until you are absolutely sure that this is the cause of the problem. On my travels I have assisted with a number of breakdowns and it is startling how many times the carburettor is the first component to be accused as the villain and stripped only to find that it is not at fault. Once the carburettor is reassembled its settings have been altered and the

vehicle now has an additional malfunctioning component. Remember, if you need to strip something, you will be working in far from favourable conditions and repairs will have to be improvised with what you have with you. With a workshop repair manual a repair job is made very much easier and one should always be carried, even if you think you know your vehicle well.

If you have a breakdown and intend to do what you consider to be difficult repairs, do not do these repairs too far away from the side of the road or track; do not hide your reasons for stopping. Nobody will stop and offer assistance if they think you have merely pulled over for a picnic.

INSPECTIONS

Regular inspection of a vehicle on safari is advisable. Check the undercarriage for bent suspension components, oil leaks, leaking shock-absorbers, loose wiring, loose transmission drain plugs, and any other parts about to drop off. In the engine bay, radiator caps, fan belts, battery clamps, high tension leads, engine oil, coolant, hydraulic fluid and battery electrolyte levels should be checked daily.

The following is a check list of vehicle support items that should be taken when travelling into unpopulated areas:

Support Items

- *Jerry-cans*
- *Tyre pump/s*
- *Workshop repair manual*
- *Spark plugs*
- *Fuses*
- *Fuel filter*
- *Distributor cap*
- *Points*
- *Plug suppressor*
- *Various nuts and bolts*
- *Galvanised wire*
- *Radiator cap*
- *Quick set epoxy glue*
- *Five litres gearbox oil.*
- *Insulation tape*
- *Locktite thread fastener*
- *Funnel*
- *Tyre repair kit*
- *Engine mount*
- *Globes*
- *Fan belt/s*
- *Rotor arm*
- *Condenser*
- *Coil*
- *Hand cleaner*
- *Electrical wire*
- *Spare keys*
- *Gasket cement*
- *Epoxy putty*
- *Hydraulic fluid*
- *Prestik*
- *Fuel hose - more than two metres - long enough to double up as a siphon hose.*
- *Second spare wheel (not essential if two similar vehicles are travelling together).*

- *Automatic transmission fluid (automatic gearboxes, power steering)*
- *Medium and fine water paper*
- *Water repellent - Q-20 or equivalent*
- *Carry enough engine oil for at least one complete engine oil change.*
- *Set of main leaves for springs - (well-used vehicles) an entire spring is not necessary. These can conveniently be carried by securing them to the front bumper and attaching a set of shackles and shackle pins onto which the leaves are fastened*
- *Set of half shafts (Land Rover Series II), essential if vehicle is fitted with wide tyres.*
- *Exhaust sealing compound and tape.*
- *Various electrical connectors matching those used in your vehicle.*
- *Set of battery jump cables.*

Tools:

- *Spark plug wrench*
- *Ratchet for sockets*
- *Two tyre levers*
- *Screw drivers*
- *Heavy chisel ±25 cms*
- *Circlip pliers*
- *Flat nose pliers*
- *Mole wrench*
- *Watchmaker screwdrivers*
- *Two hammers - 1/2 and 2kgs.*
- *Set of sockets*
- *Power bar for sockets*
- *Tyre pressure gauge*
- *Hacksaw*
- *Sharp nose pliers*
- *Wire cutters*
- *Feeler gauge*
- *Impact wrench*
- *Valve spanner*
- *Jump-cables*
- *High lift jack - for breaking tyre beads.*
- *Set of spanners to fit your vehicle (metric and/or imperial sizes).*
- *Adjustable wrench - medium and large sizes.*
- *Ignition timing light or bulb and wire with crocodile clips.*

Poor quality jump-cables are more troublesome that they are worth

Carrying tools in a strong canvas bag is preferable to steel boxes. In canvas the tools will not rattle and will not be covered in a layer of fine iron filings as will be the case if carried in metal boxes.

RADIATOR DAMAGE

Big holes can be sealed with epoxy putty. Small holes can be fixed by breaking an egg into a bowl, removing the yolk, and pouring the white into the radiator. The water must not be hot when you do this. Do not replace the radiator cap until the temperature is up, otherwise the pressure will force the soft egg out of the holes. Remember to flush out your cooling system as soon as you can make permanent repairs. Porridge is an alternative to egg white.

Overheating

This is a common problem when driving in thick sand for long periods, especially when towing.

The following causes should be investigated, and in this order:

- *A broken or loose fan belt. A fan belt is an essential item in your spares kit.*
- *Low coolant level. Do not remove the radiator cap when the engine is hot. The sudden drop in pressure will cause the engine temperature to rise sharply and this could damage the engine. Scalding steam could also injure you.*
- *Low engine oil levels. Oil cools as well as lubricates the engine. Make sure that the oil level is always at the high mark on the dip stick.*
- *Grass and grass seeds clogging the air gaps in the radiator.*
- *Vehicles with an air conditioner radiator sandwiched to the engine radiator - grass seeds and insects often clog the air gap between them. This cannot be seen unless one radiator is removed. Gradual engine water temperature increase over a long distance is often a result of this. Check your vehicle before your safari. Fit a grille net to prevent this build up.*
- *Badly adjusted ignition timing. You will need a timing light to set the ignition timing accurately. The timing specifications are given in the vehicle's handbook or workshop repair manual.*
- *Malfunctioning thermostat. Overheating will result if the thermostat is not opening to its full extent. Remove the thermostat and see if the overheating continues. If this does not help, replace the thermostat - it is not good practice to run an engine without a thermostat and one should be fitted as soon as a replacement is available.*
- *Auxiliary equipment badly positioned in front of the radiator. Overheating caused by a restricted air flow may only become apparent when the vehicle is worked hard.*
- *Research has shown that antifreeze increases the cylinder wall temperatures. If your vehicle does not live in a climate where freezing is a threat, remove all antifreeze and replace with a solution of pure corrosion inhibitor. An example is Motorcraft SXC103. The concentrations of water/antifreeze indicated on antifreeze product labels is often far too high for the Southern African climate. Reducing the concentration will aid cooling and reduce creep-seep. (The creeping properties of anti-freeze makes it ooze from pipe connectors leaving green stains over parts of the cooling system).*

RECOVERY OF A DROWNED ENGINE

I have only once drowned an engine and in the event getting going again was painless and took about forty minutes. If water is sucked into the cylinder heads the process to safely evacuate the engine is as follows:

- *Remove the air filter.*
- *Remove water from the intake pipe and turbo. Check for deposits of sand.*
- *Chock the wheels and jack up one rear wheel. Engage two-wheel drive (or unlock the centre diff) and engage high-range fourth gear. Release the handbrake.*

- *Remove the glow plugs (diesel) or spark plugs (petrol). An alternative for the diesel is to remove the injectors, but they are often more difficult to remove than glow plugs.*
- *Turn the engine by rotating the rear wheel. Rotating the engine in this way prevents the starter being stressed and prevents the possibility of a bent conrod at any stage of the flush because with hand-power, resistance can be felt and nothing is forced.*
- *Once all the water is out of the cylinders, clean, dry and replace the glow/spark plugs. Replace all seals. Only replace the air filter if it is dry, because a wet paper element could be sucked into the engine giving you a bigger problem than you started with.*
- *Have your mother-in-law stand behind the vehicle and start the engine. Why your mother in-law? Think about all the water in the exhaust pipe which has got to have some place to go when that high-compression engine starts up!*

CLUTCH FAILURE

If your clutch fails, ascertain the cause of the problem. If you have a hydraulic clutch as do most 4x4s, check the level of the fluid. In the event of a fluid leakage from the master or slave cylinders this means that the piston rubbers are leaking. Bleeding the system may provide a temporary solution. If you dismantle and reassemble these components cleanliness is paramount. If you do not have hydraulic fluid almost any liquid will do. (In an emergency, add dishwashing liquid to water but avoid bubbles). Do not use mineral oils as they will soon rot the rubber plungers in the slave and master cylinders. If your vehicle has a cable operated clutch, check the tension of the cable. Adjust so as that there is a very small amount of free play (±2mm).

If you are unable to get the clutch working, try changing gear without one. It just takes a little practice. When starting off, warm up the engine so that it will start easily and then switch it off. Engage first gear, and restart the engine. The vehicle will move forward and when the engine fires you will be on your way.

Gear changes are made in the following way: accelerate the vehicle until the engine is revving a little higher than for a normal gear change. By doing this you are allowing for the additional time it will take for each gear selection. Now, decelerate slightly until the engine is neither pushing the vehicle nor holding it back. The gear stick should move to the neutral position very easily. Now decelerate slightly until the engine revs match the wheel rotation as they would when engaged in the gear you are about to select. (If you are changing up a gear you will need to accelerate the engine). Change to the new gear slowly and gently - do not use force. When your engine revs are correct, the gear will engage quite easily and after a little practice you will make quite smooth gear changes. For obvious reasons, I do not recommend doing this in stop-start traffic.

STARTING WITH FLAT BATTERY

A flat battery need not cause panic. Assuming that the battery has enough power left to be able to fire the engine but not turn the starter motor, and you are unable to push start the vehicle due to

heavy sand, by jacking up a wheel and rotating it with a length of rope the engine can be restarted. Do the following:

- *Switch off all electrical equipment - conserve all of the power the battery has left in it.*
- *As the vehicle cannot be held by the handbrake the vehicle must be chocked. In sandy conditions one way to do this is to dig shallow holes behind the back wheels and push the vehicle into them. On hard ground, a heavy log, buried in a shallow trough and laid in front of the wheels, works well.*
- *Jack up one rear wheel but do not remove it.*
- *Wind a long length of rope tightly around the tyre so that when it is pulled the hub will rotate in the same direction as it would if the vehicle was moving forward. To do this make a knot in the end of the rope and wind the rope around the tyre crossing over at the knot. The rope must be wound as tightly as possible. Then wind the rope another two or three times, maintaining tension all the time.*
- *Gear selection depends on the size of engine and you may find that if the gear selected is too low, the vehicle may fall off the jack. Some trial and error may be required. A good ratio to begin with is high-range third.*
- *Switch on the ignition. Add choke if required.*
- *Depress the clutch and get someone to pull the rope. Release the clutch when the wheel reaches maximum speed and the engine should turn over.*
- *If your battery is totally dead and an alternator, as opposed to a generator, is fitted, this will not work. (most modern vehicles are fitted with alternators) It will also not work with automatic transmission.*

NOISY SUSPENSION

During a safari a vehicle's suspension takes a great deal of pounding and if the vehicle is overloaded it is often the suspension which is the first thing to break. Wearing of components such as rubber bushes is accelerated by the combination of heavy loads and mud and dust.

