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THE COMPLETE GUIDE TO

FOUR-WHEEL OVERLAND

ANDREW ST.PIERRE WHITE

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THE COMPLETE GUIDE TO FOUR-WHEEL OVERLAND

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6 The Kippings, Thurlby, Lincolnshire
England
PE10 0HY
+944 (0) 7946 650541
www.4xoverland.com

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THOSE OF US LUCKY ENOUGH TO FIND OURSELVES IN THE EARTH'S SECRET PLACES HAVE OUR DEBTS TO PAY.

IF WE ABUSE THE ENVIRONMENT WITH OUR 4X4s, OR TAKE FOR GRANTED OUR RIGHT TO GO THERE, ONE DAY THESE RIGHTS WILL BE TAKEN AWAY.

Andrew St.Pierre White

Andrew St.Pierre White

Andrew is one of the world's most prolific 4x4 and overland writers and film-makers. This book is his 15th on the subject.

Born in England, having lived most of his life exploring southern Africa, Andrew's books, DVDs and TV programmes are known on five continents.

His web site, 4xoverland.com, is one of the world's oldest and busiest dedicated 4x4 web sites. His other professional activity is making TV documentaries and hobbies include flying light aircraft and gliders.

Andrew lives in England with his wife Gwynn and three daughters, Stephanie, Erin and Kate.

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1.FOUR-WHEEL DRIVE

4X OVERLAND
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WHAT IS FOUR WHEEL DRIVE?

In all of the motoring world, a higher percentage of buyers become dissatisfied with their choice after buying a 4x4 than any other vehicle type. The tricky part of choosing a four-wheel drive vehicle is that modern off-roaders have dual personalities. Many are required to cruise economically and comfortably and when the road ends these same vehicles are asked to climb hills more suited to a mountain goat. Armed with insight as to how vehicles are designed to cope with these demands is of significant advantage to the buyer and operator.

4x4 or 4x2?

"A 4x2 with axle differential lock can do almost as much as, and can go just about anywhere that a 4x4 can go". This statement, often used as selling hype on the showroom floor is untrue and misleading. The difference in the off-road ability of a high-clearance 4x4 and a similar 4x2 with axle differential-lock is dramatic. The difference in the off-road ability of a high-clearance 4x2 with differential-lock and a similar vehicle without differential-lock is also dramatic, but only under specific conditions. Why are these differences so vast?

Half the load, double the traction

A 4x2 transmission means that of the four wheels on the ground, two are driven. Therefore, 100% of the tractive force necessary to push the vehicle is divided between these two wheels. Add two more driving wheels and things change dramatically. The tractive force is now divided amongst four wheels instead of two, halving the load on each wheel and thus doubling the effective traction. So in the laboratory, when the terrain under the vehicle remains constant, a 4x4 has twice the tractional ability of a 4x2.

In the real world with rocks, grass, mud and sand challenging the grip of the tyres, things get even better for the 4x4, because the tractive qualities of the ground under each wheel are never equal or constant. For the purposes of this discussion, we will assume that the 4x2 has its rear differential locked and the 4x4 has no axle differential-locks.

For our 4x2 to move, one of its two driving wheels must lie on terrain that will support the tractive effort. If not, both driving wheels will spin. In the case of our 4x4, it will move if any one of the four wheels has

enough grip to support the tractive effort, with the following proviso: should one of the wheels on any one axle lose 100% of its traction, the demand for traction is transferred to the other axle. For a moment the vehicle effectively becomes a 4x2, until conditions change. As the vehicle moves, conditions change by the millisecond, during which time traction is transferred from one wheel to another and from one axle to another. So, not only is the traction load split between left and right wheels, it is simultaneously split between back and front.

Another way to illustrate how these vehicles differ in ability is to ask how each driver feels about driving over difficult terrain. While the 4x2 driver moves along the trail he is concerned that conditions are going to get too difficult for him to continue. The 4x4 driver, on the other hand, is excited about the prospect that the trail will get tougher, and that his or her vehicle will be challenged. Yet another way of looking at it is to count the broken differentials that litter 4x4 trails. These shattered components mostly come from 4x2s that, having completed 80% of the trail and were asked to overcome a steep rocky climb that stood between them and an overnight stop. And so the driver, loath to turn back, throws caution and good sense to the wind and attacks the slope like a test pilot attempting a new climb-to-altitude record.

The reason for needing to rush the slope is the lack of low transfer gearing. Without it, the vehicle has no choice but to race. The trouble is, the high speed means that wheels bounce violently and the vehicle loses even more traction: it's a vicious circle, the more speed, the less traction, which means that more speed is needed and so on. However, low transfer gearing means that the steepest, roughest slopes can be taken slowly, carefully and with little or no risk of vehicle damage.

The dual-personality of a 4x4: Asked to cruise the highways in comfort and economy one day, then asked to tackle a mountain rockfall the next. What amazes me is the skill of the vehicle designers and engineers: So many 4x4s built today can do both things so well. Below: The Range Rover was won of the first vehicles that did not really well. Bottom: Land Cruisers and Hilux on the coastal plateau of Angola.

GIACO ANGELINI

Extra low gearing is as essential to an off-road machine as is all-wheel drive. Without it, it's not an off-roader, nor is it particularly good at heavy-duty pulling: for example, low gearing saves clutch wear when pulling trailers up steep pull-aways.

Full-time four-wheel drive

It has been suggested that a 4x4 with an open centre differential is, by virtue of having three open differentials in the system, driven by only one wheel at a time. This I believe is misleading. In ideal traction conditions this type of vehicle is being driven by all four wheels simultaneously, with 100% of the traction effort being split 25% each. Moving on a smooth tar surface, a full-time four-wheel drive vehicle requiring a very modest 25% tractive effort on each wheel, experiences neutral cornering, even tyre wear and improved handling. This means that four-wheel drive is an important safety factor for any vehicle equipped with it, improving stability on gravel, better braking, overall safety and four wheels doing the work greatly reduces the impact on the environment.

Off-road, and even on gravel, the centre differential must be locked immediately, not just prior to tackling difficult terrain. Imagine a vehicle moving off-road with its centre differential open. It is still putting 25% tractive power to each wheel, a great improvement over 50% of a two-wheel drive, but this is not going to be maintained because the tractive requirements are changing constantly and the differentials in the system will cause the tractive power requirements of each wheel to change with the terrain. As one of the wheels loses traction, it will rob tractive power from the others by spinning free. Lock the centre differential and it then requires two of the four wheels to lose traction for the same to happen. Moreover, one front and one back must lose traction before tractive power is going to be absorbed from the other wheels. That is why the centre differential must be locked whenever there is a chance that the demands on the tractive effort may change, i.e. on any surface other than smooth tar.

Axle differential locks on 4x2s

The axle lockers offered on 4x2 high clearance pickups improves the vehicle ability over uneven terrain to an extent few would believe. The important word here is 'uneven', for it is on this type of terrain that the difference in the vehicle's performance is dramatic, and nowhere else. For the differential lock to make any difference, the terrain must be the kind that will force one of the driving wheels to have insufficient traction to drive the vehicle. This happens when weight is taken off

either driving wheel and occurs in all terrain where the suspension is moving with high vertical movements. If the ground is flat and there is similar traction on both driving wheels, a differential lock will have little effect. In some situations it can even decrease traction.

NEGATIVE PERCEPTIONS

There is an unequivocal sentiment among the general motoring public that 4x4s are a nuisance. Why? Are we really damaging the environment or are we just scapegoats? The perceptions are that 4x4s are: unsafe, gas-guzzlers, environmental hazards, destroyers of roads and altogether unnecessary. Many feel that a 4x4 on the road that is not being used for a 4x4 application should be discouraged or even banned. Maybe a bit of realism will even things out.

'4x4s harm the environment'

It is impossible to generalize because there are small ones and big ones, ones with emission control and older ones without, just like regular cars. But how is it possible for 4x4s to be especially bad? To effect the fuel consumption and therefore emissions, three things could add to it: the vehicle's extra weight, loaded roof-racks, the 4x4 transmission and a larger and higher body that increases wind resistance.

Weight: The average 4x4 is between 100 and 180 kgs heavier than a similar 4x2. At most, that's 2% of a two-tonne vehicle. Not many 4x4s are over two tons, but for this argument, let's add 2% onto the weight. Roof racks: Especially if they are loaded, racks can increase fuel consumption at higher speeds by up to 25%, this from my own tests. This figure varies considerably between vehicles and rack

Typical of the 4x4s seen as 'wasters of the world's resources', 'polluters of the environment' and altogether 'unnecessary', is the Toyota Prado. It's a 4x4 and also a very safe, spacious, comfortable people carrier. Are the opponents of 4x4s frustrated at the vehicle's excellent ability off-road due to its four-wheel drive? Probably not. Maybe they think that four-wheel drive is bad for the earth; an opinion based on ignorance I think. Or are they suffering from envy? Perhaps it's none of these but the vehicle's size, because the drivers of large vehicles can exert their will on the traffic easier than those in smaller cars. This I believe is the route of almost all the loathing of 4x4s.

designs. 4x4 transmissions can cause additional fuel consumption. However the increase is miniscule. Even full-time 4WD systems, have little or no effect on fuel consumption and in all my experiments with 4x4s to disprove this, I have concluded that the difference is barely measurable.

So, what percentage increase is this really? Is it a 0.1% difference in fuel emissions caused because we drive a 4x4 instead of a 4x2? Is it even as much as this because we drive with loaded roof-racks only once or twice a year and many 4x4s drive in 4x2 on the tarmac? I cannot help but view it like this: If you feel guilty about the extra 0.1% increase in emissions, make up for it by a few less trips to the store in the family saloon.

'4x4s are destroyers of roads and tracks.'

In fact, both scientifically and practically, the opposite is true. A 4x4's tractive force on the road surface (the force exerted on the road surface to set a vehicle in motion) is one-half that of a 4x2. Once differentials are locked, this is reduced still. In all conditions. The result is reduced wear and tear on the country's roads. While on a good tar surface this variation makes little or no difference, on gravel roads and on slippery mountain roads it does. So many roads and tracks in rural areas are destroyed each year by rains as the tracks, already worn by vehicles, are subjected to erosion. Serving small rural communities the vehicles that travel these roads are mostly light pick-ups and taxis. They are almost all 4x2s, not 4x4s. If these vehicles were 4x4s there would be a significant reduction in road surface wear and a reduction in erosion. Surely then, 4x4 is good for the environment? It is the users of 4x4s damaging the environment by thoughtlessness, not the vehicles. I guess you can say the same about guns: It's not the guns that kill people, it's the people with the guns.

Typical rural roads eroded by the passage of 4x2 vehicles servicing local communities. The wheel-spin and accelerated wear of the track eventually leads to runaway erosion. If the majority of vehicles plying this route were 4x4s, the onset of erosion would have been very much slower.

'4x4s are less safe than 4x2s.'

All-wheel drive provides improved traction, four times that of a similar 4x2 and as a result there is a reduced chance of wheel spin, more neutral steering and therefore a significant reduction in the chance of skidding and spinning, the main cause of vehicles rolling. In addition, the high driving position gives an improved view ahead. In opposition to this evidence is the fact that most 4x4s (even those just built to look as if they can drive on rough terrain) have a higher centre of gravity and therefore reduced stability, resulting in a higher chance of a roll as a result of a swerve or collision. More alarming though is the tendency of some people to overload their roof-racks making some models far

more dangerous. Insurance and vehicle hire firms substantiate this statement in their roll-over accident statistics.

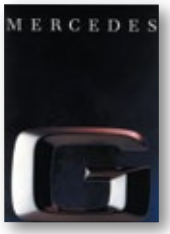
Another spat is that drivers of smaller vehicles complain that they cannot see past the larger 4x4s. This is true, but this is not 4x4 that's the problem; it's the vehicle's size that is the factor here. When people have a go at 4x4s, it's never because of the vehicle's four-wheel drive but rather its size. And perhaps many 4x4 drivers drive aggressively and that's a problem. Again, this has nothing to do with 4x4 or damage to the environment but has everything to do with a large vehicle being driven questionably.

And another debate is, as a pedestrian, if you are hit by a 4x4 you are more likely to die. This argument is because of the 4x4's larger size. Again it isn't the fact that it's a 4x4; it's the vehicle's size. On the other side of this argument is the absurd idea that being driven over by a 4x4 is safer because of its increased clearance. Either way, being hit by a vehicle, 4x4 or otherwise, is going to be hazardous.

'Drivers of 4x4s who do not use them in 4x4 terrain should be discouraged from driving them.'

This is an everyday debate from the pens of ill-advised people who want to be seen as tree-huggers, irrespective of the stupidity of their arguments. I can't see why we must take my wife's Corolla on a weekend family trip, just because we probably won't need four-wheel drive. My choice would be to leave the Corolla locked up and take the 4x4 because its a smooth, quiet, safe and roomy station-wagon. It has a frugal turbo-diesel engine, spewing out similar emissions as many medium-sized family saloons. But it has four-wheel drive! What's wrong with that? Now, if I want to I can go a little higher into the mountains and if it begins to rain I can keep my family safe. And in the week I can use the same car because it seats all my kids with their own seat belts as well as their friends, instead of taking a second car to the swimming pools. I just do not see this argument.

This is what started it all: In 1968 British Leyland's design team came up with an idea: To build a station-wagon four-wheel drive that was as at home on the road as off it. It was no use modifying an existing vehicle because there was none that came close to what they had in mind. So, what I regard as the world's first, truly versatile road-going off-roader was launched in 1970: The Range Rover. It was a decade ahead of its time and was not only good off-road; it was fantastic, even better than so many dedicated off-roaders then built. But what surprised the designers the most was that it became such a fashionable vehicle, so much so that one model was even named after Vogue Magazine. Left: 1971, Mk1 Range Rover. Right: 1995 Range Rover Vogue



FROM TOP: Range Rover's first brochure of 1970 and then in 1976. Mercedes G-wagen 1979 and 1990 brochures.

FOUR-WHEEL DRIVE VEHICLES

4x4S HAVE CHANGED a great deal since 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 a 4x4 with coil springs; the Range Rover. Even the Range Rover, the leader in the leisure 4x4 market for decades, was a year and a half in production before the introduction of carpets.

Comparing the sales brochures (left) 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 shopping mall. This illustrates how the image for most 4x4s has changed from rugged work-horse to urban fashion statement. To compound the problem of choosing a suitable vehicle, manufacturers are creating 4x4s without true off-road ability and often advertise them as off-roaders.

It is true that in the modern world comfort is as important as off-road working ability, but many 4x4s are becoming so sophisticated that while being brilliant on road they make themselves less suitable for wilderness travel. Sophistication makes servicing and repairs easy in the city but often impossible elsewhere.

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?' What follows is a guide to variations in design and original equipment and features that will be encountered when selecting a four-wheel drive vehicle.

ENGINES

The ideal power plant 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 skillfully, cause excessive wheel-spin. For a novice driver therefore, high power is often a disadvantage but for the experienced it can be an advantage. For long distance travel, larger engines are more reliable because they rev slower with the penalty of higher fuel consumption.

PETROL VS DIESEL ENGINES

It is never an easy choice, but should be. What do you expect from your 4x4? Are you towing? Are you spending lots of time on road and then a short time off it? And when you are off it, what kind of terrain will be tackled? Once you have answered these questions, and more, you should come to the conclusion that petrol is the way to go, but for one thing: fuel consumption. This is the only significant advantage diesel has over petrol. Diesels are more expensive to buy, more expensive to service, require more frequent maintenance, are slower (a general observation), are noisier than petrol, the fuel smells more, diesel is often more prone to being contaminated with water or other chemicals - the list goes on and on.

If you want to go fast, rev high and pull a heavy trailer, then a diesel is definitely not for you, I don't care how many kilowatts is produced, diesels are more prone to overheating and do not like sustained high-rev driving in hot climates - if they did, race cars would have them. So, if you are a more sedentary driver happy that on hot summer hill climbs the engine may lose some of its pulling power and that while idling, the clatter is sometimes intrusive, then go ahead, buy

Occasionally one gets a brilliant vehicle without a good choice of engines. This is the fantastic Land Cruiser 105. It was built with a thirsty 4.5-litre 6-cylinder petrol or an underpowered 4.2-litre 6-cylinder diesel. Apart from both engine's reliability, neither engine did justice to the chassis. Toyota never built it with the turbo-charged version of the diesel - I can't imagine why not - as it would have made a truly amazing wagon. The choice between diesel and petrol is often a difficult one.

COMPARISONS: PETROL VERSUS DIESEL	
PETROL ENGINES	***DIESEL ENGINES***
Petrol engines are quieter	*Some older models are very noisy*
More mechanics understand petrol engines	*Fewer mechanics understand diesel engines*
Many multi-valve petrol engines produce torque from low to high revs	*Turbo-charged diesel engines produce little torque at low revs*
Less frequent servicing required	*More frequent servicing required*
More complex electrical systems	*More complex fuel systems*
All large petrol engines are thirsty	*More economical, more range*
Less expensive to service	*More costly to service*
Fuel less pungent but more volatile	*Fuel more pungent, safer to transport*

a diesel. The additional range of a diesel vehicle, due totally because it uses less of the stuff, is another advantage, which, again, is about fuel consumption. So to summarize, get a petrol and put up with the consumption knowing that because it's often cheaper to service, at the end of the day, the cost-to-run difference is not all that much.

However, when driving off road, these engines do have their advantages, and as you will see, again, petrol comes out on top. A large capacity petrol engine is a good choice off-road, even if its power output is similar to that of a smaller turbo-diesel. They perform a lot better in the rough but are much thirstier than diesels, especially if the going is slow, through thick sand or on rutted tracks.

Turbo chargers boost power after the engine has, on average, reached 1200 RPM or more. A petrol engine will work at much lower revs, down to 600 rpm in some cases. The difference here is a mere 600 rpm, which doesn't sound much, but low rev power is a distinct advantage off-road. Turbo-charged vehicles often have to take a tricky climb one gear lower than their petrol counterparts, because at some point in the climb, the revs drop to below where the boost is working, and the engine loses lots of power and torque. Another terrain where small-capacity turbo-charged diesels often struggle is on dunes, where momentum cannot be maintained because of turbo-lag.

Some turbo-diesels are fitted with an intercooler, a radiator which cools 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 output by over 20%.

Like petrol engines, diesels are controlled by micro-processors. This is good and bad. It improves reliability and tuning accuracy. It also means that power output can be increased by the simple matter of adding a computer 'tuning chip' such as the Dastek Unichip, a remarkable device. Another advantage of a turbo-charged engine is

that altitude has less effect on performance than it has with a normally-aspirated engine.

For operations in Third World countries, diesel engines are the better choice for the reason that local truck transport relies on diesel and it is available more often and in more places. In these countries, the fuel is frequently contaminated with dirt and water with the result that fuel related problems cause more breakdowns than any other factor. Ideally, dual fuel filter systems should be fitted. At the very least, spare fuel filters should be carried.