The most common causes of suspension noises are:

- *Shock absorber rubber bushes worn or missing.*
- *Shock absorber mounts badly worn so that the shock moves in the mount.*
- *Spring shackles worn (leaf springs) - replace*
- *Misaligned coil springs - park the vehicle so that the suspect spring is extended. Try and rotate the spring. A clunk can be heard as is returns to its correct mounting position. If the noise persists, slip a short length of plastic garden hose onto both top and bottom of the spring.*
- *Coil spring suspensions have many rubber bushes linking each component. Any of these bushes in a worn state could cause suspension clunks.*

Steering vibration

Violent steering vibration, sometimes triggered by the front wheels hitting a bump, is caused by a fault with the steering

damper. The steering damper is a shock absorber that lies horizontally in front of or behind the front axle. It links the steering system to the axle, absorbing vibration so that steering kickback over rough terrain does not rattle the driver to pieces. The fault can be a loose connection, a broken fitting, worn rubbers or a worn damper. The symptoms seem to be aggravated by well-worn front tyres.

ORDERING SPARE PARTS

Ordering parts when in an outback village or town may be possible.

Parts dealers will require the following information:

- *Vehicle engine and chassis number.*
- *Part number if possible.*
- *Quantity of parts.*
- *Specify left or right side of vehicle. (This is indicated as if you are standing behind the vehicle and looking forward).*
- *If you do not know what the part is called but have to describe the part, avoid colourful language - keep the description as simple as possible.*

When the parts are received, check the packaging. Most genuine manufacturer parts are well packed and protected. Pirate parts are often mishandled, badly packed or damaged and may not be complete. Always order original parts if you can.

ACCIDENTS IN THE BUSH

Northern Botswana 1988:
I opened my eyes. The view of the road ahead was obliterated by the bonnet which had been torn from its hinges. I looked around. Everyone was motionless - staring forward in a stunned silence. The driver's door was jammed shut, so a little shaken I climbed out through the window.

We had been game viewing on the narrow dirt track that links Serondela camp site and Ngoma, the bridge over the Okavango river and the border post between Botswana and Namibia. I looked around - resting in the bush was the Toyota Land Cruiser that had rounded the blind bend at high speed, and smashed into my Range Rover. The Toyota did not appear to be badly damaged - the rear canopy was torn and the driver's door was badly dented.

The road was totally blocked. In the middle my 1971 Range Rover, with bits of it strewn around. Soon a large truck appeared. It was full of locals and to my surprise ...tourists! Local transport consists largely of open flatbed trucks used by the villagers and smaller four-wheel-drive vehicles used by government personnel and wealthier tourists.

These tourists were American students bumming their way around Africa on dollar-a-day, and for them our accident scene was a welcome break in the monotony of their overland travels.

Closer inspection of the damage was made after the Land Cruiser towed the Range Rover to Ngoma Gate, a place to work out in the open safe from lions and elephants. On first inspection it appeared that we would not be driving anywhere for some time! The entire right fender and valance had been twisted beyond recognition and the battery had split in two. The wheel rim was wrecked and the drag link, tie rod and radiator fan were badly bent. The radiator appeared undamaged, but the header tank had been holed, a problem easily solved with some epoxy putty, one of the many 'quick fix' items taken on our overland trips.

Many times during my travels in the bush had I been called upon to make repairs, but these had always been simple problems. I remembered repairing sheared bolts on a front shock turret and an oil pump failure. What confronted me now was my pride and joy with half of its front end torn up. We were a long way from home - three days of travel and the prospect of having to tow the Range Rover all the way, in searing heat and in heavy sand and corrugations. The motivation was so great to get our vehicle going again that we set about out task with intense enthusiasm.

We began by removing the front fender. The wheel arch was unbolted and the metal had to be cut to free the brake lines which would now have to be supported with some wire. The strut supporting the bonnet slam tray was removed and mounted at an angle from a bolt on the steering box to a long bolt fixed to the top of the radiator. This would prevent the radiator from moving backwards and hitting the fan. Wire from a coat hanger, another 'quick fix' item, supported the bottom. The expansion tank, once sealed and the epoxy left to set, was mounted on the now bent front bumper and secured with some shock cord, normally used as a tie-down on the roof rack. It soon seemed possible that we may just be able to get driving again. We worked tirelessly through the heat of the day and by now we had consumed most of the rest of our beer - new motivation for getting the Range Rover back on the road.

The auxiliary battery used to drive the winch was rewired in place of the main battery and the cables tied down with plastic ties. It would have been unwise to have used wire for this because the constant vibration due to the bad roads and the choking dust would have caused the wire to wear through the cables likely to result in a short circuit. A hot fire, a four pound hammer and a large flat rock were needed to straighten the steering drag link, tie rod and the fan blade. Finally the winch cable was attached to the top of the radiator as added security. It took almost two days to complete the repairs, after which we really felt as if we had accomplished something. We filmed the entire repair process with my

home video camera and when I got home I edited the sequence to music - Monty Python's 'Always Look On The Bright Side of Life'.

The following day we packed up our 'Strange Rover' for a test run to Kavimba, a small town about 20 miles away on a reasonable dirt road. Because we no longer had a bonnet fitted, I could see the engine running in front of me. After about ten miles I noticed the radiator moving about a bit too much so we stopped to sort out the problem. The right side of the radiator was not properly supported but tying the invaluable four-pound hammer to the chassis member under the radiator quickly solved the problem.

The effort that we had put into the repair had paid off and the drive home was easier than anticipated. The border post officials, pedestrians and motorists were very amused by our Rover as it created a lot of attention whenever it was seen. At the border the customs official showed utter amazement. He walked around and around shaking his head, pausing to look more closely at the four pound hammer supporting the radiator.

"Howa!" he yelled.

"It's the bad roads here...everything just fell off," I explained with a smile.

After a thoughtful pause he asked, “Was it the Nata - Maun Road?” Readers who know the Nata - Maun Road as it used to be will understand the absurdity of this comment.

WELDING ON A VEHICLE

You will need two batteries connected in series to give 24-volts. (12-volts is not enough). Use a pair of jump leads to connect the two batteries and a third lead as the welding cable. Commercial welding rods are best, but if these are not available the carbon stick from a torch battery works well. Wrap aluminium foil around the back end of the carbon to prevent the lead from melting. Round the end and taper the rod slightly. You will need goggles. If you do not have any you will require a minimum of three pairs of sunglasses. Be warned, eye damage caused by arc welding without sufficient protection can be permanent! Coat hanger or fence wire or even winch cable will work as a metal filler.

Disconnect the battery and ground the positive terminal as close as possible to the welding site. Use a jumper lead to connect the negative terminal to the positive of the other battery. Connect the negative terminal of the second battery to the carbon stick. If welding is being done off the vehicle, run the engine to keep up a good charge. If welding is being carried out on the vehicle, disconnect the alternator to prevent possible damage.

This welding technique is a cross between gas and ordinary arc welding. Heat is controlled by the arc length - the arc is started by scratching the part with the carbon rod and then pulling it away. When the weld area is molten, feed in the filler metal and proceed along the joint. Have someone keep an eye on the temperature of the ends of the jumper cables as these could melt. A field welding kit should include two heavy jumper cables with soldered connections, a third cable of the same length with eyes to fit onto the battery, eye protection, a coat hanger and welding rods.

Mobile welding kit

Unipower Electronics, by fitting a series of specially designed components, convert an ordinary vehicle engine into a potent generator, fit even for heavy-duty arc welding. For details see chapter 3.

FILTERS

In very dusty conditions, the bigger the air cleaner the better. Air pre-cleaners, designed to filter out heavier dust particles before they enter the standard air filter, are a good idea if extended desert travel is intended.

Cleaning a paper element air filter is possible, although it is always preferable to fit a new one. Soak the element for up to 60 minutes in a solution of a biodegradable, non-sudsing type washing powder as used in automatic washing machines. Rinse well and allow to dry in a dust free area out of direct sunlight. Drying the element too quickly could damage it. Do not refit a damp element as the engine suction could collapse the paper. Cleaning a paper element fuel filter is done by thoroughly rinsing it in clean fuel. Wipe the filter bowl with a clean, dry cloth before refitting. See also Safari Snorkel air cleaner extensions in chapter 3.

If in-line fuel filters are fitted, a spare should be carried as these are not reusable. In Third World countries, it is wise to fit at least two fuel filters as the fuel is often full of sediment. Resultant clogged fuel lines and misbehaving carburettors are a common cause of vehicle breakdowns in these countries. Bowl-type fuel filters can be reused in an emergency after thorough rinsing in clean fuel. Be careful not to over clean the element as the paper becomes fragile as it gets old.

HANDLING FUEL

Decanting fuel

Whenever aircraft are refuelled in the field, one end of a steel cable is clamped into a metal part of the airframe and the other end to the fuel drum. This allows any static electricity which may have built up to be discharged before any filler caps are removed. An electrical discharge occurring during refuelling could cause a catastrophic explosion. This is done because aircraft fuel is of a high octane and the fuel is extremely flammable. Motor car fuel, although not as flammable, could still ignite. So remember: discharge any static build-up BEFORE OPENING ANY FILLER CAPS OR JERRYCAN LIDS by touching the jerrycan against any bare metal part of the vehicle. Open jerrycans slowly, especially if they are hot. Pressure builds up inside the can as it is shaken about and heats up on the roof rack. The pressure release can spray precious fuel everywhere. Remember, empty jerrycans are more dangerous than full ones as they contain an explosive air-fuel mixture.

The jerrycan spout clamps directly onto a jerrycan preventing spillage and makes decanting quick and easy.

Select a funnel by first making sure it can fit into the filler without aid as two hands are needed to hold the jerrycan.

FUNNELS & SPOUTS

A small green spout designed to clamp onto the spout of a jerrycan is the only method I have found of pouring into a fuel tank without spillage. They are cheap and are a real boon to the 4x4 adventurer. They are, however, only suitable for use with steel jerrycans. Unlike the jerrycan spout, a funnel is versatile. When selecting a funnel get one that will allow you to pour fuel single-handed and which can be placed in the filler pipe and stay there unaided. Wide brimmed plastic types with a removable pipe and a gauze strainer are easy to use and easy to stow. Rigid steel types that have a bend in the filler pipe are bulky to pack and are prone to rust. A gauze filter through which the fuel is poured either in the funnel or the vehicle's filler pipe is highly recommended. To repeat warnings I have issued a number of times: fuel purchased in Third World countries, especially in remote areas, is often dirty. Some older vehicles have fuel pipe gauze fitted as standard.

Buying fuel

If you are filling up with fuel from an electrical or mechanical fuel pump, make sure that the pump gauge registers zero before pumping begins and keep a good look that it does not stop turning while fuel is still flowing. There are cases of thievery by petrol pump attendants who 'suddenly notice' after some time that the pump has broken and then claim that they have pumped far more than they actually have, and demand vast sums before allowing their customers to proceed. They then threaten to

Refuelling in remote villages can be a challenge and is always time-consuming. In this case fuel had to be decanted from 50-gallon drums into a measuring can. Each can full measured 38 litres. In this case, paper, pen and calculator were needed and it took over an hour and a half to manually fill all three vehicles and 13 jerrycans.

call the police. The entire affair can turn into a very unpleasant incident.