But if you want to be the king on and off road, nothing beats a big petrol engine. In addition, for reliability, whether petrol or diesel, nothing beats normally-aspirated large pistons.

Engine modifications

The four-wheel driver's vehicle has two kinds of life: on and off road. However, 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 free-flow exhaust systems or grinding and smoothing inlet and exhaust valve ports will increase air flow.

Modifications to engine components to increase performance are many and varied. With modern engines, a lot can be achieved with electronics.

Every vehicle design is a compromise. The better it is on-road, the worse it is likely to be off it. Sometimes the more the vehicle costs means that any compromises made have been dealt with by adding features that push up the price. Compromises include sophistication, noise levels, clearance, seating, ride comfort and load-carrying ability. One of the very best compromises is the rare Merc-G class. It's a bit noisy on the open road, but that's because it has no carpets to get spoiled!

ABOVE: A breakdown in a remote area is no fun if your vehicle is over-complicated and requires special tools to complete basic functions. Unfortunately modern vehicles are built this way. I can see a future when vehicles will have notice warnings on the bonnet: "No User-Serviceable Parts Inside".

Engine chips

Almost all currently available diesel engines, whether in a tractor or race car, are controlled by a microchip. By adding another piggy-back computer to override the manufacturer's settings more performance can be taken out of an engine. Some chips are so clever that they can be mapped in several configurations, such as limit the revs when your 18 year old takes it out, or extra power at cruise speeds, set when towing. These are just two examples. Each preset is sent to the chip using your cell phone. The chip I am referring to is the Dastek Unichip. I have seen it work and it is phenomenal.

Free-flow exhaust systems

Free-flow exhaust systems consist of big bore pipes and free-flow silencers and are worth considering.

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 less expensive than a genuine factory part.*

Although not spectacular, individually these improvements are noticeable. For example, when fitted to my Land Rover V8, fuel consumption improved by about 1.5 liters per 100 kms and I calculated at the time (in 1989) that for a new free-flow exhaust system to pay for itself in fuel savings, I would need to travel over 90 000 kilometers! At today's fuel prices, it's probably less than half that.

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.

RIGHT: Choose a vehicle with an engine that you will be comfortable with. For example, if you know more about repairing petrol engines, is it wise to drive a diesel vehicle and take it into remote areas?

TRANSMISSIONS

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 three, four and sometimes five units:

1. Main gearbox

Similar to a normal road vehicle's gearbox but built to withstand heavier torque loads. Many 4x4s are made with a choice of manual or automatic transmissions.

2. 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 high ratio is used for normal driving and the lower gear ratio is used for off-road work or starting off on a steep slope when towing a heavy load. From the transfer gearbox power is transmitted to the front and rear prop-shafts. In the case of full-time four-wheel drive vehicles it first goes through a centre differential or centre viscous coupling. In the case of part-time four-wheel drive vehicles this 'centre' component does not exist. For the most part, soft-roaders do not have a transfer gearbox.

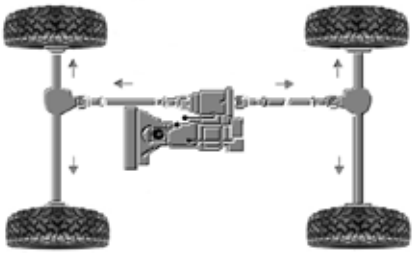
3. Centre differential/viscous coupling

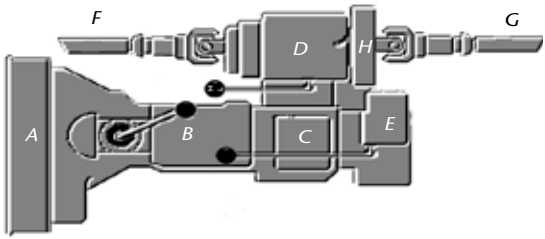
Located between the front and rear prop-shafts in full-time four-wheel drive vehicles only, this component distributes the power to the front and rear prop-shafts. Because the front and rear wheels rotate at different speeds when turning a corner this component must permit a differential in rotation speeds. A differential unit is fitted between the front and rear prop-shafts to do this. For off-road driving this differential can be locked, preventing differential rotation, locking the shafts together. This differential lock must not to be confused with differential locks found on axles as the job they do is entirely different.

A viscous coupling, in brief, does the same job as the centre differential but locking is done automatically.

A full-time four-wheel drive with its centre differential locked is the same as a part-time four-wheel drive vehicle engaged in four-wheel drive, the front and rear prop-shaft are attached, as if it were a solid shaft. These shafts drive the wheels via the axle differentials.

Typical four-wheel drive transmission layout





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

Four-wheel drive central transmission components

4. Axle differentials

These components, one on the front and one on the back, distribute power from the prop-shafts to the wheels. Again, because of the different rotation speeds of the wheels when the vehicle turns, this differential permits this speed differential. (Hence the name differential) All wheeled vehicles have differentials for this purpose. Axle differential locks are fitted to some vehicles and are discussed later.

5. Overdrive unit

Fitted as optional equipment to some older vehicles, the overdrive is a gearbox that adds an additional high gear ratio. Overdrives are built for the relatively light duty of motorway cruising and are not intended for use with low gear ratios.

MANUAL VERSUS AUTOMATIC TRANSMISSION

There is much debate as to which transmission system is superior for a 4x4. Assuming that the vehicle will have the dual role of city vehicle and off-roader, here are my findings:

Gearboxes fitted to four-wheel drive vehicle need to withstand the rigors of high torque loads and very low gearing during off-road driving. Not all gearboxes fitted to four-wheel drive vehicle are built this way. Some are easily damaged by mishandling and aggressive off-road driving techniques. They are also complex and expensive to repair. In this case the Range Rover Classic's inside had to be stripped in order to remove and refit the gearbox.

Automatic transmission enables smooth power application, an advantage in sand or slippery mud. This can be particularly effective when pulling a trailer on soft ground.

Advantages of manual transmission:

- *Engine braking down steep slopes is far superior where vehicle control is easier and safer.*
- *Easier to drive in very uneven terrain where as auto gearboxes tend to surge and can be difficult to control.*
- *The vehicle can be pull or push started.*
- *Manual gearboxes are easier to repair and more mechanics understand them.*
- *Manual transmissions are more economical to run and often less expensive.*
- *They run cooler when worked hard in heavy sand conditions.*

Advantages of automatic transmission:

- *Allows very gradual application of power to the wheels which would only be possible by slipping the clutch (with a manual gearbox).*
- *Technique of rocking, as a method of getting a vehicle out of a near-bogged situation in mud, is easier.*
- *Sand driving is altogether easier with auto gearboxes.*
- *More relaxed driving on road and on winding, rough bush tracks where there is a lot of slowing down and speeding up.*
- *Auto transmissions stress the vehicle less and are often a better choice when purchasing a used 4x4.*

Electronic Hill Descent Control (HDC)

Electronic Hill Descent Control first appeared in the Land Rover Freelander and Discovery Series-2 and is now commonplace in many modern 4x4s. HDC in conjunction with the anti-locking brakes (ABS) is used to slow a vehicle on steep descents.

I do not consider HDC a 'must have' and while it is useful in some situations it is more of a sales gimmick than a useful off-road tool. The trouble with it is that it engages at a speed that is too fast for most steep slopes. So the driver must use the brakes and transmission to slow the vehicle. In a well controlled descent it does not engage. HDC should therefore be considered as a kind of parachute should things go wrong; Release the brakes, hold on tight and steer the vehicle. HDC will assist in steering control albeit at a potentially unsafe speed. It should also be engaged when driving up steep slopes as it also engages in reverse and in the case of an uncontrolled rearward slide it could arrest a fast, dangerous descent.

Traction Control (TC)

Various systems have been developed to cancel out the wheel-spin that results from wheels without traction on open differentials, normally accomplished by axle differential locks. These range from electronic traction control working with the anti-lock braking system, first seen in the Mercedes M-class, Discovery Series-2 and Range Rover. Jeep's first Quadra-Drive is hydraulic powered and does a similar job. These systems are beyond the scope of this book to illustrate in detail, however it is enough to say that they assist traction when wheels leave the ground or spin when the surface gets slippery. They do not, as advertised, make off-road driving easier but instead change the techniques required. Early traction control systems are harder on the vehicle and environment than axle differential locks, which in effect, do the same job.

Some modern TC systems are miracles of engineering. They are so effective that it is sometimes absolutely impossible to even spin a wheel. Either the vehicle moves or all four wheels spin out and the vehicle sticks; there is no in-between. What these systems do is take away the challenge of difficult off-road driving and drivers of vehicles like the 2006 Jeep Grand Cherokee and Land Rover Discovery-3/4 are rarely tested as their vehicles do all the thinking. See Chapter-5.

One of the first vehicles to make full-time 4x4 fashionable was the Range Rover, launched in 1970. The white one pictured here was my first 4x4. It was an absolute joy because it was easy to work on and performed brilliantly. However, today's 4x4s are much more sophisticated, to the point where making major repairs in the outback is not possible. This is an unavoidable fact of life. This picture was taken on a pan in the Kalahari, winter 1987.

PERMANENT/FULL-TIME VERSUS SELECTABLE FOUR-WHEEL DRIVE

1948, when 4x4s were far from fashionable, the Jeep CJ2 was probably the best off-road car available. This one was the second ever to succeed the climb up Sani Pass between South Africa and Lesotho.

Full-time four-wheel drive

Full-time four-wheel drive has been an option for the off-road motorist for many years but only in the last 20 years has it been recognised as the most user friendly type of four-wheel drive transmission. It has been fitted to vehicles such as the Jeep CJ-6 and CJ-7 and Range Rover since the early 1970s, the Land Rover 110 since the mid eighties, and the Mercedes-G and the Toyota Land Cruiser in the 1990s. The Mitsubishi Pajero/Shogun's transmission offers the options of part-time, full-time and true four-wheel drive with a system called 'Super-Select'.

Most full-time four-wheel drive vehicles have a centre differential located between the front and rear prop-shafts to prevent wind-up caused by the different rotation speeds of wheels on sealed surfaces. (In the case of some vehicles with automatic gearboxes it is a self-locking hydraulic viscous coupling).

The advantages of full-time four-wheel drive transmissions are numerous and include safety, even tyre wear and better control and handling. Its only disadvantage is frequent misuse by those who operate it.

The trouble is that a full-time four-wheel drive vehicle with the centre differential unlocked is not operating in true four-wheel drive and drivers operate the vehicle as if it is. Hundreds if not thousands of high-speed roll overs on gravel roads around the world could be avoided if drivers lock the centre differential and drive in true four wheel-drive! More about this in chapter-5.

Contrary to popular belief, the full-time 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 my own experiments, I doubt if it is as much as 2% – 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 prop-shaft is disengaged when driven in two-wheel drive.

When a vehicle with part-time 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 part-time systems, because the rotation of the front axle side shafts and prop-shaft do not serve

any purpose when travelling on firm surfaces, free wheeling hubs disconnect these components and will improve fuel consumption.

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 four-wheel drive should have been engaged but was not, often because the driver did not feel it was necessary.

Choosing which 4x4 to purchase is more difficult today than it's ever been, because there are so many to choose from and so many 4x4s that just look as if they can handle outback travel, but are far from adequate in this department. What is more important to one person will be less important to another. For myself, who enjoys exploring the outback, the following are the most important: Reliability, handling and safety, vehicle range and ability to handle a load, comfort on long stretches of tar and gravel. Style and looks are way, way down the list.

Super-Select four-wheel drive

Super-Select four-wheel drive is found in the Mitsubishi Shogun/Pajero. This system gives the operator the full range of traction options: Part-time four-wheel drive, full-time four-wheel drive with a centre differential unlocked and then true four wheel drive when this differential is locked. In some respects this is the ideal system. Again, its only disadvantage is drivers not using the system to its best advantage and not engaging full-time and true four-wheel drive when they should. Unless this expensive and complex system is used properly, the buyer has spent his money on nothing more than a gimmick.

Hydraulic viscous coupling

The hydraulic viscous coupling solves all of the problems of axle wind-up while at the same time operating as a non-slip differential. It works like a centre differential which is permanently locked but still absorbs all differential wheel speeds caused when driving on firm surfaces.

KATE WHITE

DIFFERENTIAL LOCKS: CENTRE, AXLE LOCKING AND LIMITED SLIP

ABOVE: Two of the few production civilian 4x4s fitted with the ultimate traction configuration of locking front, centre and rear differentials are the Mercedes-G (above) and the Toyota Land Cruiser 105-series.

The subject of differential (diff) locks is one of the most confusing and misunderstood aspects of four-wheel drive vehicles. This is illustrated by the way many magazine buyer's guides indicate this in their expansive charts; 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 diff is being locked AND what kind of 4x4 transmission is fitted.

For example let's compare a Defender's full-time 4WD with a diff lock and an Isuzu Frontier's part-time 4WD, also with a diff lock. 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, locking the front and rear prop-shafts together while the Isuzu's diff lock is located on the rear axle locking the left and right rear wheels together. With the Land Rover, although its 'diff is locked', the wheels on the rear axle remain unaffected, driven by an open, unlockable differential. It is in effect in the same configuration as the Isuzu with its diff unlocked.

Differential locks on individual axles

An axle diff lock prevents differential wheel speeds on that axle, preventing wheel-spin on opposite wheels. 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, two airborne wheels, one on the back and one on the front, spin helplessly and the vehicle stops.

BELOW: Full-time 4WD on tar means that an open centre differential between front and rear prop-shafts drives all four wheels but permits wheels to rotate at different speeds. Don't be mislead by the phrase: 'Full-time 4WD'. Four-wheel drive with an open centre diff will not provide the safety and traction of true four-wheel drive on slippery surfaces. Only locking the centre differential will do this.

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 under-steer. Under-steer 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 on a flat 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. In this case only the centre diff (if you have one) should be locked.

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. Front diff locks severely inhibit steering control.

Limited-slip differentials (LSD)

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 the table below).

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 cause instability at speed.

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 and Australia. The ARB air-locker is one of the best available. Engine-vacuum powered differential locks are fitted to many vehicles as a standard fitting.

Post-delivery differential locks

ARB locker differential

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.

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*

A rear axle diff lock should be regarded as a 'nice to have' item and a front axle diff lock, a 'I want to be unstoppable' item. Steering a vehicle with both axles' diff locks is almost impossible and the average driver, even with front diff locks fitted, rarely ever uses both.

After-market axle differential locks can be retrofitted to almost every common standard rear axle. This is a Gearmax locker on an Isuzu.

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, I must assume that they are unsuited to front axles.

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 prop-shaft 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 on a firm surface.

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. Auto-free wheel hubs do not look like this as there is no manual lever or switch and are locked electrically when 4WD is engaged.

"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, bearing and spline-shaft 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 prop-shafts (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 prop-shaft 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, drive with them engaged once in a while.

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

Automatic free-wheel hubs engage the front wheels automatically when the front prop-shaft rotates under power, i.e. when four-wheel drive 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. Many serious off-roaders still prefer manual types.

PORTAL AXLES

Reduction gearboxes fitted at each wheel hub serve to increase axle ground clearance. While it increases ground clearance it also means that once the vehicle has bogged, it is very much deeper and therefore much more difficult to extricate.

Four-wheel drive transmissions - summary

1. *Part-time four-wheel drive transmissions have two differentials; one on the front axle and one on the rear axle.*
2. *Full-time four-wheel drive systems have three differentials. One on the front axle, one on the rear axle and one in the centre, driving the front and rear prop-shafts.*
3. *A differential lock on an axle prevents differential rotation between the two wheels on that axle. (Left and right).*
4. *A differential lock in the centre prevents differential rotation between the prop-shafts. (Front and rear)*
6. *It is possible to have all three differentials lockable (full-time 4WD), or two differentials lockable (part-time 4WD). This is the ultimate traction configuration.*
7. *Free-wheel front hubs are used to save fuel. They are fitted to part-time four-wheel drive vehicles only. They cannot be damaged by leaving them locked.*

Portal axle

GROUND CLEARANCE AND SUSPENSION

It is a bad idea to take a vehicle manufacturer's minimum ground clearance claim and base off-road performance on it. For example, a Land Rover Freelander has similar clearance to a Mercedes Geländewagen. The Freelander's independent suspension enables it to have a reasonable clearance which is measured from the chassis. In the case of the Mercedes, the clearance is measured from the differential housing, hung below its live axles that move up as the wheels ride over obstacles. So when these vehicles go off-road, the Mercedes's clearance increases and with the Freelander it decreases. It is the suspension type and design that enables a vehicle to keep its clearance off-road, or lose it. In the case of the Freelander and most vehicles with independent suspension, it loses it. In the case of the live axles on the Mercedes, it keeps it. The result: The Freelander has inadequate clearance for driving off road and the Mercedes, which while it is not over endowed with clearance, must rate as one of the best off-roaders of all time.

In addition, clearance should be measured not only under the lowest point of the chassis 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.

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.

Approach Angle

The maximum angle a vehicle can approach an obstacle without any part of the vehicle striking that obstacle.

Departure Angle

The maximum angle a vehicle can leave an obstacle without any part of the vehicle striking that obstacle.

Break-over Angle

The maximum angle a vehicle can ride over without striking the obstacle between its axles. The longer the wheelbase the larger this angle is. On some vehicles, parts of the transmission protrude below the chassis and this has a detrimental effect on the break-over angle. So, if you are fitting protective equipment or towing apparatus to your vehicle, it is important to consider the negative effect it may have on these angles and therefore the vehicle's off-road ability.

TOYOTA SA

Important angles that just by looking at them will give some idea of what sort of off-road performer the vehicle might be.

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, on corrugations and on fast, unsealed roads.

Short wheelbase vehicles have a few advantages when off-road. An improved break-over angle is the most significant. They are generally lighter, more manoeuvrable and more economical. Short wheelbase is a disadvantage on gravel roads and corrugations as they tend to have less straight-line stability and are more prone to slide.

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.

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. Anything above 40° is good and below 35° is poor.

CHOICE OF 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 off-road and comfort both off and on the road.

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

JULIAN SNIJMAN

With a low centre of gravity and well-tuned suspension such as the Mercedes Geländewagen has, at no time during this 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.

Solid/live axles versus independent axles

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 perform better than independent suspension.

When a wheel on a solid axle rides over an obstacle and lifts, it lifts the part of the vehicle closest to the ground (the differential) with it, thereby increasing ground clearance and clearing the differential over the obstacle. Because solid axles are very heavy, independent suspension reduces the unsprung weight contributing to ride comfort on-road.