Dirty or contaminated fuel is a common cause of vehicle breakdowns in all of the remote areas of the world. When buying fuel from old drums, check the labels on the drums. If it appears that the drum once contained another liquid, beware of contaminants or residues that may have dissolved in the fuel. For example, resin dissolved into fuel will cause severe damage to a vehicle's fuel system.

Always buy genuine metal jerrycans. Cheap imitations leak.

Fuel sampling

Testing can be done with the use of a length of PVC tubing, your nose, your eyes, a litre-measure and a small scale. It is an advantage if you are familiar with the appearance and smell of 'healthy' fuel. The PVC tube should be at least one metre in length and should be bound to a piece of stiff wire to keep it rigid.

Taking a sample

The density of the contaminant will have a different density to the fuel itself, causing the heavier liquid to sink and the lighter liquid to float. This is why tipping the barrel to take a sample will not be an accurate way of establishing what is inside.

Lower the PVC tube into the fuel until it touches the bottom. Place your thumb over the hole and withdraw it. A level-by-level sample will be contained in the tube. Release the contents of the tube into a clear glass container. Plastic containers may soon be clouded up as the petrol chemically attacks many plastics. An empty whisky or gin bottle is ideal.

Next, smell your sample. Shake the contents and then smell it again and note any difference. If possible, weigh one litre of the sample.

If a vehicle breakdown occurs far from home and help, take a break, make some shade and consider all options. Create a clear plan as to how to effect repairs and avoid deviating from the preset plan. All too often, breakdowns in the bush result in unnecessary panic. The result is unwise decisions made in haste which can cost lives.

Diesel fuel

Diesel engines can be difficult to start in very cold weather. The answer to this is a high capacity battery in good condition. To prevent diesel from freezing it can be mixed with petrol in a ratio of one part petrol to fifteen parts diesel.

PHYSICAL PROPERTIES OF FUELS

Petrol:	Volatile, highly flammable vapour. Light straw or pinkish colour. Distinctive smell.
Paraffin:	Non-volatile. Light straw colour or clear with a pungent smell similar to that of diesel.
Diesel:	Non-volatile. Light straw colour with a pungent smell.
Fuel oils:	Non-volatile. Black with a smell similar to diesel.
Foreign bodies:	Can be seen settling to the bottom. Very fine particles may remain in suspension but will be filtered out by vehicle's own filtering devices.

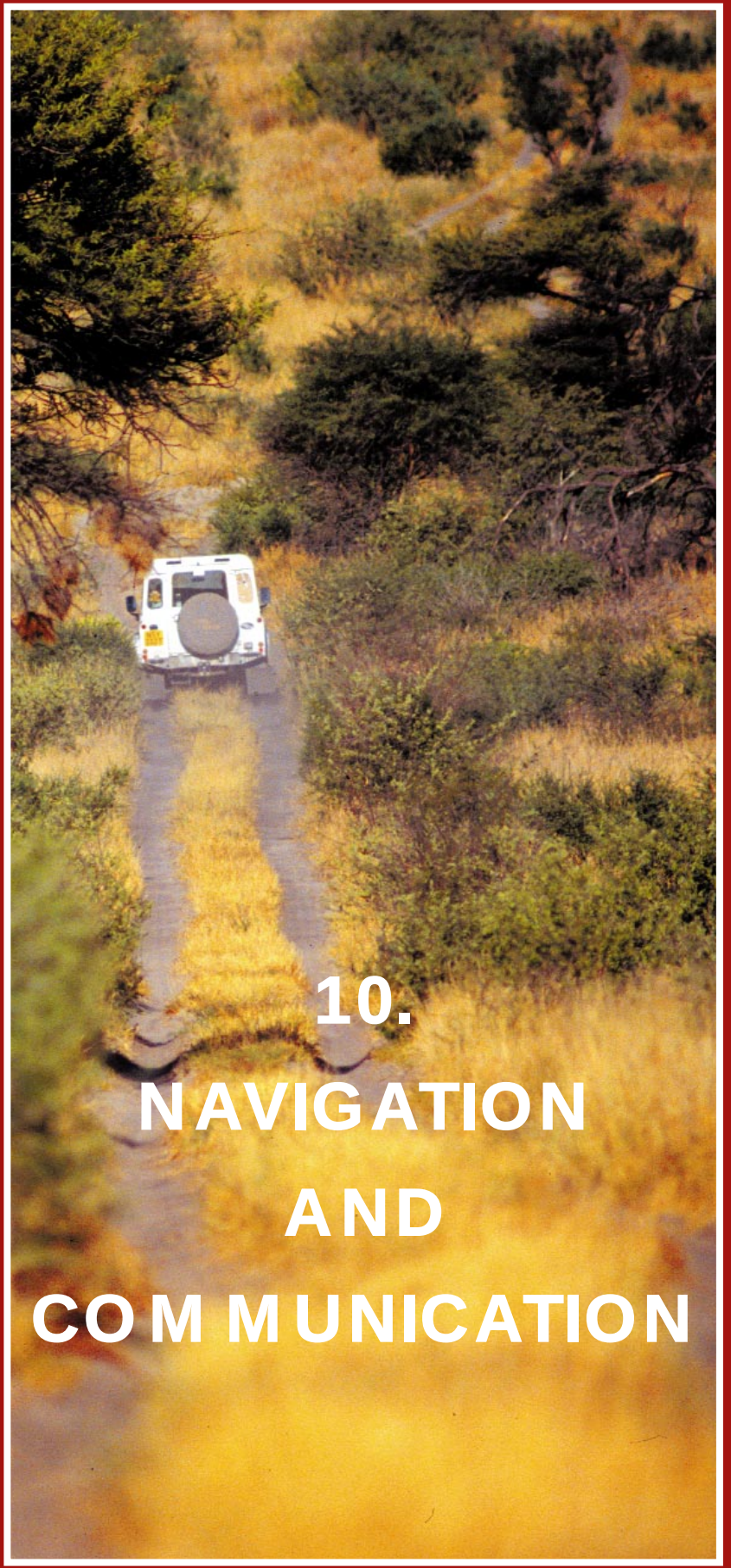
DENSITIES OF LIQUIDS:

Water	1.00	Antifreeze	1.114
Petrol	0.78	Battery acid	1.28
Diesel	0.86	Lubricating oil	0.91
Alcohol	0.79	Kerosene	0.76 to 0.86
Silicone oil (WD40)	0.76 to 0.98		

DIESEL FUEL CONTAMINATION CHART

CONTAMINANT	CONSEQUENCES	TEST METHOD
Water	Damage to pump and injectors. Rapid rusting, possibly overnight.	Visual inspection of sample of settled fuel. Water will be seen as a separate layer.
Foreign bodies	Damage to pump and injectors. Possible pump seizure.	Visual inspection of sample. (dirt) Large particles will settle at bottom. Small particles can be filtered out. No loss of smell.
Petrol (Gasoline)	Fire risk - 2%. Contamination makes diesel as hazardous as petrol. Damage to pistons.	Petrol is less dense so will settle at top. Strong gasoline smell. Poor hot start.
Kerosene (paraffin)	Reduced lubrication leads to pump and injector damage but only with severe contamination.	Only detectable by the weight/density test. No detectable change in smell.
Fuel oil (boiler)	Carbon build up in injectors and cylinder head.	Colour jet black. No detectable change in smell.
Oxidisation	Only heavily oxidised fuel is a risk.	Colour darkens. Acrid smell.

(Source - Land Rover's Manual For Africa - Land Rover LTD.)



10.
NAVIGATION AND COMMUNICATION

NAVIGATION

This chapter is in two parts, GPS navigation followed by traditional map, protractor & compass navigation. Despite the accuracy of a GPS, much of what is required in traditional map work still applies when using a GPS.

THE GPS

Today the most common navigational aid used by the off-road explorer is the Global Positioning System (GPS). There is a constellation of 24 GPS satellites and tapping into this $14 billion resource is free of charge. The receivers or plotters can be described as hand-held satellite tracking computer receivers which are extremely accurate for determining three dimensional position fixes (latitude, longitude and altitude). It is essentially a time measurement system in which signals sent from a series of satellites are received and time differences measured. Ranges are measured simultaneously from a minimum of four satellites (for a 3-dimensional fix) and providing that the satellites' positions are known the receiver's position can be established. The GPS updates its position fix continually.

When the GPS is moved it provides a host of other information useful to the navigator. Speed, track, distance covered, distance to go, estimated time to go to destination, track to starting point etc. The GPS gives a sense of security to the traveller, and as a pilot it has taken much of the stress out of long distance flying.

The Global Positioning Systems used by civilians are a result of the development of a military navigation system but are modified to be less accurate. I believe that the true military GPS can give position fixes accurate to within half a metre. The accuracy of the system one can buy over the shelf averages 100 metres.

Choosing a GPS

Like everything relating to computers, the moment you take your GPS receiver home it will be superseded by a better, smaller and faster model. All modern GPSs are much alike but as a four-wheel driver will demand different things from a GPS than a pilot, GPSs can no longer be regarded to be the same. Firstly an aircraft travels faster and in a straighter line than a vehicle and secondly, for a vehicle, a backtracking feature is very useful if not essential. Units with fewer buttons often used to be more complicated to operate because of the dual functionality of the controls, but many current models are designed for single-handed use, where the GPS is held in the palm of the hand and the buttons are pressed with the thumb. This system is ergonomically pleasing and easy to use.

When perusing the range of GPSs, glance through the instruction book of the one that catches your eye, look specifically at one particular function and go through the routine. By doing this you will see if the instruction book is well laid out and well written, as you will need to study your GPS and its instruction book to enable you to use it to its fullest advantage. Size and battery life

are important features if you also want to use a GPS for hiking. Backtracking features are very useful.
An external antennae is required for use while travelling, especially in vehicles with flat windscreens. Vehicles with well slanted windscreens may not need an external antennae to operate but the incoming signal may be weak.

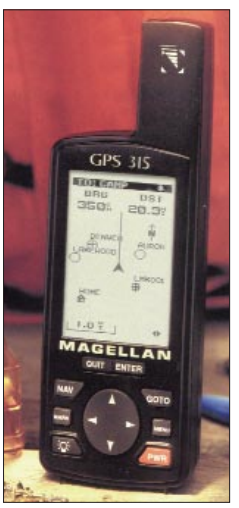
Important features to look for:

- *Ease of use*
- *External antennae (flat windscreens)*
- *External power supply*
- *Backtracking*
- *Protective bag*
- *Size (hiking)*
- *Battery life (hiking)*

HAND-HELD GPS RECEIVERS

All of the GPS receivers illustrated below are suitable for use in a vehicle. Money buys computing power, so the more you spend, the quicker and more accurate the receiver will be.

The world's leaders in hand-held GPS technology are Magellan and Garmin. No single product stands out as the very best and it is unlikely, whatever your choice, that it will be a disappointment. Like all technology, changes are swift and new models become old models very quickly.



Although there are other GPS manufacturers I have intentionally restricted this buyers' guide to the two main contenders.

MAGELLAN

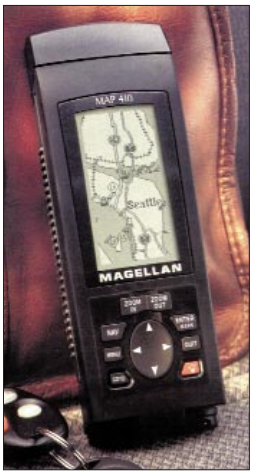
Magellan products are available from Pertec, 011 805 1996 (Johannesburg), 021 419 4450 (Cape Town). Megellan have a broad range starting at the budget GPS300 to the Colortrak powerhouse.

MAGELLAN BLAZER 12, GPS300, 315, 320

The Megellan Blazer and GPS300 are about as basic as you can get with a GPS - but there are enough features for use as an overland navigation system. The 315 and 320 are moreadvanced but still classed as budget receivers.

- AllView® 12 GPS Technology tracks 12 satellites even under dense cover
- Backlit display, fast, economical, lightweight, rugged and it floats
- EZstart with three nav screens.
- Store up to 100 waypoints, one route, 10 reversible legs. 500/20/30 with GPS 315
- 315 and 320 permit download to and from CD. 320 has back-track feature and database
- Power: 24 hours on 2 AA batteries
- Accessories standard: Carry case, lanyard strap, user's manual, quick reference guide
- Accessories optional: Swivel mounting bracket, external 16-12volt power cable

Previous page: Magellan GPS 315.
Right: Magellan Colortrack. GPS Tracker shares design but with monochrome screen.
Far right: Magellan MAP 410



MAGELLAN TRACKER AND COLORTRAK

These two models are the top of the range in hand-held GPS receivers and feature a large display with clear large digits, ideal for a driving environment. Features are top-spec. The colour screen of the Colortrak is a luxury, not a necessity. Nice features include Northfinder, course projection indicator and a thermometer.

- AllView® 12 GPS Technology tracks 12 satellites
- Extra wide screen
- Rubber grip and anti-slip backing, robust and waterproof
- IBM PC compatible downloading facility
- Seven navigation screens which can be customised
- Stores up to 500 waypoints, 20 reversible routes of 30 legs each
- Nine navigation screens
- Power: 30 hours on 4 AA batteries
- Accessories standard: Carry case, lanyard strap, user's manual, quick reference guide, detachable antenna with BNC connector
- Accessories optional: Swivel mounting bracket, external 16-12volt power supply, magnetic antenna mount, data cable, PC kit, 6ft coax cable, suction antennae mount, low profile antenna

MAGELLAN MAP 410

This models challenges the Garmin GPSIII with its moving map display. Database for loacl maps can be downloaded via computer.

- All features as per Color Trac. Additional features include very accurate altimeter course projection indicator and a thermometer.

AllView® 12 GPS Technology tracks 12 satellites

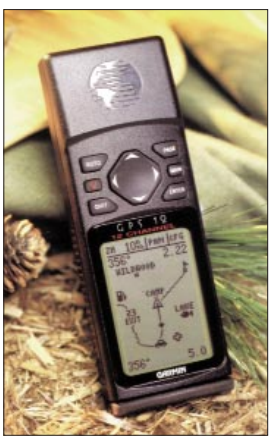
GARMIN

The agents for Garmin products are 0400, 021 948 8501 and Century Avionics (A Trading) 011 701 3244.

Garmin GPSIII

GARMIN GPS II PLUS AND GPS III

- PhaseTrac12
- User-friendly rocker/keypad, backlit LCD display with easy-to-read characters and full-featured moving map plotting.
- Screen switches from vertical to horizontal with the press of a button.
- Trip odometer, auto start/stop trip timer, average and maximum speed and more.
- EZinit feature allows fast point-and-shoot initialisation.
- Dedicated keys for zooming from 0.2 to 360 miles diagonal panning with rocker key pad.
- Moving map. GPS III only.
- User-selectable navigation screens for compass or graphic highway steering guidance.
- Waypoints: 500 alphanumeric (9 automatic)
- Internal lithium battery maintains important waypoints, routes and track log information.
- Routes: 20 reversible, up to 30 waypoints each, TracBack® & MOB modes.
- Acquisition times: warm - 15 secs, cold - 45 secs, autoLocate ±5 minutes, EZinit 45 secs
- Accuracy: 15 metres RMS
- Speed limit: 90 knots
- Physical: weight 255g w/batteries, 5.89x12,7x4,11cms, display 5.6x3.8cms.
- Power: 4 AA batteries, 0,75watts, 14 hours in normal mode, 20 hours battery saver mode, internal lithium battery backup
- Accessories standard: Carry case, batteries, wrist strap, users' manual, quick reference guide, detachable antenna with BNC connector.
- Accessories optional: mounting kit, power/data cable, cigar lighter adapter, PC kit, remote antennas - magnetic and marine.



Left: Garmin GPS 12
Centre: Garmin GPS 12 CX

GARMIN GPS 12

- 250 alphanumeric waypoints, 20 reversible routes and 14 to 20 hours of use from a single set of alkaline batteries
- TracBack® allows retrace of route without entering waypoints
- Internal lithium battery maintains important waypoints, routes and track log information.
- Waypoints: 250 alphanumeric (9 automatic)
- Routes: 20 reversible, up to 30 waypoints each
- Acquisition times: warm - 7 secs, cold - 2 mins, autoLocate® 7,5 minutes
- Accuracy: 15 metres RMS
- Speed limit: 90 knots
- Physical: weight 255g w/batteries, 15,5x5,1x3,1cms, display 5.6x3.6cms,
- Power: 4 AA batteries, 0,75watts, 14 hours in normal mode and 20 hours in battery saver mode. Internal lithium battery backup.
- Accessories standard: Carry case, batteries, wrist strap, users' manual, detachable antenna with BNC connector, quick reference guide.
- Accessories optional: mounting kit, power/data cable, cigar lighter adapter, PC kit, remote antennas - magnetic and marine.

GARMIN GPS 12XL AND 12CX

- PhaseTrac12® receiver continuously tracks and uses up to 12 individual satellites
- Proximity waypoint feature warns of approaching hazards
- Innovative TracBack® feature turns your track log into an instant breadcrumb trail so you quickly navigate back home, even if you haven't stored waypoints
- User definable map datums and UTM grids let you customise the data used for positioning
- User-friendly rocker keypad system allows room for a large backlit display with easy-to read characters and full-featured graphic plotting
- Large memory holds 500 waypoints or 20 routes of up to 30 waypoints each
- User-friendly rocker/keypad, high-contrast LCD display with easy-to-read characters and full-featured moving map plotting. Colour screen on CX
- Waypoints: 500 alphanumeric (9 automatic)
- Routes: 20 reversible, up to 30 waypoints each, TracBack & MOB modes
- Acquisition times: warm 15 secs, cold 45 secs, autoLocate® 5 minutes
- Accuracy: 15 metres RMS (selective availability program)
- Speed limit: 90 knots
- Physical: weight 269g w/batteries, 5.89x12,7x4,11cms, display 5.6x3.8cms. Ultrasonically welded heavy duty case
- Power: 4 AA batteries, 35 hours CX, 24hours XL, internal lithium battery backup
- Accessories standard: Carry case, batteries, wrist strap, users' manual, quick reference guide, detachable antenna with BNC connector
- Accessories optional: mounting kit, data transfer cable, cigar lighter adapter, PC kit, remote antenna

USING A GPS RECEIVER

Without the aid of a map or compass a GPS receiver (depending on features) can accomplish the following:

- *Pinpoint your position*
- *Give you direction from your position to a given waypoint.*
- *Tell you which way to travel to get to a waypoint. It will give a compass bearing which must be followed. If no compass is available then the trip must be begun by guessing the direction until the GPS reads a position change and correct the course.*
- *Calculate a speed over the ground.*
- *Calculate an average speed between two waypoints.*
- *Estimate the time it will take to reach a given waypoint/s.*
- *Calculate the distance to a given waypoint/s.*
- *Calculate the distance covered.*
- *Record a path taken to allow the navigator to find the way back to the starting point covering the same path.*
- *Store waypoints for instant retrieval, such as favourite fishing spots and secret campsites.*

Working with a compass and a map a GPS receiver has the following added functions:

Added functions are:

- *Converting latitude and longitude measurements from the GPS to a map and vice versa.*
- *Plot and record positions on a map.*
- *A compass converts bearings supplied by the GPS into a direction in which to travel.*

The most common use of a GPS is simply to follow given directions and as more 4x4 trail books and maps are being published with position fixes, the GPS is becoming more popular. Even in this, the most basic use for the GPS, a compass is required as all the GPS will tell you is where you are and supply a compass bearing in which to travel. A bearing is a number in degrees - you need a compass to point the way or to plot it on a map.

Converting co-ordinates onto a map

Let's say for example, the co-ordinates (in this case Bethlehem airfield) is your position fix. Your GPS reads: 27 30 00S 28 20 20E.

Translated into English this means: 27 hours, 30 minutes and 0 seconds line of latitude by 27 hours, 30 minutes and 20 seconds line of longitude. To pin-point this onto a map do the following:

The best maps for navigation are topographical because they have an accurate grid drawn on them. At the extreme top and bottom of the grid there is a ruler displaying longitude co-ordinates. Simply run along this line and locate your longitude co-ordinate and make a mark - in this example 28 20 20E. For the latitude co-ordinate do the same thing by following the rulers down either the left or right side of the grid - in this example 27 30 00S. The final step is to run lines parallel to the grid from the marks you have made and where the lines intersect indicates your position.

TRADITIONAL MAP READING

From this point you will use a map to navigate and convert the position marked on the map to a bearing on which to travel.

With knowledge of how to use a GPS and compass, how to convert bearings taken from the compass and plot them on a map will give you all the power at your fingertips to navigate with full confidence in any terrain.

THE COMPASS

Not all compasses are the same and their features will determine their versatility. For use in conjunction with a GPS as well as for regular map navigation the prismatic type compass is ideal.

The prismatic compass has the card (the part that rotates, indicating bearing) enclosed in a small case with a lid. The lid consists of a frame and a window with a hair line running vertically down it, and an extension on the opposite end to the hinge. The extension is known as the tongue and has an indentation, in the end of which is a hole to the hair line. Below the lid is another window which is marked in degrees. It can be rotated and has a pointer. On some models it can also be locked by a thumb screw clamp on the side of the compass body.

Below this is yet another window under which is the compass

0˚ - 360˚, together with the four cardinal points; east, south, west and a pointer indicating magnetic north. On the outer rim of the compass card, the degrees are printed in r
viewed through the prism the correct way up. On
pass card, the degrees are marked off in 20˚ intervals.

The Divider

A divider is used by using measurements from the linear scale printed on the map to gauge distances on the ground. Although this can be done with a simple ruler, a divider is more accurate, faster and more versatile. They can be purchased from any stationery shop.

Place the left point onto a whole number on the linear scale and the right leg on a whole number to the right of zero. Then by placing the left point on a place on the map, quick distance calculations can be made. To the left of zero on the linear scale, the distance is divided into fractions. These fractions are used in the same way.