With independent suspension, as a wheel rides over an obstacle the differential is left in a vulnerable position closer to the ground. Although independent suspension is able to offer superior axle articulation because the axle is independent of the differential, this is rarely the case with the current range of vehicles. In general, vehicles with the best axle articulation are those with solid axles and coil springs front and back.

Top: Solid or 'live' axle. Bottom: Independent front suspension showing the suspension as it is fully extended.

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 leaving it and 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 uncomfortably as the vehicle is cornered. In general, independent suspension gives less articulation and body roll than does solid axles.

SPRINGS AND SHOCKS

Three types of springs are fitted to off-road vehicles – coil springs, leaf springs and torsion bars. 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. This highly sophisticated system is controlled by a computer and is fitted to top-spec 4x4s like the Range Rover and Land Cruiser V8.

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 realizes 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.

Vehicle designers must decide how much vertical axle movement, or articulation to allow. Too little means poor off-road performance, too much means uncomfortable body roll on the tarmac. What designers of modern vehicles do is to limit the articulation and then compensate with devices such as electronic traction control or axle differential locks.

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 and shock breakages where suspension travel over uneven ground allows the axle to drop too far.

Shock absorbers

Shock absorbers control the oscillation of the road springs. When operating on rough surfaces they work hard because axle travel is greatly increased which in turn increases shock absorber temperatures. Shock absorbers 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 use your 4x4 off-road and on gravel roads and are considering improving the ride, handling and off-road performance, upgrading the shock absorbers is the first thing to consider. Gas shock absorbers and other suspension modifications are discussed in detail in Chapter-3.

The original Range Rover's axle articulation is the best of any vehicle of its type (79 cms) 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 neutral steering and good road holding.

SUSPENSION CONFIGURATIONS

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

Front coil springs with a solid axle are almost always combined with a similar setup on the rear. This setup offers the best combination for off-road ability. Examples: Land Rover Defender, Mercedes Geländewagen and Unimog, Toyota Land Cruiser, 80 and 105 GX, newer Nissan Patrol, first and second generation Range Rovers and the first Toyota Hilux. The unusual combination of solid axles back and front with coils on the front and leaf springs on the back is found on the Toyota Land Cruiser 76, 78 and 79 series.

(DIAGRAM COURTESY OF NISSAN)

Front independent coil springs or torsion bars with solid rear axles is probably the most common layout, found on many vehicles such as the first and second Mitsubishi Pajero, Isuzu Trooper, Toyota Prado and Fortuner, Ssangyong Musso and pickup-based vehicles like the Nissan Hardbody and Sani, Ford Ranger, Mazda Drifter, Isuzu KB and Mitsubishi L200 (Triton).

(DIAGRAM COURTESY OF TOYOTA)

Leaf springs on front and back axles are found on older designs such as the Land Rover series I,II and III, first Toyota Hilux, all early Land Cruisers, Suzuki SJ40, Jeep CJ, old Chevrolet Blazer, first Nissan Patrol, SVM and even the current Ford F250. This design is old fashioned and not seen much any more.

Many years ago I predicted that all-four wheel independent suspension would become the most popular solution for 4x4 designers and this is now evident in most modern 4x4s, both those designed to go off-road and those that just look as if they can. Until the mid nineties just about the only vehicle fitted with this was the VW Syncro Bus. Then the Mitsubishi Pajero paved the way and today it is found on almost all 'soft-roaders'. Now, from the third generation Range Rover, Discovery-3 and 4, and the Jeep Grand Cherokee among many others have all taken this route. This is because this system is best for on-road comfort and safety. While it works well off road, the penalties are load carrying ability and axle articulation, corrected by many manufacturers with electronic traction control.

As engineers have developed systems they have managed to improve the design of independent suspension so that it can almost match the off-road performance of solid axles. While the diehards who love solid axles off road, hold onto their older designed 4x4s for as long as possible, it will not be long before they are forced into accepting that this is the suspension of the future. Already, if we want a Land Rover with solids axles our choice is limited to Defender, and Toyota lovers are limited to Cruiser 70-series. The choice of station-wagons with pure solid axle suspension is now limited to just the Nissan Patrol and Mercedes G-Wagon.

ELECTRONICS

Are electronics a real threat of just a perceived one, when it comes to vehicle reliability? Many overlanders are concerned that a vehicle's electronics will let them down, or that if it does, it is not repairable. This should be put in perspective: In my thirty plus years of overlanding, travelling with vehicles both with and without electronics, I have only once been let down by electronics but on several occasions by mechanical stuff. The electronics breakdown was permanent and the vehicle rendered temporarily useless. In this case the electronic failure was because the non-factory immobilizer fitted was incompatible with the vehicle's electronics and it damaged the engine control electronics.

Five days later, all the way from Austria, the spare arrived and within an hour the vehicle was running again. In at least three of the mechanical breakdowns I have experienced, the vehicle was similarly rendered useless. So I reckon the important questions to ask are: Are electronics less reliable than mechanical components? Both can render a vehicle useless for a time. The answer is no. Modern electronics, by and large, are extremely reliable. Can they easily be fixed without spare parts? Almost never. Are mechanical components necessarily more reliable than electronics? In general it is safe to answer this one, no, as well. Mechanical components are if anything less reliable but the difference is that they can, on many occasions, be temporarily repaired or a plan made.

The most common breakdowns on overland trips are, wheel bearings, exhaust breakages, tyres, radiator cracks/thermostat/overheating, tyres, electrical (e.g. alternator failure), suspension breakages. Electronics are quite far down the list. In addition, many, if not most, breakdowns are related directly to lack of maintenance. No electronic component requires maintenance.

Today, you can't even buy a tractor that isn't controlled by electronics any more. The value of clever electronics in engines is often under-estimated. It radically reduces emissions (without it, no diesel engine could comply with emission regulations), it protects the engine from over-fueling, making it more reliable, it reduces fuel consumption and makes them quieter.

Some vehicles are overdosed with electronics and this worries me a bit. When items like the height of the suspension is affected, then there is always a nagging feeling about being out of control. I guess I still need to see a spring holding up the vehicle, and not a sensor, attached to a rubber tube, attached to a circuit board, attached to a microchip, doing the same job.

MORE TO CONSIDER

DIESEL TURBO FAILURES

Why is it that petrol engines seem to last so much longer than the average turbo-diesel? The answer is anything but simple. Try as I may, being simplistic about this issue isn't going to help, so here I am going to get a bit technical. So, if you own or are planning to purchase a turbo-diesel vehicle, understand the pitfalls because some are very costly. I am not advocating staying away from diesel engines but rather an understanding of them will not only prevent huge repair

Typical turbo waste-gate damage caused by excessive exhaust gas temperatures.

Top: A new cylinder head showing the three valve seats and the pre-combustion chamber. Middle: A damaged pre-combustion chamber. The change in shape of the aperture and the cracks cause severe reduction of power output. Bottom: A valve damaged by excessive heat. This damage in most cases is accompanied by valve seat and head damage. In many cases the entire head cannot be repaired and must be replaced. The costs are very high and leave many customers in tears.

JACQUES MARITZ

bills in the future but also enable you to get the long life that a diesel engine can deliver if treated correctly.

In 2000 owning a Mercedes 290GD, I experienced an engine failure which resulted in a huge learning curve for me. I called someone I knew who owned a workshop supplying a range of turbo-related products, and having more experience with diesels than anyone else I knew, I felt confident I was in safe hands. To cut a long story short, a blocked air filter had caused an excessive exhaust gas temperature which caused turbo and injector damage. Steven uses an effective analogy. A new vehicle is like a healthy child, fit and energetic. The child's body is like the vehicle's engine. Once a child becomes a teenager some begin to smoke, drink or both. The body begins a path of deterioration and becomes diseased. By forty, the equivalent of forty-thousand kilometers, doctor says, "Stop smoking!". So the smoking is stopped. Is the adult suddenly healthy because a bad habit is kicked? No. Damage has already been done.

A new vehicle drives energetically out of the showroom. In the case of a diesel engine it is often mishandled recklessly, like the teenager on a binge. Driving a turbo-diesel at full power for long periods, hauling heavy trailers up steep hills at full power, hour after hour of speeding down to the coast at 150 kph. That's how to abuse a turbo-diesel. These engines are not designed to work this way and it damages them. So if you want your vehicle to perform these tasks, buy a petrol vehicle. Petrol engines are more suitable than turbo-diesels for running at full power over long periods.

The good news is that vehicle built after about 2010, the manufacturers have mapped the engine management system so that if a driver over-powers the engine, as described above, fuel will be

held back to prevent engine damage. IN the driver's point of view, the vehicle is misbehaving as power appears to be lacking. But it's the engine saving itself from damage.

The advice on fitting exhaust gas temperature gauge early in the vehicle's life cannot be over emphasized. Drivers inadvertently abusing the engine, driving it in a manner which over-stresses it will be warned by the gauge and buzzer. This is one of the problems with buying a used turbo-diesel. Fitting an EGT gauge after the vehicle has covered 50,000km is like a forty year old quitting smoking. The damage has been done. Not smoking at all is the most desirable: never abusing the engine because a gauge is telling you that you are. It's a bit like a government health warning, but instead it reads, "RUNNING THE ENGINE LIKE THIS WILL SERIOUSLY DAMAGE YOUR WEALTH".

Diesel engines are happiest when driven on or close to the revs that produce the highest torque. At higher revs, torque drops off and while power increases so does the temperature generated. The result is high fuel consumption and high engine temperatures. This is why above 140 kph most diesel engines will consume about as much fuel as a similar petrol vehicle. At this speed the petrol engine is happiest, revving high and burning its fuel efficiently, while a diesel is at high-stress, running hot and burning fuel inefficiently.

Things have much improved over the past couple of years. If you are contemplating a used turbo-diesel built before 2003 then what I have described here is most likely the case. Thankfully almost all diesel engines built today are equipped with sensors that will cut off fuel in the event of over-stress. This may mean that newer vehicles may not appear to perform as well as similar older versions, but this is not true: The newer engines are so much better at protecting themselves from abusive users.

So when considering a new or used vehicle, think about what kind of driver you are. If you are towing a heavy load, choose a petrol. If you want the economy of diesel, decide now that long stretches at high speeds are a thing of the past. If the vehicle is used, do a diagnostic test to see if damage has been done and if it's new, fit an EGT gauge without delay and reset the diesel pump on an active dyna to limit the combustion temperatures before damage is done.

A crude but sometimes effective way of reading the condition of a turbo unit is to look at its colour. In this picture the inner part of the turbo is a rusty brown colour. This is healthy. On the outer rim the colour is blueish. A blue colour means that the turbo, at some time, has become so hot that its colour has changed. This high temperature could mean that the turbo has been subjected to regular overly-high temperatures and is therefore defective.

LOADING CAPACITY

When travelling through remote or unpopulated areas; food, water, fuel, tools and camping equipment 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 liter 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.

When selecting a 4x4, it is worth asking how much weight can be carried on the roof. Unfortunately I have rarely seen this specification published in a sales brochure, because so often it is alarmingly low, so this information may be hard to find. The range of weight to be carried ranges from the lowest in vehicles such as old Range Rovers at about 50 kgs, Land Rover Defender at 75 kgs and up to 200 kgs on a Mercedes G-Wagen and Nissan Patrol. (Specs not verified)

Loading any roof rack too well forward will cause overloading of both roof pillars and front springs. Structural failures from overloading show themselves in the form of cracks in the windscreen and fading shock absorbers. If you have a winch, bull bar, power steering and air conditioning fitted, your front springs may well be pushed beyond their design limits. Overloading a vehicle's springs will quickly result in serious structural failures in rough terrain including chassis breakage.

VEHICLE RANGE AND PAYLOAD

A vehicle required to undertake journeys into unpopulated areas needs a good range to be effective. Because payload can be converted into range by carrying more fuel, either an economical engine or high fuel tank capacity and payload is required to give a vehicle a good range.

I suggest a range of no less than 1000 kms between fuel stops if you are planning to create a good expedition vehicle. Few standard vehicles will cover this distance without additional tanks or Jerry cans. Auxiliary fuel tanks are discussed in Chapter-3.

DISC VS DRUM BRAKES

All-wheel disc brakes are an advantage on and off-road. Apart from not being affected by water, like drums, they operate effectively in reverse. This is where the disadvantage comes, which can be significant off-road, 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 hand brake are used to hold the vehicle. With the drum brakes on the rear axle doing almost all the work, and with a 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.

JACKING POINTS

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. 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. If not, suitable adaptations can be made so that a high-lift can be used with the vehicle. These modifications are fitted by off-road vehicle fitting specialists.

Toyota Land Cruisers with the 1HZ, 4,2 diesel engine are all underpowered, which can be remedied by the adding of a turbo-charger. But beware! There are pitfalls to catch the unwary and the results can be a blown engine!

WHEEL RIM SIZE

The size of the wheel rims fitted to a vehicle has a significant effect on its off-road ability and suitability as an outback tourer. Many new 4x4s are delivered with 17, 18 or even 19-inch wheel rims. Low profile tyres found on large rims are a significant disadvantage off road, for three main reasons:

When dropping the tyre pressures to increase traction or flotation, with a low profile tyre, the percentage increase in footprint size gained by the reduction of tyre pressures is less, so much so that it can make almost no difference and the vehicle performs as if riding on tyres at normal pressures.

Secondly, low profile tyres are damaged more easily as are the rims.

Thirdly, in remote areas, tyres damage, which is one of the most common cause of a disruption of a trip, can cause it to halt altogether because in these areas, replacement tyres larger that 16-inch are extremely difficult if not impossible to find. In this case, you could find yourself utterly stranded. In my view, 16-Inch wheel rims seem to be the most ideal for an average 4x4. 17" is acceptable, just because for a while now, some very good 17" all-terrain and mud tyres are available.

After driving through deep water, water can become trapped in brake drums making them ineffective. Sand can also collect in drum brakes damaging the shoes.

BUYING PRE-OWNED

The only way to inspect a used vehicle is to use a checklist. Here are some key points:

Your inspection should also include the following:

- *A service record is particularly important with diesel vehicles.*
- *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 rims. 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.*

Vehicles that spend a lot of time on or near the beach will likely have rust problems. If they spend time launching boats or are ever immersed to any degree whatsoever, the condition of the drive train and chassis is likely to be poor. Be particularly careful if the chassis looks clean - rust may be concealed by a new layer of paint.

- *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 torn rubber CV boots; the rubber glove that protects items such a CV joints. A tear means water inside, which means rust, which means they are probably in poor shape.*
- *Look for rust. Beware of a newly painted chassis – it may mean that the seller is hiding something.*
- *If you've been told that Land Rovers don't rust much, you were misled. They are as prone as any other vehicle, even the body.*
- *Open and close all of the doors, the bonnet and the tailgate and wind all of the windows up and down and test the lights and indicators.*
- *Look for damage to the chassis frame. If there is no visual damage underneath the vehicle, it is an indication that the vehicle may never have been off-road.*
- *Open the bonnet. The engine should be clean and show signs that it has been well maintained. Oil level should be normal. Lower than normal will mean that the engine uses oil, but you cannot know how much.*
- *Find the engine and chassis numbers and compare these with the registration held by the owner. Make sure that these numbers have not been tampered with in any way.*
- *In different countries, the dangers of buying a vehicle that is still owned by a bank, or not owned by the person offering it for sale, differ widely. I can't emphasize this enough. Do you homework as criminals in the car selling business are everywhere! If you suspect ANYTHING suspicious, walk away.*
- *If you find a real bargain, BE SUSPICIOUS.*

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. Some diesels running on high-sulphur fuel idle noisily.*
- *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.*
- *Black smoke? Diesels that smoke heavily under acceleration mean an over-rich fuel mixture. This causes turbocharger damage if left for more than a few hundred kilometers. Test the exhaust gas temperatures to determine any turbo damage. Extended temperatures over 750°C likely mean trouble and an expensive repair.*

- *Blue smoke means oil in the combustion chambers and is likely caused by worn rings and valve guides. Repairs are expensive.*
- *Listen to the exhaust for escaping exhaust gas from anywhere but the tail pipe. Do this by putting your shoe over the end on the tailpipe. When the engine decelerates it should not smoke. If it does, it may mean worn valve guides.*
- *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 or worn hydraulic lifters. It is advisable to have an expert take a look and have a listen.*
- *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 may 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 straight-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 could mean anything from an unbalanced wheel to an unbalanced prop-shaft which could have caused gearbox bearing and oil seal failure.*
- *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 transfer gearboxes, especially Land Rovers.*
- *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 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. For a few masochists, rebuilding a military truck is worth the effort.*

2. 4X4 VEHICLES

10 GOLDEN RULES

BUYERS' GUIDE

THE AUTHOR'S VEHICLES

4X OVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

10 GOLDEN RULES WHEN SELECTING A 4X4

Rule 1. Not all 4x4s are created equal.

Few 4x4s are really good at everything. Some are good for almost nothing. Every 4x4 is a compromise in some way: some that are good on road should never leave it, and others good off it, are a test of endurance on it. As a buyer, you will need to compromise just as the designers have done. Decide where your compromises are going to lie as you go about choosing a 4x4.

Rule 2. Know more than the showroom salesperson about 4x4s or you may be taken for an unsatisfactory ride.

4x4s have been on the market for decades but still very few sales people understand the 4x4s they are selling. (Often the marketers and advertisers don't even understand their vehicles.) As a result they could easily give you bad advice. Sales people will always make an effort to tell you what you want to hear, and rarely what you need to hear. The only way to outwit them is to do some homework and to have made a few fundamental decisions before meeting the sale force. The danger lies in that most of us are easily baffled by bull delivered by an experienced salesperson.

Rule 3. Beware of the phrase, "I don't want to do anything serious".

If you hear this in your mind, it's a danger sign because what does the word 'serious' really mean? It is vital to be clear on what you expect from your vehicle and to know if your choice can do it.

Rule 4. Beware of the myth that a 4x2 with a diff-lock can do almost as much off-road as a 4x4. It's not even close!

This is because, only when an axle on a surface where grip is removed from one of the driven wheels, will traction be assisted with an axle diff lock. Everywhere else it makes little or no difference to a vehicle's ability off-road. A diff-lock does help in some situations, but to compare it to two additional driven wheels, on a completely separate axle, is ludicrous.

I owned this 1989 Land Rover One-Ten for eight years. While it was not a particularly reliable vehicle, I never regarded it as unreliable because it was easy to fix and I knew it so well, it never intimidated me. This cannot be said for many modern vehicles where apart from general maintenance, they are very difficult to repair, requiring special tools and know-how.

Rule 5. Beware of the other myth that says a 4x4 without low range can do almost as much as a 4x4 with low range.

Again their performance off-road is not even close! Low range extends a vehicle's versatility beyond what is imaginable, as long as the vehicle is also equipped with reasonable clearance, so that the low gearing can be taken full advantage of. Vehicles without low range cannot be regarded as off-roaders in the least degree.