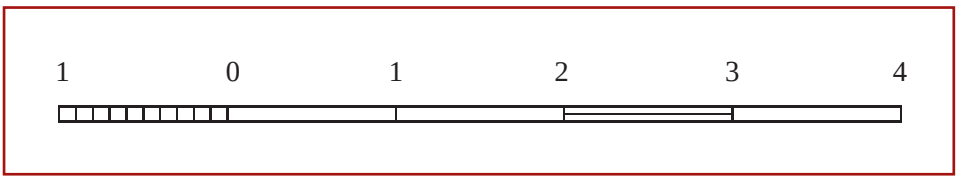
Maps

Topographical maps are referred to in this chapter as they are the most useful type of map for ground navigation. Topographical maps are drawn from stereo aerial photographs. They represent an area's topography, or the physical features of an area.

Scale

The scale of a map is the ratio between the distance represented on a map and the horizontal distance between the same two points on the ground.

The most common scale of topographical maps of Southern African is 1:50 000. The entire map normally represents a square measuring 25 X 25 kilometres. This totals 625 square kilometres. Maps are also available at a scale of 1:250 000, but these will lack some detail that may be of use to the ground navigator.



One rises 250 metres in 1 kilometre
or 250 metres in 1 000 metres
or $\frac{1}{250}$ metre in 1 000 metres
or 1 metre in 4 metres

What the scale represents

For example, 1:50 000 means that for every 1mm represented on the map, 50 000 mm is represented on the ground. No matter which measurement system you are using, the same applies; for every 1 inch represented on the map, 50 000 inches is represented on the ground. This scale is also called the representative fraction, and in this case it is 1/50 000.

With a 1:50 000 scale map, 2 centimetres represents 1 kilometre. This is obvious if one considers the calculation; 2cms = 20mm. 20 X 50 000 = 100 000 or 1000 metres = 1 kilometre. Don't let this confuse you - just remember that 2 centimetres represents one kilometre on a 1:50 000 map.

The scale of a map is of great importance to the navigator. If you are working in a small area of ten kilometres, then a small scale map will be of greater use, because the smaller the scale, the more detailed the map will be. If you are working in a large area, for example 300 kilometres, then a larger scale map will be of more use as more area will be represented on the same map.

Heights on a map are represented by contour lines. On a 1:50 000 map, they are normally drawn at intervals representing 20 metres. Intervals in feet are drawn on older maps. This interval will be stated in the map key or scale.

Orthophoto maps are available for some areas, and are particularly useful. These are prints of aerial photographs with the contour lines over-printed. They combine the advantages of photographs and topographical maps.

Using the compass

Bearing: the angle measured clockwise from True North, Magnetic North or Grid North.

Taking a bearing:

- *Open the lid to a vertical position, the hair line running down vertically.*
- *Fold the prism over so that it lies flat on the compass window. Place your thumb in the ring and hold the viewing prism up to your eye, supporting the compass with your forefinger. The compass must be held as horizontally as possible.*
- *Swing around and view the object on which you wish to take a bearing.*
- *Line up the hair line to the exact point on the landscape, and let the line cut through it.*
- *Cast your eye downward. You will see that the hair line also cuts through numbers written on the compass card. When the compass card has come to rest, read off the number. This number is the magnetic bearing of that object.*

A magnetic compass can give a false reading if it is placed in the following places:

- *Inside a vehicle.*
- *Close to a vehicle. Walk 20 metres away if it is a light car or truck, and 60 metres away if it is a large truck.*
- *Electrical power cables. Move at least 40 metres away.*
- *Spectacles and jewellery made from steel or other magnetic material.*

If you are in any doubt that a reading may be inaccurate due to external influences, take more than one bearing. Walk some distance away from or towards the object on which you are taking a bearing, and the reading should be the same. If it is not, then you know that one of the readings is false. To confirm which one is false, you must then take a third bearing. If all three are different, then some common magnetic source is affecting all your readings and you should move a considerable distance away and start the process again. This may occur if you are in an area of rocks containing large deposits of magnetic material.

The three norths:

When working with bearings and maps it is essential to know about the three norths: magnetic north, true north and grid north.

Magnetic north:
This is the direction to which the compass card pointer will always point. It is the direction on a map that is clearly marked 'Magnetic North'. It is also the bearing which a GPS receiver will display.
True north:
True north never changes. The North Pole is the most northerly point and is situated at 0˚ true north.
Grid north:
Maps are covered with lines, running both vertically and horizontally, dividing the map into squares. In fact an entire country is divided up into squares on a grid system. It follows that if these squares are in fact square, and the earth is round, not all of the vertical lines will point to true north. (Remember a map is a three dimensional area represented in two dimensions). The difference between grid north and true north is very slight, so for practical purposes they will be regarded as the same.

Because of the three norths, there are three types of bearing: magnetic bearing, grid bearing and true bearing.

The three bearings:

Magnetic bearing:
This is the direction in which the compass card pointer will read and relates to magnetic north.
Grid bearing:
This is measured on a map with a protractor.
True bearing:
Because of the curvature of the earth, the grid lines on a map do not always point to true North. For practical purposes we shall regard the grid bearing and the true bearing to be the same.

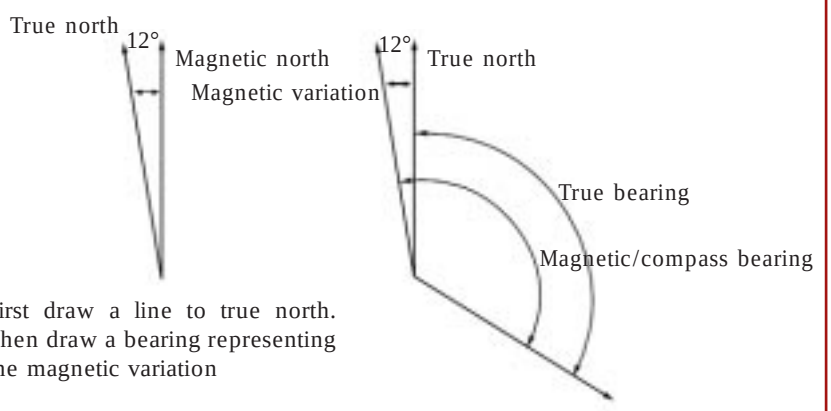
The protractor and the conversion of compass bearings, GPS bearings and map bearings

The conversion of bearings is necessary if you wish to use your map and compass/GPS together. Another important tool to the navigator, the protractor, will be used. The protractor is a link between the compass and the map. It enables a bearing taken in the field to be

to be measured in degrees and then used in the field to find your way with the aid of a compass or GPS.

To plot a bearing on a map:

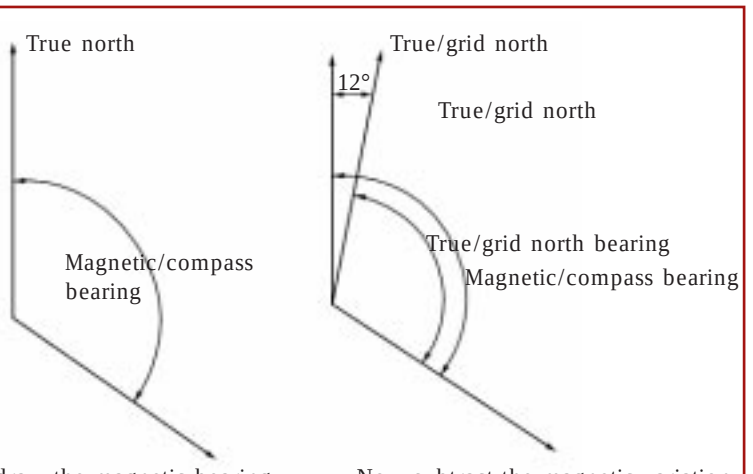
- *Draw a pencil line between two positions on a map from which you wish to take a bearing.*
- *Place the protractor on the map so that the base line is absolutely parallel to the grid lines on the map. If the bearing to be measured is between 0˚ and 180˚, place the protractor to the right of the point on the map and if the bearing to be measured is between 181 and 360˚, place the protractor to the left of the point on the map as follows:*
- *Place the zero edge, or base line (from were the degrees marked is zero) over the pencil line so that it precisely cuts through it. It can be placed anywhere along the plotted line.*
- *Read off the degrees from the degrees scale on the protractor. This is the grid bearing from one point to the other.*



First draw a line to true north. Then draw a bearing representing the magnetic variation

The compass bearing is then drawn on the same diagram. The 12° magnetic variation must be added to the true bearing to arrive at the magnetic bearing.

CONVERTING A GRID BEARING TO A MAGNETIC BEARING



First draw the magnetic bearing

Now subtract the magnetic variation

CONVERTING A MAGNETIC BEARING TO A GRID BEARING

CONVERTING DEGREES TO GRADIENT:			
1° = 1 in 57.29		14° =	1 in 4.01
2° = 1 in 28.63		15° =	1 in 3.73
3° = 1 in 19.08		16° =	1 in 3.48
4° = 1 in 14.3		17° =	1 in 3.27
5° = 1 in 11.4		18° =	1 in 3.07
6° = 1 in 9.5		19° =	1 in 2.9
7° = 1 in 8.14		20° =	1 in 2.75
8° = 1 in 7.11		25° =	1 in 2.14
9° = 1 in 6.31		30° =	1 in 1.73
10° =1 in 5.67		35° =	1 in 1.43
11° = 1 in 5.14		40° =	1 in 1.19
12° = 1 in 4.7		45° =	1 in 1
13° = 1 in 4.33			

If this bearing is now going to be used to travel to an object, it must first be converted from the grid bearing taken to a magnetic bearing so that a compass can be used to follow it. In the case of navigating with a GPS, the two positions can be stored as way-points and the GPS will do the rest.

Converting bearings

Firstly, you need to know the magnetic variation of your map. It is written on the base of all topographical maps. Let us assume it is 12° west. This means that whatever grid bearing you have measured on your map will be 12° more or less than the magnetic bearing.

Converting a grid bearing to a magnetic bearing

The best way to find out if you should add or subtract the 12° is to draw a diagram. Draw a line to true north. The variation is 12° west, so draw another line 12° west of the line to true north.

Converting a magnetic bearing to a grid bearing

Converting from a compass bearing to a map/grid bearing is a similar procedure but the process is reversed. First draw a diagram of the magnetic bearing that you have taken from your compass. You will now want to convert this bearing to a grid bearing so you can plot it on your map.

Features of Maps

Contour lines

Heights on a map are represented by contour lines. Contour lines are continuous lines drawn on a map that join all the areas of equal height above sea level. By looking at the shape of the contour lines the map reader can read the shape of hills and valleys and also judge the gradient of slopes.

Other ways of indicating height are trig beacons, spot heights and colours. Using these for navigation will result in improved accuracy.

Trig beacons

These appear as a small triangle with a dot in the middle. They have a figure printed underneath or alongside which indicates the exact height above sea level.

Spot heights

Black dots usually on a hill, or on the highest point on a road, also indicate the exact height above sea level.

Contour lines and gradients

For the off road driver, an understanding of gradients and how they appear on a map is of great importance.

Where a series of contour lines run equidistant to each other the slope has an even unchanging gradient. Where contour lines are close together, the slope is steep and where contour lines spread far apart the slope is gentle. How gentle or how steep the slope is, is determined by the vertical scale. If the contour lines are drawn at 100 metre intervals (this interval can be seen by reading the numbers written on each contour line) then with the aid of a ruler or a pair of dividers to measure the distance between each contour line, and by referring to the scale of the map, the angle of the slope can be calculated.

The distance between two points on a map is called the Horizontal Equivalent (HE). The difference in altitude between these two points is known as the Vertical Interval (VI).

To calculate the gradient of a slope, the formula is as follows:

For example, the distance between two points (HE) is one kilometre or 1000 metres, and the height difference (VI) is 200 metres:

- *Contour lines drawn at height intervals of 20 metres which are 2mm apart mean that the slope rises 20 metres every 100 metres. (2mm converted to scale of 1:50 000 is 100 metres).*
- *Likewise, contour lines drawn at height intervals of 20 metres which are 50mm apart means that the slope rises 20 metres every 2500 metres. (50mm converted to scale of 1:50 000 is 2500 metres = 2 kilometres).*

Another example is a one in one slope. This is a slope that for every one metre covered horizontally, there is also a one metre gain in height. The contour lines will be 0.4mm apart. For some off road vehicles, a one-in-one slope is technically possible, but the calculation of a vehicle's ability to climb a gradient is measured when driving on a smooth concrete surface offering ideal traction to all four wheels. Driving over ground is very different, as there will be other obstacles to halt your progress.

Colours

Areas of height can also be coloured to assist in quick recognition of landmarks. Greater heights are normally shaded darker. You will notice that the edge of each shaded area runs along a contour line.

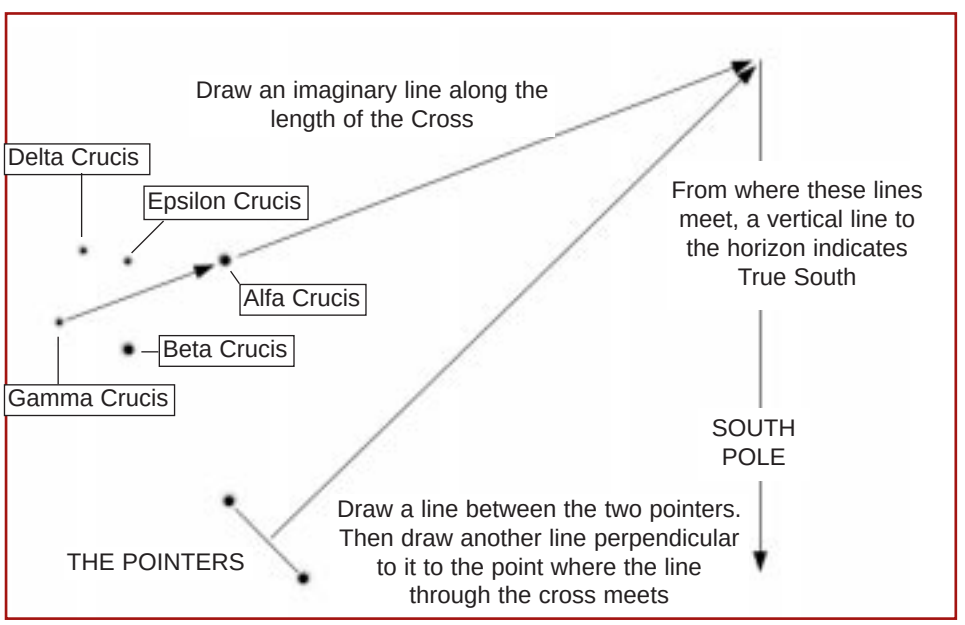
The Southern Cross

This constellation is best viewed between January and September because it is during these months that the Southern Cross is highest in the sky. So many people travelling from the northern hemisphere to the south often ask about this famous constellation that is represented in the national flags of Australia and New Zealand.

The stars of the Southern Cross constitute the constellation Crux, a Latin word meaning cross. It is the smallest of the 88 constellations in the sky. To face south, estimate the position on the horizon where the sun sets and then turn anti-clockwise for approximately 90˚. The stars of the Southern Cross are bright and well defined, so if you know what you are looking for it will be easy to locate. As shown in the diagram, the Cross is often seen lying on its side. There are also two bright stars, although not strictly part of the same constellation, that point to the 'top' of the crucifix, and aid in its location. They are called the Pointers. These two stars form the two front feet of the half-man, half-horse constellation of Centaurus. One of them, Alfa Centauri, is the closest star to our solar system and is a mere 4.3 light years from earth. (The measurement of distance when talking about the stars is the light year. It is the distance at which light travels in one year which is 9.4607 million million kilometres).

The other star, Beta Centauri, is 330 light years from earth. The Cross itself is made up of five stars and an area that appears devoid of stars which is called the Coal Sack, which is what astronomers call a dark nebula. It is an area sufficiently opaque as to hide the stars behind it.

Another interesting feature of the constellation is that the colour and brightness of each star varies, and this can be seen easily with the aid of binoculars. The stars are named after letters of the Greek alphabet, Alfa being the first letter. The others in order of brightness are; Beta, Gamma, Delta and Epsilon Crucis. The colour



variation tells us how hot each of the stars are. Gamma Crucis is red, indicating a relatively cool star whose surface temperature is close to 2000˚C. Epsilon Crucis is orange and a little hotter while Alpha, Beta and Delta are blue white stars with surface temperatures exceeding 25 000˚C.

As the diagram illustrates, by creating an imaginary line along the long axis of the Cross and a line perpendicular to a line drawn between the two pointers, the intersection lies directly due south (not magnetic south).

Finding your way

In the event that you are lost and you have neither map, compass or GPS, the most obvious thing to do is to follow your tracks and retrace your steps. But if you have been driving around lost for some time, following your tracks will probably be of little use. The best course of action is as follows:

- *Think back on landmarks that you drove close to before you became lost or disorientated. Rivers or dry river beds, small hills, villages or settlements, cattle or game watering holes and very tall trees are all things that you could make your way back to.*
- *Now calculate where north is. If you have no compass use the methods described previously. Finally, work out the approximate direction from which you have come and write it down; north-east, south-west etc.*

Landmarks

Rivers and dry river beds

The one thing that rivers, dry or flowing have in common is trees. Walk to the highest point that you can find. Stand on your vehicle's roof or climb a tree if necessary. Scan the horizon with your binoculars. A river valley will appear to be a long stretch of trees that are greener and taller than those surrounding them. Knowing where north is, write down the bearing of the trees to which you are heading. If the ground is flat you may have to re-establish north and/or look for the landmark periodically.

Villages and settlements

Paths with human footprints or litter will either lead to a settlement or a source of food or water. It may be necessary to walk in front guiding a vehicle along at walking pace.

Cattle or game paths

A little tracking knowledge or a book about animal tracks will help you determine whether a path is cattle or game. If the path is well trodden, it will probably lead to a watering hole or river. If it goes in the approximate direction from where you remember seeing a familiar landmark, such as a water hole, follow the path.

COMMUNICATION

No matter what you do with your four-wheel drive vehicle, communications can make it safer and often a lot more fun. Whether you are off-roading in a club environment, touring or overlanding in remote terrain you can have confidence that someone else knows where you are which lets you push the limits a little further.

The technology explosion over the last 20 years has resulted in efficient radio communication products becoming smaller and smaller; in some cases the size has been reduced to 1/20 of the size of radios of the 1970s. Batteries last longer, weigh less and reliability has been dramatically improved with some manufacturers obtaining Mil.Spec (military specification) approval for their equipment.

Competition between the manufacturers has also created an environment for better, cheaper, more reliable and smaller products and in such a market the consumer always wins. A number of duties and surcharges have been dropped and or reduced, compensating for the jump in the dollar - rand exchange rate, with some products being cheaper now than they were five years ago.

EQUIPMENT

Before investing in radio equipment ask yourself the following questions:

- *How far do I need to communicate?*
- *Will I be on foot or in a vehicle most of the time?*
- *Are the radios going to be for emergencies, fun communications, business control or for safety of clients.*

Radio equipment is available in the following modes:

- *FM (frequency modulation) - crystal clear communications.*
- *AM (amplitude modulation) - noisy communications, clear for short range.*
- *SSB (single side band) - gives the best range and even if no signal is present on the built-in meter the voice quality can be excellent.*

Radio equipment will give you the following ranges:

- *FM Equipment - up to one kilometre.*
- *HF Equipment (also called SSB or long distance radio) - up to 5000km*
- *VHF Equipment (Midband range) Mobile radio up to 70 km, hand-held up to 3 km.*
- *VHF Equipment (Highband range) Mobile radio up to 25 km, hand-held 0 to 3 km*
- *AM Equipment (similar to above but better penetration through concrete) 29 MHz (Ski boat type) mobile radio up to 15km, 27 MHz CB radio up to 30km*

The information above is approximate and ranges are dependent on output power of equipment, antenna type, terrain, altitude, and in

the case of HF, time of day and solar activity and frequency. Hand-held radios are ideal for very short range communications (line of sight).

The advantages / disadvantages of hand-held radios are:

- *Size*
- *Portability*
- *Reduced range*
- *Limited by battery life*

With a full charge and intermittent conversation the battery on a typical hand-held, the Motorola P110 gives about 7 hours of use. Extra batteries can be purchased and they are small enough not to get in the way in your pocket or backpack. Batteries can be charged from 220v AC supply or from a cigarette lighter socket, with an optional adapter. Accessories are available to make the use of the hand-helds easier, such as speaker, microphones, headsets with boom microphones, carry cases, etc.

Advice on purchasing hand-helds is to look for well-known brands that will be well supported with a spares network in most countries. Motorola products have proved themselves and are probably the most used hand-held radios in the world.

MOBILE RADIOS VHF MIDBAND AND HIGHBAND

Mobile radios will give you a range of up to 70 km depending on the frequency and antenna installation.

Mobiles are 5 times more powerful than hand-helds. These are ideal for vehicle convoy applications as well as for hunting, game counting, rescue, hot air balloon recovery, boating and fishing.

The advantages are:

- *High power*
- *Range of up to 70km*
- *Cannot be dropped or lost.*
- *Vehicle antenna is efficient*
- *These radios are very versatile in that they can be programmed for repeater use, the prime source of communications in urban areas.*

MOBILE HF LONG RANGE SYSTEMS

HF or high frequency systems offer communication from your vehicle for a range of 5000km plus. There are numerous factors affecting the range of HF systems such as:

- *Installation quality*
- *Frequency selection*
- *Time of day*
- *Transmitter power*
- *Antenna position*
- *Solar activity*

You can invest anything between R10 000 for a top ham HF rig down to a less than R1000 for a CB radio. The more you spend the more versatile the equipment.