Rule 6. Clearance is the single most important factor - but there is a catch.

Do not consider as important the clearance measurement provided by the manufacturer. This is because it is measured when the vehicle is on flat ground. Clearance is only needed when the vehicle is on anything but flat ground, so the flat ground measurement is close to meaningless. This is because a vehicle's suspension and chassis layout has a huge impact on its clearance when off-road. A vehicle with a high clearance measurement can lose all its clearance the moment a wheel lifts over undulating ground, while another vehicle with lower clearance on flat ground, has suspension that clearance its increases the moment a wheel moves over uneven ground. So the question has to be; how well does the vehicle maintain its clearance off road? And not how high is it above the ground. So, how to you tell if a vehicle has good clearance? Understand what maintains clearance over undulating terrain. And watch one off road. Its the only sure way to tell. In addition to this, wheel size plays a significant part.

Ford
RANGER ODYSSEY
2014 Africa

TOUGH AFRICAN TERRAIN, TOUGH CONTESTANTS, AND THE TOUGHEST 4X4.

Africa is not for sissies. The landscapes are challenging and the climate can be unforgiving. Along with the ups and downs however, there is a lot of natural beauty. To fully experience this mixture of grit, amazing scenery and rugged environments, you need a vehicle that can take on all that Africa has to throw at it and still come out on top. The Ford **Ranger** is built tough to combat the harshest of terrains and win every time.

Adventure is calling once again. And just like in 2013, when Ford took ordinary South Africans on a truly African adventure, we will again rally together 20 courageous people to embark on the - Ford **Ranger** Odyssey 2014 Africa.

This journey will not only test the sheer power and capabilities of the **Ranger**, it will also test the resilience and character of the contestants. The toughest and smartest among these contestants will get to drive a limited edition Ford **Ranger** Odyssey for 12 months.

The Ford **Ranger** will be put through its paces as it navigates sandy dunes, rocky landscapes and steep hills that would force a lesser 4x4 to surrender. The **Ranger** isn't your average 4x4 and this journey will prove once again that Ford's 'Built-Tough' badge is a true testament to the quality and high standard of this vehicle.

But don't be misled. Just because the **Ranger** is 'Tough', doesn't mean there's no fun to be had on the Odyssey.

The **Ranger** Odyssey promises to be a fun-filled adventure along some of Africa's most majestic routes.

The competition element in the **Ranger** Odyssey will add further intrigue and excitement to the journey. The teams will be put through their paces as they're tested on their 4x4 driving capabilities, team-spirit and tenacity.

RANGER ODYSSEY 2013

*"While the **Ranger** is built to tackle the harshest of environments, not everyone has what it takes to conquer Africa,"* said Ford Marketing Manager Gavin Golightly.

The **Ranger** Odyssey is designed to set average and exceptional apart. And in 2013, there were some truly exceptional contestants who proved to be full of stamina, strength and wit. The contestants also got to show their caring side as they helped out with distributing food-parcels and

SMART TIPS FOR DRIVING IN WILD AFRICA

- Conduct a 20 point check daily.
- Watch out for animals.
- Do not travel after dark.
- Take extra fuel with you in Jerry cans.
- Take a GPS and maps.
- Take at least 100 litres of water & ration daily consumption.
- Ensure you have at least one satellite phone within the group.
- Carry extra spare tyres and a puncture repair kit with an air compressor.
- Ask a local dealership to recommend a set of tools for your specific vehicle.
- Take a medical aid kit for the group (take note of allergies and blood types)
- A spade is also an essential item for digging out stuck vehicles.

relief equipment to underprivileged communities.

*"The contestants, did us proud. We could not have asked for a better group to take on the challenge. Each fully embraced the spirit of the Odyssey, by coping with the many challenges and became not only effective brand ambassadors for the Ford **Ranger** but also for Africa,"* continued Golightly.

Combining ingenuity and toughness, the contestants that took part in the 2013 edition of The **Ranger** Odyssey exemplified the spirit of the Ford **Ranger**.

RANGER ODYSSEY 2014 – THE NEXT GENERATION ODYSSEY!

In 2014, the **Ranger** Odyssey is back and set to be even more gruelling and challenging.

The participating teams will undertake humanitarian projects along the way, as they battle each other for the ultimate prize. The winning team of the **Ranger** Odyssey 2014 will have the opportunity to each drive a special-edition Ford **Ranger** for a 12-month period.

According to Dale Reid, Brand Manager at Ford South Africa – *"**Ranger** Odyssey 2014 Africa is set to prove that the **Ranger** is 'Built Ford Tough' and more than capable of tackling the worst Africa can throw at it."*

Ranger Odyssey 2014 will take place in September and will see 20 contestants battle the tough African environment.

Qualifying participants will be placed in pairs of two and given a Ford **Ranger** to drive through some of Africa's toughest but most beautiful terrain. Throughout the expedition they will be evaluated on their driving as well as camp-craft, communication skills and product awareness.

With the Ford **Ranger**'s smart technology and incredible 4x4 features, there's no doubt that these contestants will enjoy what will undoubtedly be the toughest ride of their life.

For further information on the Ford **Ranger** Odyssey, photos, and footage – visit **www.rangerodyssey.com** and follow **@FordSouthAfrica** on Twitter using the **#RangerOdyssey.**

Information is also available on Facebook (**www.facebook.com/FordSouthAfrica** and **www.facebook.com/FordRanger).**

SMART CAPABILITIES

- Bluetooth® with Voice Activation
- Advanced Shift-On-The-Fly (SOTF)
- Electronic Locking Rear Diff
- Driver Recognition Software

So anyone who bases their argument that one vehicle has to be better off road because of a higher given clearance, is displaying their ignorance when it comes to vehicles and how they behave off road.

Rule 7. Full-time four-wheel drive provides any vehicle a significant safety advantage.

The added grip, neutral steering and sheer pleasure of driving a full-time four-wheel drive transmission is often offset by the fact that most 4x4s have a high centre of gravity and therefore fall over easier. All in all, 4x4s are not necessarily safer than similar sized and equipped saloons. So if you are going 4x4 for safety reasons, the low-slung models are going to have a safety advantage.

Rule 8. Don't be dazzled by the words, 'diff-lock' and 'traction-control'.

Diff-locks and traction-control are not magical devices that prevent vehicles getting stuck, although they do, in many cases, go a long way toward it. It is so easy to be confused here and it is important to understand that one vehicle with one of these systems may behave utterly differently to another. Over simplified vehicle buyer's guides that give a yes/no answer to the question of diff-locks and traction controls can be misleading because some traction-controls work brilliantly while others hardly work at all and diff locks can be located in varying locations in the transmissions, and as a result, have widely varying effects.

Rule 9. Bling and 'off-road' should never be used in the same sentence.

Bling usually means big wheel rims, often shiny and always a hindrance off road. It isn't the shine that is the problem, but a low profile tyre, when its pressure is reduced for flotation and traction off the road, it does not lengthen its footprint as much as a higher profile tyre does. Overly large rims are a sure way to take the shine off any attempt at going off road.

The second problem comes with outback travel because low profile tyres are far more prone to damage by rocks and stones, and when they are damaged, spare 17, 18 and 19-inch tyres can rarely, if ever be found in remote towns and villages. 16-inch rims seem to be the ideal size. And if a vehicle has a narrow, space-saving spare, it's going to need to be changed for a real one before heading out.

Rule 10. Reliability means different things to different people.

Some vehicles have particularly good reputations for reliability and others less so. But reliability can mean two things: If you are capable of making repairs, serviceability is as important as reliability. If you are incapable of making more than basic repairs, reliability is probably the most important factor in choosing a 4x4 for outback travel. Establishing a vehicle's reliability can only be done through clubs, friends and the Internet. For obvious reasons it's pointless asking the salesperson.

BUYER'S GUIDE

It's only my opinion

Opinions and impressions here are my own. I've based them on 30 years of driving and testing 4x4s. I've owned 11 myself. I've always worked hard to be subjective, and not be biased one manufacturer over another. And sometimes it's been hard. But what I have learnt is this: What is the point of an attachment to a huge multi-national company that makes cars? I really don't care much on who builds the vehicle, but rather what it is, can it deliver what a customer might expect and how well it does that. So if you disagree, don't get mad. It's just how I see it. So for those who are interested in what my 30 years have come up with, here it is.

Vehicles in this chapter include past and current models. Vehicles not equipped with low-ratio gearing have been intentionally omitted.

CHEVROLET TRAILBLAZER

The Trail Blazer name was introduced in 1999 as an up-market Blazer, and in 2002, the Trail Blazer turned into a separate model. My experience of the Trail Blazer began in 2005 in the USA, when I hired one for a family touring vacation. I liked it, but found it heavy on fuel and hated the horrible ride on dirt tracks. But it was very comfortable everywhere else and I grew to like it, but not love it.

The 2014 model is a different story. The ride on gravel is excellent, the four-wheel drive activation is fast, the ride on tarmac is very good, and firm, which I prefer. American SUVS are often spongy and far too soft, and this one isn't. The space feels large inside, easily more roomy than a Fortuner or Pajero. The traction control works quickly and is effective, although it has only a single setting. Its low range gearing is well geared, and not too high. During a 10 day test in Namibia, 2,8 turbo-diesel's fuel consumption averaged 11,4 kms per litre,

Overtaking acceleration from say, 100 kph to 120 is outstanding and the gearbox kick-down is smooth and it does not have any tendency to change gear necessarily. The engine is quite and unobtrusive, even at high speeds.

The interior is plain but comfortable. The visibility is okay and I found the wing mirrors a bit on the large size, hampering visibility, although I got used to it quickly. On gravel roads, in 2-wheel drive, it has an over-steer tendency, which is not surprising. Click it into 4-wheel drive at any time and any speed and the Trail Blazer is the perfect platform where the safety advantages of four-wheel drive on gravel at high speeds can be demonstrated.

If you are looking for a medium-sized SUV with off-road ability and street comfort, the Trailblazer is a winner. On the down-side, there have been some reports of gearbox failures with vehicles used to tow heavy trailers over long distances.

FORD EVEREST

Introduced in 2009, from the moment it arrived, I was looking forward to the new model. Ford's Ranger is Ford's entry into the medium weight, true off-road SUV together with Toyota's Fortuner and Pajero Sport. What a pity about the Ford's dated styling. Its engine and drivetrain are excellent and while its suspension is very similar to the pickup, its ride is not bad at all, but not as good as the others. All models have the excellent 3.0 diesel which works very well indeed in this dual purpose vehicle. There is a choice of auto or manual, and while the sales brochure and Ford's own publicity, unbelievably never mentions it, the Everest has low range gearing, essential for off-road driving. Suspension is by front coils and wishbones, with leaf springs at the rear. The upgrade came in late 2013, which included significant interior and exterior improvements. But it still has dated styling, which will no doubt ensure it doesn't sell particularly well.

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FORD RANGER

When I wrote the first edition of this book in 1993, all the way to about the fifth in 2004, the Ford Courier, and now Ranger, were not particularly popular 4x4s in the 4x4 trail and overland community. How times have changed. From being an also-ran, it now leads the pack.

In 2004, there were the two engine options; a 2.5-litre, 4-cyl, turbo-diesel and a 4-litre, V6 petrol. Here the turbo-diesel was by far the better choice, in my opinion, for everything, even towing! It's lively, economical and pleasant to drive on road and off. But the 4-litre V6 was horrible in almost every way; being thirsty, underpowered and the troublesome and awkward auto gearbox ruined an otherwise, not very good pickup.

A major revision was released in 2008, this one with an Americanized big, shiny grill. In almost every way, it was a big improvement. The cabin was better in every way, as was the ride. While the auto box still surges a lot, the V6 was so much, better, but still quite thirsty. With this model, if you want the power of the V6, I recommend the manual

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as the auto is still not very well tuned and I did not like it. The turbo-diesel is still sweet, smooth and frugal.

In 2012 an all new model Ranger was released, and what a beautiful machine. It is a great looking pickup, and its easy to see, for years manufacturers looked at the Hilux for their styling clues. But not any more. Now they are looking at the Ford. The 2.2 turbo-diesel has some reliability issues and is a poor second choice to the 3.2. If you have a choice, save a bit and buy the 3.0. It is so much better in every way.

FORD F250

Built in single and double-cab layouts the F250 is big by any standards, and is not drivable on an ordinary drivers' license. This is because it measures a whopping 6,2 metres in length (D/cab). It is also a lot higher and wider than average 4x4 pickups: Over two meters wide and over two meters high. Town driving anywhere but in the US, it's far too big and unwieldy for comfort. The F250 drives well; a pleasant drive and comfortable due partly to its enormous wheelbase, but driving Africa's sand tracks in it can be a little awkward because the very wide track means that tyres tend to run along and over the sand ridges that line the tracks, rather than in them. The result is vague steering and huge amounts of dust kicked up behind the vehicle. Suspension comprises rudimentary leaf springs: this is one of few vehicles still being equipped with leaf springs front and back. The South African spec vehicle comes with a 4.2-litre, 6-cyl, inter-cooled, turbo-diesel engine producing 132 kW @ 3800 rpm, attached to a 5-speed manual, part-time four-wheel drive gearbox. Power can be described as adequate for most jobs. Its first major disappointment is that it has no low range gearing. Its second comes when loading: while the load area is vast, payload is a disappointing 1100 kgs for the single cab, and a puny 900 kgs for the double cab. In my view, for such a mammoth vehicle, this makes it an under-achiever.

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GM HUMMER

Designed in 1979 by American Motors Corp for the US military as a 'High Mobility Multi-purpose Wheeled Vehicles, or HMMWV pronounced Humvee. Over 200 000 have been produced and the Gulf Wars have made 'Humvee' a household name. Engines include a V10 diesel and full-time four-wheel drive transmission. There are several derivatives including a civilian version. For expedition use this version is particularly unpleasant to drive as the wide track does not fit into the average dirt or sand track. The H1 civilian is no longer made.

Main: Humvee (H1)
Below: Hummer H3

In 2002 the Hummer H2 was launched and two years later the H3, a smaller, less expensive, more practical vehicle, built in South Africa. It is powered by a 5-cylinder, 3.7 litre petrol engine. It is the first Hummer with manual transmission although automatic is an option. It has full-time four-wheel drive and three buttons operate its three main functions: high-range 4x4, high-range 4x4 centre diff locked and 4x4 low-range, also locked. A locking rear differential is an option, clearance is good, approach angle is good and departure angle is fair. Interior space is mediocre for such a large vehicle and the load bay is taken up by bulky plastic panels that seem to serve no other purpose than to take up useful space.

On the road the ride is ordinary, comfort ordinary, visibility poor but off-road it is pretty good, although not quite up to Jeep Wrangler standards. The rear diff lock is necessary if you want to show off, off-road. But as a package, I can't say I like the Hummer very much at all, because it's an extraordinarily ordinary car in a fancy skin. H3s were built until 2010.

HYUNDAI TERRACAN

Hyundai's heavyweight has lost its place as one of the best value off-road station wagon available to the Toyota Fortuner. However, for the price of the average double-cab the Terracan is a comfortable and able city cruiser with acceptable (Only just because clearance is poor) off-road performance. Sure it's not in the league of a Prado or even the

Pathfinder, but at so much less money, this vehicle is still worth a look. It's a much better vehicle than the Santa Fe and if the styling isn't your taste the layout may be. Front torsion bar independent suspension, rear solid axle on coils with gas shocks all round. The ride is good, in just about every sphere. It is a bit soft at the back and the front tends to nose-dive a little but the limited-slip rear diff helps a lot off-road. The 2.9-litre turbo-diesel is peppy and not thirsty. Alternatively the 3.5-litre V6 petrol engine is typical V6, producing its power at fairly high revs. It has low range gearing. When off-road it is sometimes nicknamed the 'Terracan't' which is a little unfair.

ISUZU KB

Isuzu's initial foray into the South African 4x4 world was in March 1972 with a 2-litre petrol pick-up 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 included in the range that 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 being single cab layouts. In March 1993 the noisy but trend-setting 2.8-litre direct injection turbo-diesel and the 2.6-litre petrol engines were introduced together with a double-cab body. 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 was the 250D, a 2.5-litre normally aspirated diesel engine in the single cab.

In the nineties the Isuzu KB evolved into a respectable off-roader against stiff competition from Nissan, Colt and Toyota. Later it still managed to hold its own against the 1999 revamped Toyota Hilux, despite the Isuzu's design being by far the oldest in the range. A rear

differential lock, now becoming standard on many pick-ups, upgraded the Isuzu to an effective off-roader. Lack of ground clearance is the Isuzu's biggest drawback and the standard towing attachment snags on obstacles, but can be replaced at modest cost. Changes in the new models were largely cosmetic while the diesel-turbo-engine remained frugal and reliable, and ideal for a working 4x4. It was this engines that kept a very old design popular for so long after more modern vehicles were introduced by its competitors.

Mid 2004 came a much bigger KB. Gone is its small size and tractor-like diesel engine. Isuzu did their homework well and the latest KB, apart from the unbelievably large turning circle, is brilliant. The diesel is just as frugal as it ever was, but more powerful, the V6 is a gem and the off-road performance is almost as good as the Hilux and Triton, although it does need a suspension lift to be effective. On-road it is as refined as these two, but the interior is less flashy. Comfort and quality of ride on a rough farm track is as good as, if not better than any double-cab out there.

ISUZU FRONTIER

The Isuzu Frontier was introduced in early 1998 competing in the budget priced station wagon market. The Frontier is a good cruiser, quiet and comfortable and the interior is fairly simple, without many frills. Off-road its standard rear diff lock is a needed feature as the axle travel is fairly small. The Frontier doesn't carry a heavy load well; the rear suspension seems particularly light but aftermarket springs are available and most are a really worthwhile modification. Engine choices are the noisy but frugal 2,8 turbo-diesel and the 3-litre V6 petrol. The diesel is better if you intend taking your Frontier exploring, the V6, if the noisy diesel is too much to bear. Fronteir production stopped in 2003.

ISUZU TROOPER

The Isuzu Trooper was one of few vehicles to directly compete with the Range Rover when it was released in the early '80s, and there are still a fair number of these older machines around, mostly covered with rust, but still running. Suspension is by independent front wishbones and leaf springs and a solid axle at the rear.

The second generation Trooper is an altogether different vehicle with independent torsion bars at the front and a solid axle and coil springs at the rear and all the fittings making it top-spec 4x4 competing with the Pajero, Discovery and Prado. The Trooper's most serious handicap emerges when it is taken off-road. When moving over rough ground in low ratio and trying to keep the speed down it is very difficult to control as delicate power applications are awkward due to an over-sensitive accelerator. For the same reason, driving in slippery stuff at low speeds becomes difficult and the Trooper tends to display a lot of unnecessary wheel-spin. Troopers are fitted with automatic free-wheel hubs and part-time four wheel drive. Called the Holden Jackaroo in Australia, the Trooper's looks were dated from the time it was launched to the time it was discontinued.