If you need to communicate with your office, make telephone calls and require communications for safety purposes in remote areas, HF is the way to go. With a professionally installed system (including an automatic antenna tuner) you can expect to have good communications for 90% of the day (daytime hours). Communications are usually good in sub-equatorial Africa and always better than the rural telephone systems. For trans-Africa trips specific frequency predictions can be carried out to ensure that communications are successful from Cape Town to London.

The HF system can be directly linked to numerous telephone systems, and with the use of an operator you can make telephone calls to any location in the world. These telephone systems, which are similar to the system used in the Australian outback, are used extensively in Africa. With a similar system at your office you can go touring for weeks and still keep control. By linking a laptop computer to your radio you can send and receive data files from your office.

Advantages of HF:

- *World wide communications.*
- *Telephone facilities.*
- *Vehicle antenna is efficient.*

HF radio systems are not easy to install and will not work unless the correct frequency selection is made and applied for by the dealer. When selecting a dealer to install a system ensure that he has successfully installed HF systems in the past (ask for references) and that he can undertake computer simulated frequency predictions for your application. Insist that the equipment is synthesised, not crystal controlled, and that the equipment will automatically reduce power if antenna problems occur.

29 MHZ AND CB RADIOS

These systems are the cheapest available and are ideal when travelling in convoy with communications up to 15 km. The system is AM and is therefore associated with the usual snap, crackle and pop of this mode. These radios only put out 4 watts of power and have limitations in terms of versatility. When a single side band CB is used, power output increases to 12 watts and you will be able to communicate up to 30 km, albeit with worsening voice clarity.

Advantages:

- *Range*
- *Price*
- *Low power consumption*
- *Sound quality*

With all radio communications the single most important factor is well-engineered and accurately tuned antennae. There is no point in spending thousands of rands on a top quality transceiver if you cannot hear anyone because the antenna has not been properly installed.

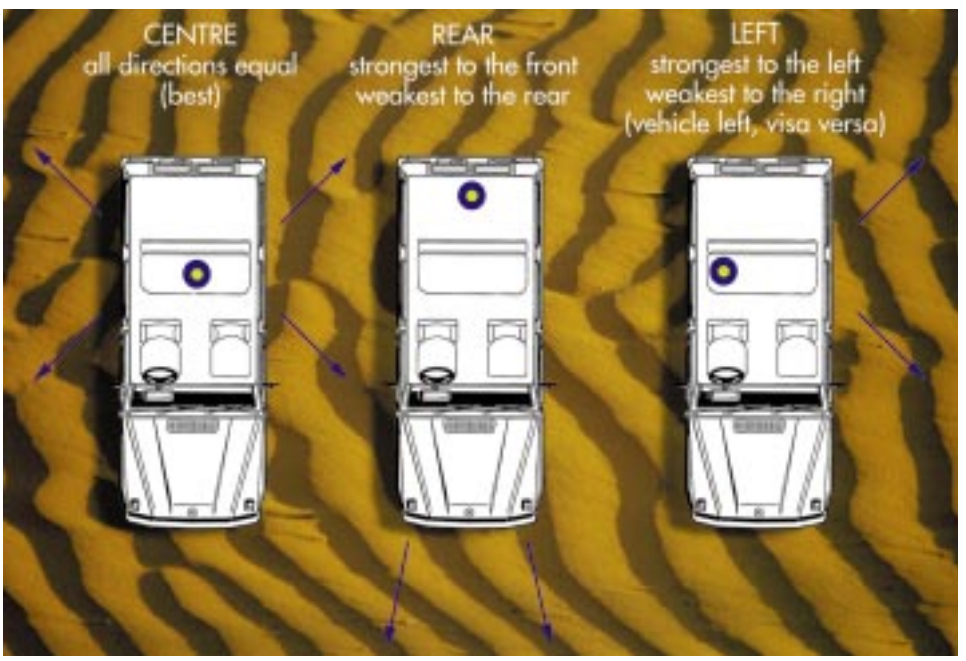
There are basically three types of antennas on the market - magnetic, glass mount and body mount antennas.

Magnetic antennas have the advantage of being easy to remove and install but have a number of distinct disadvantages. With vehicles having aluminium bodies the antennas do not stick, even a small amount of dust will cause damage to the vehicle paintwork and overhead bushes can knock it off. Also the antenna cable will have to be fed into the vehicle through the door or window and will result in dust entering the vehicle and the chance of damaging the antenna cable is increased. The only real application would be in a hire vehicle in which you cannot drill holes.

Kenwood's UBZ series of diminutive FM two-way radios offer brilliant voice clarity over short distances for little money. Perfect for driver training but without the range required for convoys of more than two vehicles. A wide range of accessories include hands-free vox headsets and other bits and pieces that make them versatile and fun. Available from Makro.

Glass mount antennae are neat and easy to mount and also do not require holes. These antennae are the least effective of all and the only application that they have is on radio repeater systems and then only if you are close to the repeater.

Body mount antennae are therefore the best way to go. If installed properly the vehicle will not rust around the antenna and the antenna's earthing system will be sound. The antenna cable is mounted permanently and is therefore less susceptible to damage



The location of the antenna on the vehicle will affect the radiation pattern of the antenna which will affect transmission range. The antenna should be mounted as high as possible.

by friction or passengers. In general the higher the gain an antenna has, the better the range over flat ground will be. However, this will be a slight disadvantage in hilly terrain.

INSTALLATION

The radio, no matter which type, should always be connected directly to the battery via a fuse, and not to any convenient wire under the dashboard. By doing this, you will isolate any interference from the vehicle's electrical system which could be misinterpreted as poor reception. A filter can be wired between the power supply and the transceiver to reduce interference. The fuse is purely a protective measure against short-circuit and fire.

Positioning of the radio

The actual transceiver should be positioned so that you can see it without taking your eyes off the road but out of direct sunlight which will damage it. If you are going to be crossing rivers or launching boats, consideration should be given to keeping the unit out of reach of rising water.

Left: Body-mount HF with built-in single-frequency coil.

Right: Glass mount VHF which requires no drilling and is ideal for temporary use.

Body-mount VHF.

The perception that radio communication systems can be installed by anyone is generally incorrect and although success may be apparent after an installation, it is very rare that the radios and antennae are fitted and tuned perfectly, giving the user the best available transmission and reception. Sometimes, only when a home installation is compared with a professional's can the difference be appreciated.

The reasons for this are simple; all antennae have to be adjusted to r
correct frequency and if this is done incorrectly a transceiver can malfunction and can require repair. If an error is

made in the wiring of the system a fire can occur with disastrous results. Don't select an antenna for its looks - go for one that works.

License and regulations

The Department of Post and Telecommunications is the management body of radio spectrum in South Africa and controls the use of transceivers, radio equipment specification and the assigning of frequencies. All equipment must be type approved and licensed before it can be used in South Africa and the same applies in neighbouring countries. Of all the authorities, the Namibian Communications Commission is the friendliest and by far the most efficient. Contact addresses:

- *Department of Posts and Telecommunications, Private Bag X1 Marlboro, 2063, RSA*
- *Namibian Communications Commission, Private Bag 13309, Windhoek, Namibia*

Maintenance

Once you have your radio properly set up, there are a few simple ways to keep it working in top order.

Prevent water from entering your antenna cables by sealing them with silicone prior to any trips. Once water has got into the cable, corrosion will occur and the antenna system will stop working efficiently and the cables must be replaced.

Check the power cables and antenna cables are not getting pinched under plastic linings and in doors.

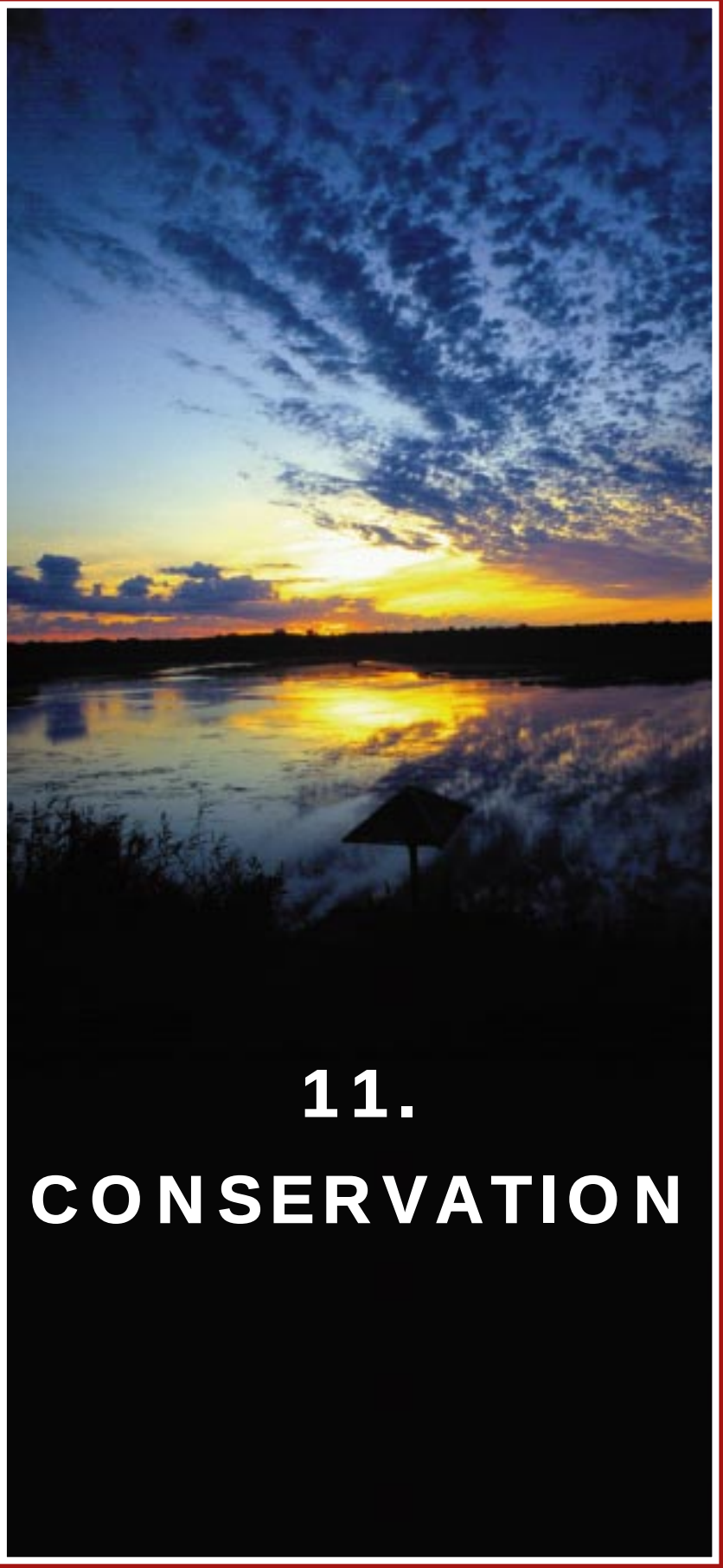
Check your antenna to make sure that it is still secure on the vehicle as you will be amazed what vibration can do to locking nuts.

Check to see that the whip has not been bent or broken, and if it has, replace it immediately and get your local two way radio dealer to set up the new antenna before you use it. Using an antenna without tuning it can result in overloading and burning out your radio.

Before a trip check that the equipment works, clean all fuse holders and fill them with non-conductive silicone grease. Clean all corrosion from battery terminals and smear with Bosch battery grease.

Remember that when transmitting your transceiver draws a lot of current from your battery, especially if it is a high-power HF rig. Wire it to your deep-cycle auxiliary battery if you have one.

Thanks to Greg van der Reis for his help with this section. Greg runs a specialist radio installation company, GRS Two-Way Radio, and a club assisting four-wheel drive enthusiasts in the Western Cape called 'Off Road Adventures'. He can be contacted by calling (021) 913 2709 or fax (021) 913 2709.



11.
CONSERVATION

Let's stop paying lip service in the cause of conservation. Talk is cheap. Every one of us has a contribution to make. The most valuable contribution is to stay on existing tracks and encourage other motorists to do the same. Do not assume that a vehicle track, if it is visible but not well used, is an official track. It may be that the driver ahead of you has been thoughtless and has made his own track over virgin ground. Should you now follow the new track it won't be long before it becomes a well-used track – adding yet another to the vast maze criss-crossing our continent.

It has become apparent that in Southern Africa some of the most outspoken members of the 4x4 community, who advocate responsible driving practices, who are recognised by the country's environmental protection institutions and claim to be the leaders of the cause when it comes to protecting the environment against the damage done by 4x4s are themselves the worst offenders. For obvious reasons I am not at liberty give names, but in one case, an individual 4x4 tour guide took a 70-vehicle convoy on a Cape West coast beach drive. This same individual frequently takes ten or more vehicles onto the Botswanan salt pans and encourages the vehicles to drive alongside one another. Not a single track is created across the pan, but 10! In the video footage I saw he encouraged his party to collect as much firewood as their roof-racks could carry and burn several massive bonfires.

It is no surprise that the most of the Cape West coast is about to be closed to 4x4s and the Botswana wildlife department are suggesting the closure of the Magkadigkadi Salt Pans to general traffic.

In mountainous terrain what begins as a vehicle track soon becomes runaway erosion.

ON THE BEACH

The University of the Cape Town has done some research on the effect of vehicles on beaches. They divide the beach into four regions, the glassy layer, the intertidal, the drift line and back beach and the dune field.

The glassy layer is the shallow surf where most animals are tolerant to disturbance and can handle the effects of humans and vehicles. However, effects are seen as large molluscs respond to the liquefaction of the sand by 4x4s because they 'think' that the tide is rising and come to the surface. This then makes them very susceptible to damage by vehicle convoys as they are crushed while on the surface. Plough shells also occur here and are often seen feeding on jelly fish and other drift material. Research has shown that 10% of these animals are destroyed for every 50 vehicle passes. Large convoys increase the percentage.

CAROLINE CROWTHER

Sodwana Bay on a typical Saturday morning. Where 4x4s are permitted overcrowding by vehicles is often the result. This picture was taken before the crowds arrived!

The intertidal region is quite tolerant of beach traffic. The finer sand the less the damage. Course grain beaches where vehicle tracks are deeper impact more. During low tide, most animals found on fine and medium sandy beaches are plough shells, juvenile sand mussels, sand lice and worms. Less than 15% of the juvenile mussels are damaged per 50 vehicle passes.

Drift line and back beach. This is a narrow stretch of beach frequently used by vehicles as they move at high tide. This is unfortunately the home of the giant isopod (*Tylos granulatus*). Approaching the endangered species list, this animal, which grows to 55mm in length, is now absent from most South African beaches. They remain buried during the day and at night feed on the drift-line material. As the tide begins to rise again they bury themselves to hide from predators, sun and water. However they have the tendency to bury themselves in disturbed sand which, if it is a vehicle track, may be fatal if the track is used by other vehicles. The most serious hazard to this isopod is driving at night when the percentage killed by passing vehicles is alarmingly high.

Dune fields are without question the most vulnerable region of the beach. The general consensus is that there should be a total ban on driving on dunes, tidal marshes and the back-shore because of the extreme damage caused by vehicles in these areas. Not only do vehicles disturb the nesting sites of birds such as Oyster catcher and terns, sanderlings and plovers but also the salt crusts and dune-stabilising bacteria and vegetation. The results are blow-outs which destabilise the dunes and vegetation. Recovery takes a long time.

The success of indigenous dune-stabilisers such as Scaevola are critical to beach survival

In addition to the conservation aspects of driving on beaches, most beach users hate vehicles. People who love to walk for long distances to escape other people are often disturbed by vehicles, which are usually racing

across the beach. The beach is not a vehicle playground, it is a people playground. Due to irresponsible driving and today's self-centred attitude among so many people, I advocate the principle that on a beach people and vehicles don't mix. Vehicles should therefore be banned on beaches where people regularly find relaxation as well as the total ban on driving on all beaches at night.

Conservation when driving on the beach:

- *Never drive on the dunes. It leads to dune erosion and 'sand blows' which ultimately results in the destruction of coastal forests. Many animals, including turtles and some sea birds, nest in the dunes.*
- *Vehicles pose a hazard to people walking on, and sunbathing amongst the dunes.*
- *Driving on a beach at night severely endangers beach dwellers. Even shining bright lights on nesting creatures disturbs them and can cause them to abandon their nests.*
- *Keep the area which is used for parking.*
- *Do not bury your litter on the beach.*
- *Don't drive on the beach as though it's your right of way. It is surely unreasonable to ask people strolling or children playing on the beach to look left and right as if they were on a street in a town. Give them right of way and drive slowly.*
- *Because conservation opinions differ, it is important to read conservation literature relevant to the area. This is often readily available and free to the public.*

CAMPING

Surely one of the main reasons why we enjoy four-wheel driving as a hobby is to enable us to explore the untouched wilderness? Then why do we not take better notice of good camping practices in order to preserve it?

Sound camping practices:

- *Dig a deep latrine. Faeces simply covered with a layer of soil is not sufficient. Jackals dig up shallow latrines. The deeper the hole the faster the decomposition. Bury the minimum amount of toilet paper. Burn the rest. Use unbleached toilet paper.*
- *Never bury rubbish. Wild animals dig it up and spread it around.*
- *Most cleaning chemicals contain phosphates, which contain nitrates. These run into water courses after rain and pollute the water. Water containing excess nitrates promotes the growth of algae to unnatural proportions, and eventually waterways can become choked with algae, starving the water of oxygen. Therefore wash well away from water courses.*
- *Avoid setting up camp on animal tracks. These look like human paths – they often lead to water.*

- *Never feed wild animals – you may be signing their death warrant. Animals which become accustomed to being fed usually end up making a nuisance of themselves. Often they have to be destroyed by wildlife department officials. Those that feed them are the real killers.*
- *When camping in arid areas, do not camp close to a water hole. If it is the only water hole in a large area, desert dwelling animals will travel great distances to get to the water. If you are camped too close they may be scared away and this could cost them their lives.*

LIGHTING FIRES

Be especially careful when preparing your camp fire:

- *Dig away an area and make sure that the surrounding grass cannot catch alight.*
- *Do not burn newspaper without breaking it into small pieces and rolling it up. Large pieces can catch the wind and be blown into the air.*
- *Never leave a fire unattended. Don't go to sleep inside a tent and leave a fire blazing away.*
- *Bury a fire after it has turned to ash.*
- *Use existing camp fire sites if you can. It's very unsightly when the ashes from old camp fires are scattered all over the place.*
- *Be aware that buying wood from roadside vendors could mean damage to indigenous forests.*
- *Do not make fires under a tree or on its roots. If possible, take your own firewood – you may think you're not doing much damage yourself by burning a single dead branch, but when all campers do it a single dead branch soon becomes an entire tree.*
- *Never take wood from a live tree.*

Simple carelessness by campers causes untold damage to our wilderness every year.

RESPONSIBLE BEHAVIOUR

Poor driving techniques and irresponsible driving are the biggest cause of damage to tracks and the resulting erosion. Drivers who repeatedly spin their wheels or apply accelerator in frustration when a tyre battles for traction unsettle the surface layer. The rain falls and the unstable topsoil washes away.

This concept is not new, but what is, is the attitude if some off-roaders to try and make it over an obstacle no matter the cost. If all of the off-road obstacles we encounter were easy, there would be no thrill of overcoming the tougher ones.

But, challenging obstacles to the point where vehicles are damaged and the track is destroyed is not worth it.

Two examples illustrate the point:

In the Western Cape there is a 4x4 trail beginning from the Cederberg town of Wupperthal. The trail is scenically splendid from beginning to end, but nowhere more so than about two-thirds along the route where the track runs on the edge of a deep valley before descending sharply to the valley floor. The descent is potentially dangerous in the most ideal conditions, even for experienced drivers. It is about 300 metres in length, as steep as 40 degrees in places and is surfaced with loose rocks, sand and deep holes.

Towards the end of 1998 a team tackled the trail and over 20 vehicles, driven by both experienced and novice drivers successfully completed the trail. The trail guides, all of whom were experienced, coached each driver through. Everything was professionally and safely orchestrated until someone asked if they could try and go up. The response should have been negative. But, the go-ahead was given and the specially prepared Hilux with front and back diff locks engaged made it over the top. The climb was dangerous and a few times the driver almost lost control. The damage to an already hazardous descent was severe and made even more dangerous for those coming down. Many men pay for one selfish man's prize.

The second example took place while I was driving on the Lamberts Bay trail. The trail consists of a large dune field, ideal for experimenting with vehicles, tyre pressures and driving techniques. It is operated by experienced off-roaders who should know better. I was at the head of a group of novice drivers organised by Toyota to try out the range of new Hilux 4x4s. After an hour or so most of the drivers had gained confidence and were looking for something a little more challenging. The guide suggested that they attempt a short but very steep dune climb in two-wheel drive. At this moment I made the mistake of letting it happen. A vehicle will climb anything, it will even fly, if it goes fast enough. And that is exactly what happened - a vehicle took off. At that moment everyone looked a little embarrassed that things had got out of hand. The Hilux involved sustained no damage. It is this same attitude that promotes reckless use of our environment.

Alcohol may have played a part in both of these scenarios. Alcohol and driving, including off-road driving don't mix. Unfortunately, I feel as I write this, that my words will be like an ant trying to persuade a buffalo to give way.

Other good off-roading practices:

- *After digging a vehicle out, fill in the holes.*
- *Bull bars are not for clearing bush in front of your vehicle. They are to protect against impact.*
- *When winching off a tree never tie cable around a tree. It ring-barks the tree and kills it.*

source: Mail & Guardian, 'The Thoughtful Tourist', and a selection of works compiled by Ronel Nel of the Zoology department, UCT, Rondebosch, 7701. Email PNEL@BOTZOO.UCT.AC.ZA