JEEP - HISTORY

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 hope to cope with the production volumes required and so a number of other manufacturers were called in to evaluate the Bantam.

The original Jeep evolved into the CJ and Wrangler models.

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. And so the 'Jeep' was born.

The final wartime 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 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 for the civilian market. The CJ2 was the first, and early models are now collectors' items. The second model, the CJ3, with raised bonnet to accommodate the new engine was first built in 1952, and is still made even today in India by Mahindra, although with a different engine. All CJ Jeeps are excellent off-roaders, the CJ2 and CJ3 being the most favoured by the Jeep fanatics. 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, there are few good second-hand units available.

COMPARISON CHART. 1948-1953; THE FIRST JEEP, LAND ROVER AND TOYOTA LAND CRUISER			
ENGINE	**JEEP**	**LAND ROVER**	**TOYOTA**
Capacity	2199 cc	1595 cc	3386 cc
Cylinders	4 in-line	4 in-line	6 in-line
Bhp	60 @ 3600 rpm	50 @ 4000 rpm	85 @ 2300 rpm
TRANSMISSION			
Main gearbox	3-spd selectable 4wd	3-spd full-time 4wd	4-spd selectable 4wd
Transfer gearbox	1.97:1	2.52:1	no transfer gearing
Final drive	4.88:1	4.88:1	n/available
CHASSIS			
	Pressed steel channel	Steel box section	Pressed steel channel
SUSPENSION			
	Live axles on leaf springs	Live axles on leaf springs	Live axles on leaf springs
DIMENSIONS			
Wheel base	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	n/available

JEEP WRANGLER/RUBICON/SAHARA

The replacement to the CJ is called the Wrangler with sub models called Rubicon and Sahara for the five-door version. It is a vehicle primarily designed to be modified because, particularly in the USA, such a high percentage of buyers accessorize their vehicles, sometimes to the extreme. So, any two Wranglers standing side by side are rarely the same. From the showroom the Wrangler is delivered with a 4-litre, 6-cylinder petrol engine in South Africa and also a 2.5-litre petrol elsewhere. A limited-slip rear diff, good low-down torque and fair clearance make the Wrangler great fun off-road. Add a little clearance, some diff-locks and it becomes almost unbeatable over obstacles. Some of the most popular modifications are a change to the differential ratios to aid towing, differentials locks, raised suspension to

Top: Jeep CJ2.
Bottom: Original CJ-3

increase clearance and an engine head modification that manages a very healthy power increase from the standard engine.

The model called Sahara was launched mid 2007 and consists of a five-door layout but with none of the original loose-fitting panels and rough and ready finishes taken away. It still has the feel and fun of the Wrangler but is now a much more practical vehicle. Off road performance, while not up to par with the short wheelbase Wrangler, is excellent. On road, it's a bit noisy and the roof lets in a lot of dust. The petrol version is unreasonably thirsty, the diesel is much better, but the cost is performance: the petrol version is a great performer while the diesel is a bit flat. Off-road, both models are great.

JEEP COMMANDER

Like the Grand Cherokee, the Commander is equipped with full-time four -wheel drive, Quadra-Drive-2 traction control, tyre pressure warning system and three engine options: 3.0-litre V6 CRD, the 4.7-litre V8 or the 5.7-litre HEMI. While the Commander is spacious, its clearance, like the Grand, is not particularly good, but enough for some off-road fun. It's obviously trained for the US market as most of its features focus on on-road city use, like the rain and speed-sensitive wiper system and the 'radar' that warns of parking mishaps. Nothing on Jeep's local web site talks about off-road use, four-wheel drive or clearance stats, which shows where Jeep is looking for its customers. To sum up the Commander is not the off-road beast it might have been, with clearance, especially break-over angle inadequate, but

with the same brilliant traction system and smooth drive-train of the Grand Cherokee. Anyone purchasing one for off-road fun may be disappointed but as a city family-carrier with the occasional adventurous excursion in mind, it may satisfy.

JEEP CHEROKEE / CHEROKEE SPORT

The Jeep Cherokee, until 2001 was an old-fashioned, basic but good all-rounder. It is a vehicle which excels at nothing, but manages to do everything with a degree of competence that attracts third and fourth time customers year after year. Its weakness is that after a few years of even modest off-road work and long distance touring it feels like a box of loose bolts. The steering soon becomes vague and the handling deteriorates. As a pre-owned purchase expect to spend a bit replacing bushes and having the steering and suspension components tightened or replaced. And it has character, unlike its replacement.

The current model, the Cherokee Sport is smaller than its predecessor and a far more fashion-conscience vehicle. The 2,7 turbo-diesel engine, developed by Mercedes Benz, pulls the relatively light Sport extremely well. However, the big petrol engine is a horrible alternative as it is extremely thirsty. On-road the Sport is ordinary, nothing to complain about really, just boring. Off-road it's a fair performer but because of its serious lack of clearance between the front wheels, it can become a real frustration to those taking theirs into rough terrain. Off-road, the suspension does not hold its clearance well and so after-market suspension kits transform this vehicle for much tougher and rougher off-road use. The Sport is a fairly small vehicle and therefore not particularly well suited to extended safaris for more than two people.

QUENTIN DU PREEZ

QUICKPIC

JEEP GRAND CHEROKEE

The Grand Cherokee has always been the flagship of the Jeep range and is a top-spec 4x4 crammed with comforts. Early versions had solid front and back axles with soft springing. The 2nd generation Grand was fitted with an extraordinary traction system: Instead of an ABS brake-managed traction control system found in so many 4x4s, Jeep used hydraulics to prevent wheel slip and called it Quadra-Drive. The result was good traction and good off-road performance but for its mediocre clearance. To really take advantage of its awesome traction, a suspension lift was necessary. The Grand's weakness is its drive-train and build, which are not designed for heavy-duty off-road expeditions and not infrequent failures of these components have been reported by those using it for extended expeditions. In addition, the Grand is a small vehicle and as a family off-roader, doing extended trips, can bring packing-it-all-in problems. Also, the standard spare tyre is a compact type and should not be relied on during back country travel.

In 2005 Jeep launched an all new Grand, a restyled model with some new features and some new engines. Firstly it is larger. Secondly, for the first time the Grand has independent front suspension which, as can be expected, improves on-road performance. However, unlike many of its competitors, this hasn't made its off-road performance worse: This is mainly because the older model's suspension behaviour off-road wasn't that good to begin with. But what is absolutely spectacular, and has to be seen to be believed, is its new traction control system: Quadra-Drive-2. If this vehicle had better clearance it would be as unstoppable as any 4x4 in the world because this system is so good at preventing wheel-spin and providing grip, that the vehicle's ability over undulating ground is nothing short of jaw-

droppingly brilliant! In my opinion, Quadra-Drive-2 is a superior traction system to Land Rover's Electronic Terrain Response as fitted to the Discovery-3/4 and Range Rover. It seems a real pity that it does not have better clearance to take better advantage of this awesome technology. A face lift Grand was introduced in mid 2008. Another major model update was introduced in 2013.

LAND ROVER - HISTORY

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.

Early Land Rovers can still make a worthwhile purchase. They are easy to work on and if you are prepared to tinker they make great playthings. Below: Series-2 Next, top: Series-1.

What made the Land Rover unique was its ability to accept power take-offs for driving agricultural equipment such as pumps, saws and winches, and it was marketed as a lightweight 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 vehicles had a standard layout and an all-new welded box section steel chassis 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 a tyre for the standard spare wheel.

Land Rover's design, being simple and easy to maintain, gave it the potential for worldwide 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 still turning a profit.

By the end of 1949, 8000 Land Rovers had been delivered. 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 that had a free-wheel inserted between the front propeller shaft and the transfer box to overcome the windup when driven on a sealed surface. The new system was truly selectable, allowing the driver to engage the front prop-shaft at will. This system continued until 1983 with the release of the full-time 4WD system in the newly developed Land Rover One-Ten, now know as the Defender.

In 1954 the first change was made to the chassis. Still designated the Series One, the new wheelbase was increased from the original 80 inches to 86 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 two 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.

Land Rover Forward Control 109-inch. 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.

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

I owned a 110 Defender for eight years, but even though I no longer drive one, I look back on the eight years that I owned it with affection. Why, you may ask, do I not still drive one? The Defender's body is still based on a 1948 design and its chassis is truck-like, so that it is outperformed in all but the most challenging off-road environments by almost every 4x4 available. Its safety and reliability is questionable and its comfort levels are poor. Every 4x4 is a package: a combination of on and off road ability. For me the reasons to own a Defender are its looks, character and the people who own them. Not the vehicle itself.

Series-Two. 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 1.997cc 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. By today's standards it does not sound a lot, but for the '50s, it was quite an achievement. 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.

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, 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 head lamps 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 plastic grille that could no longer be used for cooking over a fire.

With the new design, however, water cans could now be fitted in the recesses next to the grille without blocking the head lamps. 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.

THE LAND ROVER CULT.
Unique in the world of 4x4s is the Land Rover cult. The passion associated with this vehicle, in particular the older Series 1,2,3, and Defender is unmatched in the automotive world. The glue is a bond of mutual respect, passion and love for their vehicles. Waves from complete strangers, flashing headlights and warm greetings in a camp site just because you drive a vehicle with the same badge is rarely understood by those who have never experienced it.

LAND ROVER SERIES 1, 2, 2a AND 3

Many of these workhorses are bought and sold second-hand. If they are well maintained, and you are prepared to spend some time keeping them running, they are a good purchase and are sure to last

almost indefinitely. Although the body is aluminium it does corrode. Pay special attention to the chassis, which must be inspected closely. Areas prone to rust are in the area of the spring shackles and the rear cross member. By modern standards, they are unsophisticated vehicles and Series-1 versions are now 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. They are common second-hand purchases and most continue to plague their owners with overheating. Another Land Rover that shared the flush grille of the R6 was the V8. This was the predecessor to the One-Ten. It had a V8 engine and Range Rover transmission but with leaf spring suspension. As not many were built they too have become a favourite with collectors.

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 was smoother, stronger, more comfort with less noise. Although the vehicle appeared to be a Range Rover-Land Rover hybrid, it did not share as many components 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. Engine options were a 4-cylinder 2.1/4-litre and 3.5-litre V8 petrol.

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

The Defender is a truck. Its close cousins, the Discovery and Range Rover, are off-road cars, so the Defender can best be described as an off-roader with acceptable road manners. It is not altogether suited to everyday suburban motoring and, although not uncomfortable, it is

big and turns like a school bus. Luxury packages are called County or Hi-Line and include cloth seats, carpeting and air-conditioning.

Between 1988 and 1991, V8 Defenders were fitted with a Spanish-assembled LT85 5-speed gearbox. A high percentage of these gearboxes were faulty due to under-sized bearings being fitted in the factory. These gearboxes are good for only about 80 000 kms, though many have failed much sooner. Purchasing a second-hand vehicle fitted with an untouched LT85 gearbox is risky. Virtually all Defenders have or have had waterproofing problems. I guess this is the last remnant of a 1950's design.

In later years engine options were a 2800cc 6-cylinder BMW petrol, three versions of a 2500cc 4-cylinder turbo-charged diesel and a 5-cylinder turbo-diesel engine, the TD5. The first diesel was the '100' engine and was plagued with over-heating problems. The second version, the '200' was a vast improvement, offering reliability combined with excellent economy. The last 4-cylinder, predictably called the '300', was again an improvement. A cam-chain tensioner modification to the 300 engine was necessary and if considering a second-hand purchase, make sure this mod has been done. If not, the clock is ticking to a huge engine rebuild bill should the timing belt fail! The BMW engine is thirsty and way overpowered for the chassis.

With the TD5, 5-cylinder diesel gone was the tractor-like thump of the older diesels and almost gone, the severe turbo lag. Lots of low down torque and improved cruising made a great improvement. It is controlled by electronics and the control unit is located under the passenger seat. What an absolutely absurd place to put it. Don't Land Rover know that Defender drivers like going off-road and this includes deep water and that electronics and water don't mix? An unbelievable oversight or they could find nowhere else to fit it. This I think is the most likely scenario.

The double-cab 110 variant is another incarnation of the design, practical and ideal for expedition use. It is supplied with a very trendy and good looking but otherwise almost useless canvas canopy. Back seat passengers quickly complain of lack of leg and head room and an overly high seating position. Double cabs are also built on the longer 130 high-capacity chassis.

Late 2007 brought in a major update with most of the changes hidden under the familiar body. The interior has seats, in the true sense, as well as a real dashboard, instead of the unmistakable inside of a Land Rover, which is a bit of a pity. Parts of it are taken from Discovery-3, so the new dash looks odd to say the least, but it's functional and I am sure is acceptable to all but the die-hard Defender owners. It also has a restyled bonnet, although one could be forgiven for not noticing.

However, gone are the splendid, delightful, leaky and truly unique opening air vents below the windscreen. The good news is gone is the troublesome TD5 replaced with a Ford 4-cylinder, common-rail 2,4 turbo-diesel engine and six-speed gearbox, the sixth gear being almost useless, as on all but a downhill, the engine doesn't have the power to pull it. Its anti-stall electronics makes descending very steep slopes a really horrible experience because the brakes are often not powerful enough to slow the vehicle and it charges down at its own, and not the driver's pace. Other than this, the update is a significant improvement. Safety, handling and comfort remains the same: well below any other vehicle on the market today.

A few things taint all Defenders: The driving position for large people is uncomfortable because the front seats are positioned so close to the doors that broad-chested drivers find that their shoulders constantly rub against the centre (b) roof pillar: Many people just do not fit into the seat of what is not a small vehicle. But more significantly, and sadly, over the past 20 years, the build quality of Land Rovers has deteriorated to the point that they now have a widely held reputation of unreliability. Unlike in the '60s and '70s, when electrics were a common but fixable problem, repeated failures of engines, gearboxes and drive-trains are tainting the reputation of what once was the icon of strength and dependability. The result is scores of Land Rover owners are now driving Japanese replacements, which while they lack the character and pose of a Defender, are well ahead in almost everything else. I am among this group.

LAND ROVER DISCOVERY

In 1989 Land Rover developed a vehicle to compete in the rapidly expanding SUV market, in a segment lying between the Land Rover (Defender) and the by now very luxurious Range Rover. This was done 'on-the-cheap'. The Range Rover chassis and drive-train was used almost unchanged. The body shared components with other Leyland vehicles, such as the rear lights from the Austin Allegro and the door handles from the Morris Marina. It was first offered with the 3500cc V8 or a 2500cc four-cylinder Tdi-200 turbo-diesel engine. The interior was all new, but the packing space and load bay ergonomics is best described as dismal. What were they thinking? Clearly, not clearly!

The Discovery joined a range of top-spec leisure vehicles like the Pajero, Isuzu Trooper and Toyota Land Cruiser SW. Like all these vehicles, off-road ability and on-road comfort trade-offs had taken place. Compared with the others the Discovery was better suited to off-road use, with the associated on-road performance penalties.

Interestingly, while it shared the early Range Rover chassis its on-road comfort was far superior but off-road was inferior.

The 1994 face-lift introduced an all-new interior, new light lenses, an up-rated 3.9-litre V8 engine and improved on-road manners with the fitting of anti-roll bars to the suspension; a worthwhile improvement. But the Discovery remained cramped inside and the rear springs have never carried a load particularly well. A joy to drive in all surfaces other than corrugations, where the Discovery has a nasty, fishtailing tendency that can be frightening and dangerous. Lock the centre diff and lower the tyre pressures solves the problem. Old Discos sell cheaply and for the beginner who is happy to spend some time working on the vehicle, the Discovery makes an excellent introduction to the world of off-roading. While it does not offer the reliability of many Japanese competitors it sells for less and is a great all-rounder.

The launch of the Discovery-2 in early 1999 introduced the same wheelbase with a longer and wider body with some new technologies. In addition to HDC (Hill Descent Control) new vehicle management systems namely HPI, EUI, ECM, ACE, ETC and FTC, the details of which go beyond the scope of this book, were introduced. Even without ACE (Active Cornering Enhancement), Land Rover's new stabilising system is better than ever on-road. Off-road, however, is a very different story. It features ETC (Electronic Traction Control) which is combined with a centre differential that cannot be locked. This utterly ruined this Discovery and I grew to loath driving or even driving with this vehicle. To put it briefly, ETC is a system that relies on traction being lost before it engages, for traction to be regained. How preposterous! It goes against everything I know about off-road driving, where keeping traction is done at all costs. When coerced into traversing wheel-lifting terrain, it spins its wheels and digs holes into the earth before moving over it, normally in a huge cloud of dust. The

Bottom centre: Discovery-1
Below top: Discovery-1
One from top: Discovery-2, distinct from earlier models by the long rear overhang, high tail lights, traction control and no centre diff lock, the latter update ruining its off-road ability, because the traction-control wasn't any good.
Third down: Discovery-2, Series-3, good off road because the centre diff-lock was put back. This was the last Discovery with solid axles.
Bottom: Discovery-3, now so complex, it has for many, removed itself from the list of expedition-worthy 4x4s.

LAND ROVER SA

trouble is that a well set-up vehicle in the right conditions can perform quite well but, a poorly set-up vehicle (ETC setup, which is extremely difficult to get right), which almost all of them are, are worse than poor performers off-road and in some cases are outperformed by 4x2s with rear diff locks! That said, the auto gearbox models with their viscous centre transmission out-perform the manual versions by a large margin.

In 2002 Land Rover announced the Series-3: (not to be confused with Discovery-3). This had mostly cosmetic changes and most importantly of all, the centre diff-lock returned. The Discovery moved back to where it once was, at the top of the off-road ladder, an excellent performer on rough terrain and a very nice road cruiser.

I still find this Discovery small and a bit cramped and three adults in the back is not a serious option for long trips. The Discovery has a reliability issue that has followed it since it was introduced and while it has been one of the best-selling SUVs in the world, it is severely outclassed by all the Japanese and German manufacturers in this department. When selecting a used Discovery, make low mileage the primary concern, and select petrol over diesel and auto gearbox versions over manuals.

LAND ROVER DISCOVERY-3/4

Introduced in 2004, Discovery-3 is considerably larger than its predecessor and has all-round height-adjustable independent suspension. At last they got the Disco's ergonomics right: Now it is a big vehicle inside as well! It has a new traction system called Electronic Terrain Response. The system reminds me of a modern digital camera, where the photographer just points and shoots and is guaranteed a pretty good result every time, but when lighting conditions get tricky, performance is not great. It works like this: See the terrain ahead, select from between five terrain settings on a knob on the console, and then drive. The software then makes most of the decisions; the only decision left to the driver is how much to turn the steering. Even the throttle opening is sometimes controlled by the computer. Other decisions made by the software are what differential to lock and when. It is fascinating to watch, especially when in my opinion, the decisions are clearly the wrong ones and the vehicle stops in its tracks, or other occasions when it works brilliantly. A large screen in the centre of the dash explains what is happening, wheel by wheel, as it tackles the terrain. When I drove the vehicle in sticky, gooey mud, I kept yelling, "Why can't you keep the rear diff locked?!" The system is clearly not as clever at as the Jeep Grand Cherokee's Quadra-Drive-2, but because of everything else about the Discovery, including its adaptable clearance, it is a much more versatile vehicle and leaves its American rival choking

and spluttering in its very classy dust. I learnt later, that like everything on an unfamiliar vehicle, this traction-control has to be leaned by the driver, and I grew to understand it. It is very impressive.

I only have one serious criticism of Discovery-3, and it's a potential deal-breaker. The auto-ride height drops the suspension to the low, high-speed setting at a puny 50 kph. Anyone having crossed a desert will know that a bit of extra clearance at 70 kph is a really useful thing. The result can be real frustration, because the speed at which the corrugations are smoothed out, cannot be reached, and instead one has to endure being shaken to pieces.

Engines include a 4.0, V6 petrol, 2.7, V6 turbo-diesel and a 4.4, V8 petrol. The diesel is almost as quiet as the petrol and more frugal, but not as frugal as some of its competitor's diesels, probably because of the Discovery's almost three ton kerb weight.

Discovery has never has a good reputation for reliability, and while things changed a bit with Discovery-3, they haven't changed much. At 150 000 kms most Discoveries begin to give trouble and their resale value plummets like a logbook down a mine shaft

Discovery-4, (or LR4 in the USA) was launched in 2009, looking very much like a face-lift Discovery-3. But hidden away were many improvements. Engine choices include the absolutely brilliant Jaguar 3-litre V6 diesel, which buy itself, puts the Discovery in a class of its own. It has enhancements to its traction control, larger brakes, and improved emissions. Unfortunately the ride height still drops at 50 kph, complex electronics keep the Disco in the town-car 4x4 category, and its wheel rims now 19", are a disappointment to anyone wanting to take it off the tarmac. And it's not easy to fit smaller rims or more robust tyres. But as an all-rounder, the LR4 is a revelation, and while I can't really consider it a true expedition vehicle, as a dual purpose,

While the Discovery 3 & 4 are truly brilliant vehicles, they can be extremely expensive to run. My urgent advice to anyone considering one of these fine vehicles, is that if it's new, take out a motor-plan and extended warranty. If it's used, beware of ones with over 100 000 kms on the clock. This probably means that they are about to be troublesome. And if they are, they are costly in the extreme to maintain and even more costly to repair. So purchase all the warranties that are available. Or, buy a helicopter; It may be cheaper to run.

everyday wagon, it is remarkable. Its outstanding off-road ability due to a brilliant traction-control, adjustable ride height combined with a superb ride in all conditions, good load carrying ability and sometimes very clever ergonomics, make it the best all-round 4x4 wagon made today.

RANGE ROVER

This is the vehicle that I credit with the birth of the now huge 4x4 leisure industry. The Range Rover represented a departure from the norm when it was introduced in 1970, being 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 comfort. Development of the Range Rover began in earnest in 1965 and in less than five years the showrooms were bursting with customers. Range Rovers were displayed with pride at motor shows all over the world and the motoring press announced a triumph for British engineering. And it was.

The Range Rover was a combination of powerful lightweight engine, full-time four-wheel drive incorporating three differentials, and long-travel coil spring suspension. It was concluded that coil springs would not only produce a more acceptable ride on tar but also offer greater axle articulation to greatly improve traction over rough ground. Contributing to its almost revolutionary performance was the alloy 3.5-litre, V8 engine bought from General Motors in 1965. This engine, or forms of it, stayed in the Range Rover until 2002. 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. Full-time four-wheel drive gave the new vehicle the advantage of improved traction, cornering and wet weather handling in all conditions. In the rough the driver could decide at any time to lock the centre differential and prevent slip between the front and rear axles. This made the Range Rover far easier to drive off road than any other 4x4 of the time.

Land Rover made sure that no one was in doubt as to the Range Rover's pedigree – the early models displayed a badge on the tailgate: "Range Rover by Land Rover". The brilliance of the design did not go unnoticed and the vehicle won several engineering and automotive awards. And in 1970 its stylists were recognised as an ambulance derivative was even honoured by the Louvre Museum in Paris.

With the birth of the 4x4 leisure industry 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 some instrumentation missing. In 1973 when the Mark-2 version was released the interior design was completed.

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.

Range Rovers were built in Kenya, Brazil and from 1979 to 1985 in South Africa. In most countries quality control was poor and many vehicles earned a reputation for unreliability.

Payload is 680 kgs and the roof requires supporting if a heavily loaded roof-rack is to be carried as the maximum roof load is just 50 kgs. To increase the Range Rover's payload, fit Discovery rear springs, and if that's not enough, an OME suspension kit. The last Classic Range Rover rolled off the Solihull production line in 1996.

In 1994, for the first time in its 24-year history, the Range Rover underwent a major styling change. Most models do the same in ten. This model is called the P38. The concept was to create a vehicle that matched if not exceeded its predecessor's off-road ability, improve its driveability, comfort and loadability, while making sure that what is created is unmistakably Range Rover. It did all that, but did not quite reach the off-road ability of the original, which in its 44 year history, remains one of the best every built.

The result was a far more complex machine that once again set the standard in 4x4 luxury fashion vehicles. Models came 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. Early P38 Range Rovers suffered reliability problems but after

a year or so of production things improved, so if you are considering one for purchase, look for models later than 1998.

The third edition Range Rover was released in 2002 and the vehicle was again a radical departure. All-round independent suspension on a hybrid frame and monocoque chassis with every conceivable luxury keeps the Range Rover leading the 4x4 fashion world. The big question is: Is it soft off-road? No, the Range Rover still has adequate clearance and low gearing. It is undoubtedly styled for the huge US market: Silky smooth, powerful and while awesome to drive does not have the agile feel of the similar-sized Cayenne. The payback is superior off-road performance, better than all its competitors, many by a very long way. A large vehicle, can be cumbersome on and off the road and the independent suspension lifts wheels even in modest axle twisters. The Range Rover's reputation for reliability is not as good as many, but it does not seem to affect its sales much. Engine options include a 3.6 litre, V6 turbo-diesel, a V8 turbo-diesel, a 4.4 litre V8 petrol and a supercharged 4.2 litre V8 petrol. Post 2004 models include Discovery's Electronic Terrain Response system.

In late 2012 a brand new model was launched. Amazingly, it's even better off-road than before. To me it's wonderful that the designers have not forgotten its pedigree. On-road, of course, its the best Range Rover ever, being lighter, more economical to run, but a lot more expensive to buy and maintain.

RANGE ROVER SPORT

Under the skin the first generation Range Rover Sport is more Discovery-4 than Range Rover. So, because it is really a very expensive Discovery, is it worth the extra? It has a better looking body (most will agree on that), better seats, a Discovery dashboard with annoying (sunlight reflects into the driver's eyes) chrome trim, a centre console that is not ergonomically good at all, the same engine and transmission, fewer sun-roofs, the same number of doors, a one-piece

LAND ROVER SOUTH AFRICA

tailgate instead of two, no drop down tailgate (which is extremely useful) and a smaller interior and back seat space. As a practical everyday vehicle for use in town and country, the Discovery is better. Clearance is similar, it has Discovery's Terrain Response system and so off-road its about the same. But unlike its competitor's such as X5 and Q7, it is still a true off-road machine.

In 2013 an all-new Range Rover Sport was released, this time not based on Discovery. So now, this picture might be altogether different.

LADA NIVA

The Lada Niva is built by AutoVAZ, 900 kilometers 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.

The Lada is a very mobile, effective off-roader and pretty awful on-road: Noisy, slow, underpowered and they keep breaking down. Reliability problems and its total lack of parts back-up continue to be the most serious drawbacks of the Niva.

The Niva has a live rear axle and independent front coil spring suspension, which has excellent articulation. The Niva has permanent

four-wheel drive with a lockable centre differential. The interior is reminiscent of a 1975 Fiat 124. Current models have a 4-cylinder 1700cc engine. Models available include the Standard, Safari, Cub, 5-door s/wagon, single cab and double cab pick-up. Advanced option packs include alloy wheels and sunroofs. The Niva is the ideal vehicle for someone who wants to trash their vehicle off-road and then fix it themselves. Otherwise, it is very easy to find something better.

MAHINDRA SCORPIO SW

Indian built compact four-wheel drive station-wagon about the size of the Jeep Cherokee Sport, the Scorpio hasn't found a large following despite being one of the best value 4x4 SWs on the market. The early turbo-diesel are not overly powerful and are noisy both inside and out. They are also quite thirsty. The new turbo-diesel engine introduced in 2010 is altogether a better engine, refined and a huge improvement. The Scorpio is about two thirds the price of a the Jeep and will easily match it off-road where it is fun to drive, the clearance being better than the Jeep. Road handling is also good for a vehicle with a relatively short wheel-base, although the steering is a little vague and so its handling is not as crisp as the Jeep's. On the down side, the fuel tank is a miserly 53 litres. The ride is really quite good on tar but a brittle on rough gravel, and bone jarring on rough tracks, where engaging four-wheel drive improves things. It has electrically-operated four-wheel drive with low range. Suspension is coil springs and live axle at the back, independent torsion bars at the front. I really think that the Scorpio SW has a lot going for it, and it's mainly the price.

MAZDA B-SERIES/DRIFTER

The Mazda-B is a badged-engineered For Ranger. For details was introduced in November 1990 as a single cab version, followed by a double-cab variant that is still with us today, although it is now called the Drifter and is a well-developed and popular off-roader. Today, two engines are offered: a 4-cylinder 2.5-litre inter-cooled turbo-diesel and a 2.6-litre 4-cylinder petrol. 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 automatic free-wheel hubs are now standard.

The diesel version is the better vehicle in just about all driving conditions and performance of the diesel is the same as the Ford Ranger, where the chassis, engine and drive-train are so similar.

MITSUBISHI COLT / L200

Introduced in November 1994, the Mitsubishi Colt started life as a twin-cab 4X4 based on a 4x2 pick-up. It has part-time four-wheel drive with automatic free-wheel hubs. 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. Another weakness are its free-wheel front hubs as they are not robust and failures are common.

The second generation Colt is happily not a first-generation Colt with some new body panels and interior; it was a complete revision. Off-road the improvement is excellent: Gone is the harsh ride and lack of wheel travel. And so the Colt became an accomplished off-roader to take its place with the best of Toyota, Isuzu and Nissan. The Colt is also well built and I know many who have successfully used them for the most rugged outback adventures and the vehicle proves itself time and time again as robust and reliable. The Colt's weakness is its turbo-diesel engine, which can, and often is, troublesome after about 130 000 kms. These engines, if used for heavy work like towing long distances in high ambient temperatures, do not last particularly long and turbo failures are common. The Colt was the first double-cab to be available with automatic transmission, which I don't recommend if your intention is rough off-road driving, especially with the V6.

MITSUBISHI TRITON

Introduced mid 2007 Triton was launched in addition to the Colt, as Mitsubishi's premier pickup, and I am sure will soon replace it as

Mitsubishi's one-ton single and double cab pick-up. Its looks appear to be its drawback, as it is not finding the following enjoyed by Colt. The engine lineup is all new, with a 2.5-litre turbo-diesel replacing the 2.8-litre, but producing more power and torque while being lighter and producing lower emissions. There is no big petrol engine option. Transmission is similar to Pajero's Super-Select four wheel drive. White the Triton is better suited on-road than off, it is still good in the rough, and while not having the Colt's solid feel, it is gaining a good reputation off-road. When comparing it with the Colt, its a better ride, off and on road, it has better seats, better steering, improved safety and visibility and is a much nicer drive. As a package though, unlike the Colt, it is a modern vehicle and competes well against its competition for performance, if not looks. Early Triton models were available with Super-Select gearbox, but this has ended as a cost-saving measure.

MITSUBISHI PAJERO

When first introduced in the '80s, the Pajero was built with 2.8-litre turbo-diesel or 3.5-litre V6 petrol engines and has since evolved into the excellent, dual-purpose vehicle it remains today, home in the city and bush. Through its evolution the Pajero has retained the vital ingredients of a true off-roader, namely low-range gearing and good ground clearance.

One of the Pajero's selling points is that it is neither a part-time nor full-time four-wheel drive vehicle as the driver may choose to be either. 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. This system is a mixed blessing: good in theory but in practice less so, because rarely do drivers use the system correctly; engaging four-wheel drive when it rains or even

Below top three: The second generation Pajero that put it on the map as an excellent all-rounder. Bottom two and right: Styled like the Paris-Dakar race winners, the Pajero, like so many similar vehicles, has become more luxurious and while it is less well adapted to off-road use, has kept the off-roader's key ingredients of low-range gearing and adequate clearance.

on gravel roads where it is designed to be used for the safety benefits derived from four-wheel drive. Also, I believe that full-time four wheel drive is safer, wears tyres slower, impacts the environment less and provides an altogether better ride than two-wheel drive; all these advantages for an almost immeasurable increase in fuel consumption. I must therefore ask: why offer a two-wheel drive option at all?

Off-road the Pajero is a good performer and is easy to drive. 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. Despite this, this shortcoming can often be overcome by driving technique and the Pajero has gained a vast and devoted following. Some models have a rear diff-lock fitted, a significant advantage with this vehicle.

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.

The 1998 cosmetic changes did not help the Pajero in any way and the additions look like cheap after-sales add-ons and did nothing meaningful other than lower its clearance.

The 2002 model, distinguished by its rounded wheel arches and rally-car styling, is better off-road than it looks: Its bodywork, on first appearance looks low to the ground but off-road it's quite good, its auto gearboxes working brilliantly in the rough. Add some additional clearance with an after-market suspension kit and the Pajero becomes an off-roader that performs extremely well, even in very challenging

terrain. The SWB version is similar to the LWB but, with adults in the back, expect complaints about a severe lack of leg-room and packing space. Upgrades since 2002 have been mainly cosmetic, and in my view all have made it a better looking vehicle than its first manifestation. Engine options were a 3.8 litre, V6 or the 3.2 litre, 4-cyl turbo-diesel.

The 2007 face lift introduced a better looking Pajero but with no significant performance changes, although I am sorry to say it is beginning to go soft. The GLS high-spec version is very annoying: it peeps warnings seemingly without provocation, the super-select is slow to inputs (locking the centre diff while moving can take minutes instead of seconds) and it frustrated me off-road as I learnt a bunch of new skills when handling its traction control and hill descent control.

On a dune driving excursion I, for the first time ever, damaged a loan vehicle. The front bumper was bent back, the rear bumper was ripped off, the wheel alignment went out and the sump tray was bent. Only the front bumper damage could I assign to a mistake while driving, after I went over a dune slip-face a bit too fast, but all the other damage were due to wear and tear. This kind of damage for this type of terrain is unacceptable for a vehicle claiming to be an off-roader. My conclusion is that Pajero has gone soft and I once really liked it, but no longer do. It still out-performs the Pathfinder off road, but is way behind the Prado and Discovery for robustness. If you want a Pajero and want to go off road, don't even consider the GLS, but rather go for the GLX version and upgrade the suspension to give a little more clearance. Engine choices are a now quite old 3.2-litre, 4-cylinder diesel with common-rail direct fuel-injection for which Mitsubishi quotes 121 kW at 3500 rpm and a 3,8-litre V6 petrol engine producing 184 kW at 6000 rpm.

The very handsome Pajero Sport is not nearly as popular as its chief rival, the Toyota Fortuner. But I am not sure why.

MITSUBISHI PAJERO SPORT

Introduced in 2010 as direct competition to Toyota's very successful Fortuner, the Sport is a worthy contender for best light 4x4 wagon. Comfortable, sporty and great to live with, there is only one this that really lets it down - and that is its engine - which is not as refined and doesn't quite have the oomph of its competitors. It love it seating, the ride is excellent, it handles gravel brilliantly but its pulling power is ordinary. It has full time four-wheel drive, rear coil springs and wishbones and coils on the front. There is one engine option: a 3.2L turbo-diesel. I am really not sure why it doesn't enjoy the huge success of the Fortuner.

MERCEDES BENZ G-WAGEN

Still only built in Austria, the Mercedes Geländewagen is one of the most impressive 4x4s ever made. The secret is a long-travel coil spring suspension that provides 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 that from the driver's seat it feels invincible. Almost all pre-1998 G-Wagens are underpowered, which often means low first gear when the ideal gear would be low second, although the vehicle is so good off-road it rarely seems to matter! But it does mean that none of them are particularly good on sand.

As good as it is, it has weaknesses. Firstly its rear springs which should be replaced after 200 000 kms as they are prone to breakage after this. Manual transmission clutch plates are small and if you ask me, a little under-engineered. The break-over angle on the 463 LWB

Some consider the G to be a bit of an ugly duckling. For me, I love its chunky, boxy, purposeful looks. This is the 300GD Professional, launched in 2012

G-Wagen 461-series have the black grille and are the workhorses while the 463-series with the colour-coded squared-off grille are the luxury variants. Some consider the G to be extremely ugly but its engineering was decades ahead of its time. The G may well be the best engineered civilian 4x4s ever produced.

models is not particularly high. The 461-series versions have part-time 4WD, the 463-series full-time 4WD and ABS brakes. G-Wagens have remarkable transmissions: It is one of very few 4x4s where low-range can be engaged while the vehicle is still moving and this happens effortlessly. In addition all G's have front and rear hydraulic locking differentials that can be engaged at any time by pulling a long lever out of the floor (461) or pushing a button (463). Another weakness is the front diff lock actuator, which is prone to failure.

In 1998 the 290GD was introduced in Europe and South Africa. It was a 461-series, 5-cylinder, 2.9-litre turbo-diesel auto in long and short wheelbase, absent of many frills but many with cruise-control, air-con and electric windows. The rest of the vehicle was spartan and practical, all the way down to the floor plugs to drain water from the interior after hosing it out after a long safari. Between 2001 and 2010 RHD G's were built in very small numbers and sales virtually stopped.

In 2011 the G-Wagen was reintroduced in left and right-hand-drive with three models: a 461, what they call 'The Professional' and then two 463 models with all the trimmings. All are powered by the 3.0L turbo-diesel and all are absurdly expensive. But if I had the cash, I would buy one in a heartbeat. But for the same price as a full-spec Land Cruiser Prado VX, the only frill you get with it is one airbag. You don't even get electric window winders.

I find it amusing that the almost famous 4x4 explorer, author of several books for Land Rover and my mentor, Tom Sheppard, drives as his personal vehicle a Geländewagen 290GD. This doesn't surprise me one bit.

Top: Mercedes M-Class Bottom: Mercedes G-Class, not to be confused with the G-Wagen.

MERCEDES M-CLASS

The M is not a thoroughbred off-roader, its light duty chassis and clearance keep it in the class of Pathfinder and Terracan; vehicles with low range gearing but inadequate clearance for off-road use. The M-Class has improved in most ways since it was first introduced and its traction control is excellent. Standard tyres are suited only to ordinary road use so for gravel operations they should be changed. The trouble is, the makers do not approve any alternative tyres that are suitable, so owners must run on 'unapproved tyres' if they want to leave the tarmac. Engine options are 3-litre V6 diesel and 5.5-litre V8 and 6-litre AMG, V8 petrol. There is no manual transmission option.

MERCEDES G-CLASS

First released in 2007 the best way to describe the G-Class is a big M-Class. Thankfully, the G-Class was never meant to replace the G-Wagen, because there is not much G (Gelände) about it. Soft and cosy but with advanced traction control and big powerful engines, it

is no doubt, like the M, developed to attract American city dwellers and not world tourers. Engine options: 3-litre V6 diesel and a 5.5-litre V8 couple to Merc's 4-Matic auto gearbox. It is equipped with low range gearing, inadequate ground clearance and low profile tyres. I imagine it is magic in the high Alps carrying Ray Ban ski-bunnies to the uppermost ski-lift. But for Africa? I don't think so.

NISSAN HARDBODY

In the early eighties Nissan launched the Tracker, a 4x4 derivative of their 4x2 pick-up. The Tracker was very much a conversion, a vehicle that performed reasonably well but fell way behind purpose-built 4x4 pick-ups like the Hilux. In 1989 Nissan's new Sani became the most popular Nissan 4x4, a station-wagon built partly of fibreglass, and based on the newly released Hardbody body and chassis. Hardbodys have part-time four-wheel drive, manual free-wheel front hubs and were built with two petrol engine options including a 3-litre V6.

All Hardbodys have a solid rear axle on leaf springs and independent front double wishbone torsion bar suspension. In late 1995 the front suspension was given a major revision with the addition of dual front coil springs and shock absorbers designed primarily to improve performance in rough conditions, a layout which was a big improvement

The 2007 line-up comprised 3.3-litre V6 petrol, 3.0-litre turbo-diesel, 2.4-litre petrol and 2.7-litre petrol. Nissan's engines have an excellent reputation for reliability and of these the 3.0 turbo-diesel is the best choice for a long distance cruiser into the outback.

NISSAN NAVARA

The Navara looks bold and beautiful on the outside but under the skin it is a light to medium duty pickup, not even close to the heavy-duty class of the Patrol pick-up. It has a class-leading cab for both roominess and plainness - the inside is dull and this is why so many Navaras find their way to specialists to have the interior spruced up.

Nissan's line of four-wheel drive pickups from the Tracker in 1982 to the Hardbody of 2005.

NISSAN SA

The 4.0 V6, 198 kW/385 Nm of torque engine option is so quick it is attracting the petrol-heads. The second engine option is the new generation common-rail turbo-diesel. The Navara has a lot going for it and it is summed up by saying that it is one of the biggest and roomiest pickups around, with a load bay that is really big and deep. Low-range gearing is activated with a switch, ABS, air-bags and brake-assist are standard - unusual for a pick-up. And so is the cruise-control, the first to appear in a double-cab. But be aware: when test driving a Navara, try it out on some corrugations and gravel. Its ride is harsh and unforgiving.

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. It has part-time four-wheel drive, low range but without any axle diff locks and its approach, break-over and departure angles are good.

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; the high driving position just right and packing space is generous, even in the SWB version. On the downside the Terrano is a light duty vehicle and those used for rough trips soon develop a hundred annoying rattles and the vehicle soon feels like its falling to bits. The Terrano is no longer built.

NISSAN PATHFINDER

Pathfinder is a large, boxy station-wagon and should be compared with Prado, Discovery and Pajero. It competes well in all theatres of operation until it hits any traction-limiting surfaces, where it falls short by a long way. On road, especially on the long run, the Pathfinder is an pleasure, the 3.0 turbo-diesel pulling well and without excessive fuel use. Like most of the other station-wagons, it sags its rear end long before the max payload is reached. It's well equipped for long distance travel with cruise-control and really comfortable seating, plenty of room in the back and a square-shaped load-bay ideal for packing lots of stuff. But the Pathfinder is a real disappointment off-road; it just hasn't got enough clearance, and on undulating terrain doesn't keep what little it has. In this regard it is way behind its competitors. In addition, during my test a number of us impaled our skulls on the absurdly-designed and probably overlooked, sharp, v-shaped edges of the upper tailgate. It is more than just an annoying design oversight.

NISSAN PATROL

The current Patrol is fourth in a generation of Nissan's dual purpose 4x4 station-wagons. Since the beginning they have had a reputation for reliability and strength. Early Patrols were called 'Safari' in some countries, immensely tough but suffering a little through lack of

NISSAN SA

ground clearance between the 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. Coil springs were introduced while the live axles were maintained together with part-time 4WD and a rear axle diff lock was introduced. Its over abundance of chrome and almost grotesque styling found it few friends in the west.

Introduced in 2000 the 3rd generation Patrol is a refinement in every respect, particularly cosmetically, and now the vehicle has broad appeal. To evaluate its performance it should be compared to the Toyota Land Cruiser GX where it 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, although this has been improved with later models. On-road the turbo-diesel 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. The big-petrol engine Patrol feels very similar to the similar engined Land Cruiser and its tsunami-like fuel consumption is a match too. One thing the Patrol does have over the diesel Cruiser GX though, is its diesel engine which is turbo-charged and powerful.

Seating, ergonomics and space utilisation are an improvement over its predecessor and in terms of extras it is good value. Due mainly to the requirements of the UN, the all-round solid axles and coil springs, an unquestioned advantage in the rough, are retained. I am not sure why more serious off-roaders don't ride the Patrol: it is immensely strong, ugly (but then so is a Land Cruiser) practical and totally at home on rough road expeditions.

NISSAN PATROL PICKUP

At first glance, this seems a great idea: The roomy, comfortable cab of the Patrol spliced to a rudimentary and utilitarian pick-up rear end. The cab is just like the basic Patrol with plain, vinyl seats, basic instrumentation; ideal for the farmer and miner or off-road explorer. It looks as if it is trying to capture the Land Cruiser pick-up market share, but it hasn't a hope until it offers more; like more comfort and air-bags. Even so, not much need be said about the Patrol's excellent reputation. The engine is a non-turbo-charged 4.2-litre diesel mated to a two-speed transfer box. Underneath there is a rear limited slip diff, front coil springs and unfortunately, rear leaf springs that turns the Patrol's car-like ride into that of an ordinary pick-up, which is a real pity. No locking differentials are offered. Axle articulation is good and solid axles all-around means that its a very robust off-roader, ideal for modification and personalising. It's not selling particularly well in, due I am sure, to its lack of refinement when compared to its competitors.

NISSAN SANI

The Nissan Sani originated in South Africa in 1983 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, the prototype built in a 3x6-metre garage. In 1986 James Bently joined Holden and together they created what is now a well known marque with a large group of contented followers. The Sani was built by Sani Industries in Pietermaritzburg, KwaZulu Natal, where initially production stood at about five units per month. By the late eighties it had reached 25 per month at which time Nissan, on whose chassis the Sani is built, bought a large share holding in the company and then invested in an entirely new factory. The original Sani chassis was

The Nissan Sani was a private venture 4x4 developed in an attempt to produce a luxury 4x4 at a price far below other similar vehicles. The factory closed when import tariffs were eased and vehicles like Discovery and Pajero were imported for a similar price. During its fifteen year reign it drew many avid followers and many are still seen plying the remote outback tracks of Southern Africa.

based on the Nissan Tracker, Nissan's first pick-up-based four-wheel drive. Later Sanis were based on Nissan's four-wheel drive Hardbody pick-up. In 1989 the 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 Executive and the familiar 5-door Executive.

The last model was the third generation Sani, better than earlier models in almost all respects including off-road performance due mainly to its double-front shock absorber set-up. Good, well maintained Sanis have become a rarity and good ones sell for high prices.

PORSCHE CAYENNE

The Cayenne is a top challenger in the sports-suv category, combining good off-road ability, scintillating road performance and the Porsche badge it surely is the world's most desirable SUV. Full-time four-wheel drive with a traction control, a centre diff lock, low range and a rear diff lock turns the Cayenne into what must be the ultimate manifestation of off-road sports sedan. Its variable air suspension (optional) provides a not under-generous brake-over angle and a wading depth of 500mm. The two most popular engine options are the 'S', a potent 250kw V8 or the 'Turbo', an unspeakably quick 331kW, V8-turbo. Both are coupled to a silky six-speed tiptronic gearbox. The off-road package includes a button to disable the ant-roll bars, releasing the wheels to reach down and up, over the obstacles.

Rarely have I been this miserable when parting with a test vehicle. If you are in the market for this kind of vehicle, even if it is an SUV without true off-road potential, like an X5 or similar, drive a Cayenne: It really stands apart.

Top: Porsche Cayenne, looks much like many inexpensive South Korean SUVs. But it is spectacular to drive.

SSANGYONG MUSSO & KORANDO

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 competitive price, has done quite well. The Musso is a road vehicle with fair off-road ability. The handling feels limp and awkward and the moment one pulls away the reason for the Musso's budget price-tag becomes evident: Early, normally-aspirated diesel versions were grossly underpowered. The later petrol versions are really quite quick and may make a nice tow vehicle. Off-road the Musso is a reasonable performer. Ground clearance is the Musso's biggest problem but can be improved by adjustment of the torsion bars.

Transmission is part-time four-wheel drive Borg Warner 5-speed manual gearbox and automatic free-wheel front hubs. Mussos are not particularly well made and those that spend a lot of time on gravel roads and rough conditions do not fair well and breakdowns become common and as the suspension components wear it becomes even more loose, losing even the little bit of steering feel it possessed when new. A double-cab derivative is available and is called the Sport.

The Korando was based on a shortened Musso chassis, off-road performance of the Korando is below average in most respects because while its engine works nicely off road, it is constantly let down by the overly large front-end overhang that causes the front suspension to dive in, bottoming at the slightest provocation. Wheel travel is fair but clearance, especially between the front wheels is poor. While the Korando petrol versions feel powerful its road feel is heavy and ponderous for such a compact vehicle. The turbo-diesel model is the better choice. The current model does not have low range gearing.

Above: Ssangyong Musso Sport, below that, the first Korando and then bottom, the truly hideous Actron, which I removed, because its so unbelievably ugly.

SUBARU FORESTER

The Forester blurs the lines between light SUV and true off-roader. The Forester has an almost uncanny ability over slippery surfaces on extra slippery ground it seems to float where others plod. This, I believe, is due mostly to its high power-to-weight ratio. Traction is better than average due to its symmetrical 4WD system, viscous coupled centre transmission and rear limited-slip differential. Unlike the Freelender-2 it does not rely on electronics for its traction, which on paper appears superior, but in soft terrain is not, for the Forester out-performs the Freelander in most areas. Low-range gearing is present in the non-turbo, manual transmission variants and amounts to a 20% reduction in overall gearing, not as much as true off-roaders but enough to make a significant difference to its off-road performance. Even the non-turbo engines pull strongly from very low rpm and the flat-four boxer type engine layout gives the Forester an ultra-low centre of gravity. Handling is, as a result, far crisper, with less body roll and more sport car-like handling than any other SUV, by quite a long way.

In 2008 an all new model was introduced and while it looks really smart, it lacks something that the old model has. It has anti-skid control and softer springing which, while making it more comfortable, takes some of the familiar, crisp sportiness from it. I think I prefer the old one. In my view, the Forester is the best light SUV by quite a large margin.

SUZUKI ALTO

SUZUKI VITARA AND GRAND VITARA

Suzuki's best 4x4 is the Vitara, a vehicle with two wheels in the softies category and two wheels in the off-road category. Unlike many vehicles often compared to it, the Vitara has a low-range gearbox, equipping the vehicle with reasonable off-road ability. It does, however, suffer from a lack of clearance. 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 me. Current models have a 4-cylinder, 16-valve double overhead camshaft engine producing 122 kW or a 3-litre, 6-cylinder producing 165kW. This last one is very nippy and great fun to drive.

SUZUKI ALTO

SUZUKI JIMNY

The nimblest, lightest 4x4 of them all, the Jimny tries hard to be a four-by-four but doesn't really make it. It tries hard to be serious, but fails, and so every Jimny needs a sticker on the back: 'Stop calling me Jimmy. My name is James!'. It reminds me of the SJ410 but without the SJ's uncontrollable tendency to fall over. Powered by a 4-cylinder, 1300cc petrol engine it's meant as a fun plaything rather than an adventurer's vehicle. But it does have true low-range gearing and just enough clearance to be real fun.

SUZUKI ALTO

SUZUKI SJ 410 and SJ 413 SAMURAI

The diminutive Suzuki Jeep is not considered a serious expedition platform because of its small size and inability to carry the kinds of loads needed for extended trips. It is also slow and uncomfortable.

However, its off-road ability is excellent due mainly to its small size and light weight. On the beach and over dunes it will out perform most 4x4s but its limitations show when asked to climb hills on uneven terrain where its lack of weight and stiff suspension hamper ability.

Early models roll over very easily, so a novice driver should be very careful with obstacles taken too fast. When bogging down, even in the worst case, a SJ can be easily dug out. Suspension is by solid 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 better features with its revised suspension and a wider track, making it more stable. The long wheelbase models are better working machines and are a favourite with aid organisations operating in Central Africa.

TOYOTA CONDOR 4X4

The Condor is a light-duty station-wagon off-roader and has proved itself to be competent off-road as well as a reasonably comfortable long distance cruiser. Available with 2,4 petrol and 3.0 diesel engines, the transmission is full-time 4WD, centre diff-lock and a low range transfer gearbox. The chassis is a high-strength ladder frame and suspension is front independent torsion bars and on the rear, leaf springs and a live axle.

While the Condor cannot be regarded as a serious off-roader many are being used successfully for extended safaris. Its weakness is that it is not a particularly stable vehicle and so, from a safety point of view, not ideally suited to the wearing of a loaded roof-rack. Failures of front drive shafts were reported but these were determined to be caused by drivers using sharp brake activation during wheel spin, to simulate the actions of a differential lock. Condor production ceased in 2005.

TOYOTA FORTUNER

When launched in 2007, Fortuner brought some good news and some better news. The good news was that is had no traction control, no on-board navigation system, no hill-descent control, no fancy 17" mag rims and no associated high price tag. The better news was that the Fortuner had permanent four-wheel drive with lockable centre differential, locked four-wheel drive is done with a lever, not a switch, it had good old 16" wheel rims, good ground clearance and petrol and diesel models are both powerful and lively and not thirsty: All the ingredients that make up an effective off-road family wagon.

The Fortuner's front end looks like a stylized Hilux and that is exactly what it is. As part of their IMV (International Multi-purpose Vehicle) project it is, to put it crudely, a Hilux station-wagon. But this statement could be misleading, for I assure you, this is no pick-up. While the Fortuner uses the Hilux's front end, the rear, including the chassis and suspension is completely different.

On-road both petrol and diesel models ride well, The moment I passed 120kph, I realised that this is no remodelled pick-up. It's sure-footed, comfortable, has a fairly firm ride but handles corrugations with exemplary manners. Off-road the Fortuner has a gearbox and transfer box that are among the smoothest in the business and the auto-version even has a low-gear lockup. This is a function of the auto transmission that prevents it from moving into a higher gear when going down steep slopes.

Clearance is quite good, and quite adequate for some fairly challenging off-road driving. The suspension is on the firm side, which means off-road occupants are not thrown about overly much, unlike the Hilux. It will bottom its front suspension reasonably easily so an aggressive off-road driving style will be quickly felt. The only other criticism is the small fuel tank. There is nowhere to fit a larger one

unless the spare wheel is relocated by replacing the rear bumper with a bumper wheel carrier, all expensive and weighty.

There have been isolated reports of roll-over accidents with Fortuner, and as usual in cases like these, one complaint on an Internet forum can lead to press and public questioning of the vehicle's safety. Having researched the issue in detail, my conclusion is that Fortuner may have less degree of intolerance for overloading and incorrect tyre pressures than is usual, and there are inconsistencies in the shock absorbers fitted. While I found the Fortuner an outstanding performer on gravel, owners should earnestly heed the warning: overloading, poorly loaded trailers and under-maintained tyre pressures may make Fortuner unpredictable on gravel surfaces. Because, like the Hilux, Fortuner is under-shocked, If this doesn't work, change the shock absorbers, but don't just fit anything... Spend some money and fit Koni or TJM (XJS) gas shocks.

The 2009 face lift introduced improved climate control, cruise-control, stability control, a larger fuel tank and 17" wheel rims. The D4D engine is my engine of choice although the petrol is also fantastic. I cannot express how impressed I am with the Fortuner and it is without doubt the very best of the lower-priced 4x4 wagons.

TOYOTA HILUX

Once called 'The Workhorse of Africa' the Hilux 4x4 first made its appearance in 1979, 10 years after the first 4x2 Hilux was introduced. This 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. The country's 4x4 leisure market got what it wanted: A true loadable workhorse that could carry passengers too.

In 1989 the Hilux became the first diesel 4x4 pick-up on the market and in 1991 the well known Raider models were introduced. In 1998 the Hilux changed what I believe to be fundamental to 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 made 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 general criticism was that the Hilux's suspension has always been too harsh but could be put down to the fact that the vehicle was designed to carry a load under adverse conditions. In the case of the old Hilux the suspension was not compromised to a great extent and the occupants paid for it by having to endure a back-breaking ride in

TOYOTA SA

the rough. Although the Hilux is tough it does not like to be overloaded and can be broken if this is done. In pre-1985 versions the battery support bracket is prone to failure and, although this was improved with later models, it often fails in vehicles used in off-road conditions. A most worthwhile modification to the old Hilux to improve the ride and its off-road performance is Old Man Emu suspension.

The first major mechanical and styling change came with the launch of an 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 a well set up independent front suspension a disadvantage worth noting.

There is no doubt that the 2nd generation Hilux's popularity did not wain one bit and it remained one of the best in its class, although it was at about this time that the well-worn phrase, 'The Workhorse of Africa', seemed no longer apt. The engine line-up improved the Hilux's appeal, especially the 2,7-litre fuel injected petrol that has good acceleration and is easy to drive off-road. The 3-litre diesel is not unlike the earlier model 2400 petrol in difficult conditions as it is a little underpowered. For a while Toyota built a turbo-charged version of this engine but it was a disaster in terms of reliability and they all overheated. It was quickly withdrawn from production. The introduction of the KZTE turbo-diesel managed to set the trend for high performance diesel-turbo pick-ups and it took some years for its competitors to catch up.

LAND CRUISER VERSUS LAND ROVER. No other testament to the Toyota Land Cruiser's claim as the best four-wheel drive in the world can be more convincing than the Third World. No matter where you go, every remote area of the world from the high Andes to the Sahara, the African plains to the highlands of Afghanistan, Land Cruisers are everywhere. Thirty years ago it was a very different story as the Land Rover dominated. Today in the Third World, most of the Land Rovers still running are old models, sometimes more than thirty years old. Despite being more expensive, Toyota's unrivalled reliability is why they are now the vehicle of choice of transport companies, aid organisations, governments and the majority of private travellers in all of these countries.

In 2005 the third generation Hilux was introduced. Its chassis is a combination of Prado front and Hilux back. The ride on the road is by far the most refined of all the pick-ups, with only the Triton coming close. Its ride off-road, on rough tracks and the kind of terrain that throws the vehicle around a bit, the Hilux is not as comfortable as most of its competitors. The suspension feels very soft, sometimes too soft and a set of firm gas shock absorbers improves it a great deal. Clearance is also not as good as its predecessor. The V6 is the best engine in its class: A comparison with similar Ford or Nissan engines makes them feel quite old fashioned, and the 3.0 D4D turbo diesel is stunning in its versatility and flexibility. Toyota's engines, which were not so long ago out-performed by many rivals, are brilliant. No surprises that the Hilux continues to be near, or at the top of the shortlist of the world's best pick-ups. SInce 2008 there have been two face-lifts but with both, one has to look hard to tell the difference. With the first facelift came a auto version, the smoothest of all the double-cab auto derivatives. Late 2011 a brand new Hilux is due for release.

TOYOTA LAND CRUISER - HISTORY

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 AK10. In only five months a Jeep-like prototype named 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. 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 that 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 that could be engaged without stopping. This power plant remained the only engine available until 1968.

Left: The first Land Cruiser station-wagon, the FJ55.

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 carburetor and the drive train was given Burfield 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 power plant, 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 also the year that the first diesel engine 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 seat belts 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.

In the '80s and '90s the pickup was the 75-series, only available in a long wheelbase version in South Africa. Its design is old fashioned and rugged, very reliable and spare parts availability second to none. There are a few station wagon variants of the FJ40 and FJ75 but these are rare and make excellent safari vehicles. Current Land Cruiser is the FJ95 and although similar in appearance is a different vehicle to the FJ75 in many respects. Wheelbase is longer, front springs are coil and the load bed is longer. Clearance and angles have been improved marginally and interior comforts while plain, have been improved. Engines are the 4,2-litre diesel and 4,5-litre petrol. The diesel is just about the only engine on the market not controlled by an engine-management computer.

TOYOTA LAND CRUISER 70-SERIES

This can get a little confusing: The 76 station-wagon is the five-seat, five door wagon with a wheelbase of 2730 mm and is primarily designed as a people mover. The 78 wagon, a five seat (SA spec) three door

high roof wagon with a wheelbase of 2980 mm primarily designed as a multiple people carrier and ideal for conversion (ambulance, overlander etc.) and lastly the 79-series, a two door load-carrying pickup with a wheelbase of 3180 mm. All three have live axles front and back, coil springs on the front and leaf springs on the back. Since 2007 these models have the widened front end developed to enable the fitting of Toyota's first V8: the 4.5-litre, turbo-diesel, as fitted to the Land Cruiser 200. All models share part-time four-wheel drive with auto and manual front hubs and front and rear diff-locks (standard in SA) give it a major advantage when things get sticky. The rear diff lock's protection plate is inadequate and should be replaced before venturing into the really rough stuff. Interior is as drab and boring, (saved by a measure by the new dash) as in any vehicle, but in some way its lack of frills is appealing. Ventilation is much improved, there is a rev counter and gone is the hideous, farm-pick-up steering wheel. The suspension is the same in all models: All-round live axles, coils on the front and leaf springs at the back. The ride of the 76 and 78 is far easier on the back than the pick-up's, so a suspension upgrade is more of a luxury than a must-have. Engine options are the familiar 1HZ 4,2-litre diesel and 4,5-litre petrol (older models of the PU) and 4.0L V6 (current) only in the pick-up and only the diesel option in the others. The 76 is a four seater, not five: the centre section on the back seat is so hard it's barely suitable for the family pet - as is the 78. Why they bothered fitting such an uncomfortable bench seat in the back, I don't know. The interior is an empty shell, ready for adaptation and it's cavernous to say the least while the driving seat space in all of them is a little cramped. 76 station-wagons are a favourite with hire car companies who at last have a 4x4 wagon tough enough to withstand the rigours of not only overland travel, but the careless attitude of hire car drivers.

The Toyota Land Cruiser 70-series now comes in three standard varieties, each with a different chassis. The 78, known in Australia as a Troopy.
Top: 76-Wagon, five-door station-wagon.
Bottom: 79 pick-up.
Depending where you live, they are available with the 4,5l V8D4D, 4,2l D and the 4,0l V6 petrol

Left main: 78-Troopy converted into a self-contained camper by Autograph4x4. Top: Land Cruiser 76 wagon extended in South Africa by Baillies Offroad. Its becomes a six-door, nine-seater. Lower: Before the double-cab 70-series Land Cruiser was offered by Toyota, double cab conversions were done by companies such as Meanos Brothers, based on a 79 pickup..

In 2012, 4,5L V8 diesel engines, already well established in Australia, were introduced in South Africa in the pickup, wagon and a new four-door double-cab pickup. V8s are not offered in the 78 'Troopy' model, which is only available with the 4,2L 1HZ engine.

TOYOTA LAND CRUISER FJ

Based on the Prado chassis, the FJ Cruiser is an odd mix of the fabulous and the impractical. It's a great drive, on the road. And off it, it's every bit as good. Fun, fast, easy to drive, and in the rough, over rocks and on the trail, it is not just competent, it's brilliant. And, what is so good, it's good even without spending another dime on it. Perhaps a set of off-road tyres would be advisable, but that is all. And if that isn't enough, add some larger wheels, lift it a bit and it's an outstanding off-roader. Would I buy one? Maybe. While I loved it for a day, would I love it for a couple of years?

Firstly, I have a family. I wouldn't put my dog in the back of an FJ. I would be cruel. It's not just cramped back there; it's claustrophobic. The rear seats are there for something to put the shopping on. And not surprisingly, rearward vision is not good at all, and the odd shape makes parking in a tight spot a bit tricky. There is not lots of space in the back for an outback trip, although this can easily be corrected with a roof-rack. But for two people, for the weekend trail and the occasional overland trip, it could do very well indeed. The ride is excellent, on tar and rough track, the steering a little vague (like the Prado) but its not a deal breaker, and the dashboard and interior is spartan to the point where the lack of features is attractive. The flashes of painted steel are just enough to make a statement without looking cheap. No carpets, which I like very much, because the sound insulation is good, and they are easy to clean. For me, it's the ideal solution for a dual purpose vehicle such as this. Secondly the engine. Because the 4.0 petrol V6 engine is the only option, the FJ Cruiser is a bit pricey to run.

TOYOTA LAND CRUISER PRADO

The first generation Prado was a station-wagon development using a Land Cruiser pick-up styled cab very similar to the current Land Cruiser-70 wagon, first launched in the mid '80s. The first Prado to reach South Africa was the second generation and best known Prado, arriving in 1997. The Prado is a medium-sized luxury station-wagon with permanent four-wheel drive transmission with lockable centre and rear differentials, independent front coil spring suspension and a solid rear axle on coils. There were two engine options, a 3,4-litre V6 petrol and 3-litre 4-cylinder diesel. This model Prado is not well suited to heavy loads and vehicles built before about May 1998 had rear suspension problems that resulted in easy bottoming of the rear axle, even without a load. This was corrected to some degree on later models. Well cared for Prados easily reach 400 000kms before major work is needed, proof of a well-built workhorse.

The 2002 model, the third generation Prado (120-series) was launched with more than just a styling update. It is an altogether more modern vehicle being quieter, smoother and more refined. It features a host of traction, stability and safety systems which has also improved its off-road ability over the older model. Engine power of the diesel is a little down over its chief rival the Pajero, on-road performance is on a par and off-road beats it by a small margin. Its steering is a little vague at speed and it would do well with stiffer rear springs. Suspension upgrades do wonders for Prados taken into the rough. The standard mag rims are 17", which is a disadvantage if outback travel is intended. The Prado can be regarded as a true Land Cruiser as it is heavily built and rugged, although it doesn't look like it at first glance.

The Toyota Land Cruiser Prado (Land Cruiser 90-series) like all such SUVs is a compromise between off-roader and everyday town car. The Prado is surely one of the most effective compromises. Its off-road ability is really very good while it is a practical, nice to own vehicle that does just about everything well.

The third-generation Land Cruiser Prado 150. Late 2013, the face-lift Prado 150 is incredibly ugly, with a huge chrome grill. They have ruined what once was a great looking SUV.

QUICKPIC

One weakness is its tailgate hinges which seem inadequate for the weight of the spare wheel, and they are known to break.

In 2010 the current Prado (150-series) was launched in two models: the VX, which because of its air suspension is not well suited to expedition travel but a superb all-rounder, and the TX, which being very similar mechanically to the previous model, is probably the best compromise between family station-wagon and tough off-roader available today. Engines are a lively 4.0 6-cyl petrol and a up-rated 3.0 D4D turbo-diesel, which is the only thing that lets the Prado down when compared with its competitors, whose diesels are far more powerful and so make much better tow vehicles. That said, if you are choosing a comfortable wagon and want to reach really remote areas, the diesel isn't so underpowered that its difficult to live with. I would still choose the diesel over the petrol.

TOYOTA LAND CRUISER WAGON 50, 60, 80,100 and 200 series

I am unable to establish exactly 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 more than heavy loads. This was the FJ55. In 1980 the FJ55 (Series-55) 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-conditioning. There were petrol and diesel engines.

The FJ60 is still 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.

In 1990 a totally new station wagon entered the market; The FJ80. Land Cruiser fans may tell you, 'This was Toyota's finest hour'. It introduced coil spring suspension to the Land Cruiser. Called the 80-series, it was a major improvement in every sense, a fast and comfortable vehicle with improved off-road ability and an outstanding towing vehicle. In the rough the FJ80 is supremely confident and on-road, at speed it is exceptionally stable with steering feel superior to many. Fuel consumption of the petrol version is quite acceptable up to 120kph from which point it soars rapidly. But load the petrol version, and it is a guzzler of note. 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 frustration and can create difficulties during rough-country travel. 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. Like the petrol, the 4,2 diesel is fine up to 120kph after which fuel consumption quickly becomes unacceptably high. By far the best engine options are the 4,2 twin valve turbo and multi-valve turbo found on later VX models. Both are outstanding performers: powerful, reliable and not overly thirsty.

Above left: Land Cruiser 80-series is one of the most sought after used 4x4 purchases and they fetch good prices, no matter the condition. Some say the 80-series Cruiser was "Toyota's finest hour".
Above right: The Cruiser FJ60, the first Cruiser where some attempt was made to make it comfortable. The designers did pretty well for the time, but it remained a truck-like beast.
Far right: More commonly known as the 100-series, this is the GX version, with its solid axles back and front, a most desirable Land Cruiser for the overland explorer.

The 100-series was launched in mid 1998, a development of the 80, retaining the solid axles on coil springs on the GX models (Also called the 105-series) but independent front suspension on the VX and V8. The GX is aimed at the off-roader who demands the very best in off-road performance. To this end the GX, in some countries including South Africa, is fitted with front and rear axle diff locks coupled to

Right. The brilliant Toyota Land Cruiser 105.
Below: Land Cruiser 200 VX, an unworthy replacement to the fabulous 100.

full-time four-wheel. The Cruiser-100 is a big vehicle in every sense but the balance of on-road comfort coupled with loadability and off-road performance is excellent, but for some drawbacks. Clearance between the axles is not enough and the spare wheel stowage under the load bay means that it protrudes into the path of even medium middle-track humps. If you are going to take this vehicle through challenging off-road conditions, this has to be remedied by either a lifted suspension or by moving the spare wheel to an external carrier.

Engine options let down the GX because the familiar 4,5-litre 6-cylinder petrol is too heavy on fuel for an effective expedition vehicle and the 1HZ, 4,2-litre normally aspirated diesel can be underpowered to the point where cruising can be frustrating, particularly on mountainous roads. The 105-series with the 4.2 turbo-diesel as fitted to the VX would be a close-to-perfect 4x4 wagon but this configuration was never built anywhere. For anyone considering fitting an after-market turbo to the 1HZ, be aware that major engine failures are common. My advice begins on page 39.

The 100, VX and V8 challenge the 4x4 limousine market but remain true off-roaders, given a little work needed to stiffen the suspension because air suspension doesn't work very well under the loads needed for outback travel. The V8 is superbly refined, the fuel

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consumption is similar to the GX's 4,5 petrol and the 4,2 liter turbo-diesel of the VX is an outstanding all rounder. Beyond this there is the V8 Lexus, refined to the point where off-road and load carrying performance is mediocre.

The Land Cruiser 200 series was launched mid 2007. It has the familiar V8 of the 100 series and an all new 4,5 V8 diesel. This engine is a marvel of engineering - as smooth as the petrol, frugal as the 4.2 and provides effortless power. But that unfortunately is where my praise for the 200 slows to a crawl. The only version available in South Africa is the VX. The GX or lower spec version available in other countries is not found here, and this leaves us disadvantaged over customers elsewhere. The VX is just too lavish and too electronic for overland travel, although I am sure it can handle it, although the V8 diesel is unsuited to poor quality fuels found in the Third World and tends to be troublesome. The international press and buyers' main criticisms of the 200 are its poor load carrying performance. All this means that I don't think the 200 is as good an all-rounder as its predecessor. The 200 GX version found in other countries is not like the 105, with solid axles, but it does have far less electronics and a ride that is firmer and better in the rough. It is unlikely that a solid axle 200 will be built, given that the 76-series wagon has unworthily stepped into the 105's shoes.

For overland travel expect to move the spare wheel from under the rear bumper and lift the suspension. But if you just want a really large vehicle with superb on and off road performance, the 200 is hard to beat.

VW AMAROK

Amarok is as stylish as any pickup out there, and while its off the line performance is not a market beater, its economy is. So is it a better package that its competitors?

I am told that South Africa's pick-up market is one of the toughest in the world. It's about the way we use and often abuse them. Local manufacturers, including Toyota, Ford and Isuzu don't just take a design from overseas and build it here, because if they do that, they have found, the vehicles don't last. The Amarok is built in Argentina. And its been around for long enough now for it to have earned a reputation, and it seems, it's a very good one. Now sold all over the world, it began, like most new models, with some teething problems, and like most has overcome them and now offered with more transmission options, including an auto gearbox.

My test ran over two weeks and 5000 kilometers in Namibia. My conclusion is that there are only two things I don't much like, but neither of them are things that I would consider as deal-breakers. The

low levels of low-down torque means that the Amarok stalls when you pull away. And reverse is worse than first gear, as it's got a higher ratio. I found that even mild off-road manoeuvres had to be done in low range, or slip the clutch. And it has no blue-tooth or iPod compatibility in the dash, but I am imagine that will soon be updated.

These aside, the Amarok is terrific. It's roomy, very comfortable and quiet, feels sure-footed and well-mannered on tarmac as well as gravel tracks, has a huge load bay, brakes well, and is the most economical pick-up I have ever used on a long trip. Clearance is average for a 4x4 pick-up, and hill-descent control is properly programmed and works better than in any other 4x4 I have ever driven.

So, if you in the market for a pickup, you might be losing out in a big way if you don't give it a test drive. The small engine, by comparison to its many competitors, means better economy, with very few penalties.

VOLKSWAGEN SYNCRO BUS

A four-wheel drive adaptation of the very popular rear-wheel drive minibus is no longer made and good second-hand units are now rare. 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 prop-shafts. 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.

VW TOUAREG

Touareg really is a marvel of modern technology. The body and chassis are built for safety and comfort. Performance, handling, pulling power, particularly with the V10, is brilliant. On road it is an outstanding 4x4 SUV. Now off-road: The suspension can be air-lifted so as to provide not just adequate but excellent clearance. Then comes an excellent traction-control and safety enhancing electronic skid and braking controls. The result is a vehicle of supreme performance in all theatres of operation.

Many consider Touareg to be over-endowed with electronics and a driver who is foolhardy enough to drive it off-road without thoroughly getting to terms with the very thick instruction book, are risking embarrassing themselves.

Other features are the automatic ride height system settles to the 'low' setting at a practical ±110 kmh. The interior has classic refinement but with enough buttons, switches and knobs to intimidate an Airbus pilot. Its two biggest drawbacks as an all rounder is that its 18" wheel rims cannot be swapped for smaller rims to enable higher-profile tyres to be fitted as the huge brake discs and calipers do not permit this. Toaureg is also not overly strongly built, and cannot be expected to perform in the rough long term like a Land Cruiser or Nissan Patrol.

QUICKPIC

THE AUTHOR'S VEHICLES

At the time of compiling this book, which has seven editions behind it, I have owned 11 4x4s. Why so many you may ask? It's because I love them so much, that I love playing with them.

I purchased my first 4x4 when I was 22. It was with this vehicle that I learned 90% of this 4x4-thing. I drove it, explored with it, went off-road with it, crashed it, fixed it, got water in the sump and ran the bearings, rebuilt the engine... To make a long story short, when I wasn't in Botswana with it, I spent most of the '80s lying under it, fixing it, having bits of grit fall into my eyes. It was a 1972 Range Rover. The rest, as they say, is history.

This is the first image taken with me and my own 4x4, May 1982. Its legacy after three decades are hundreds of images, 15 books and six TV series .

1982 Range Rover. (used) 8 years, 125 000 kms

I purchased my first 4x4 when I was twenty one. It was with this vehicle that I learned 90% of this 4x4-thing. I drove it, explored with it, went off-road with it, crashed it, fixed it, got water in the sump and ran the

JANNINE FRENCH

When I began this was for me the most fabulous car ever made: The Range Rover.

bearings, rebuilt the engine; to make a long story short, when I wasn't in Botswana with it, I spent most of the '80s lying under it, fixing it, having bits of grit fall into my eyes. It was white but after an accident, I had it sprayed green. It's a fantastic vehicle for the first timer, as long as you are happy to spend some time keeping it running. My heart still lives in the driver's seat of an early Range Rover.

Still an avid Land Rover fan, my second vehicle was a One-Ten. I kept the Range Rover for a while, but then realised that having two of them to keep running was beyond my capabilities.

1989 Land Rover 110. (new)
8 Years. 127 000 kms

Much, much better: more comfortable (it had power steering and air-conditioning) my Defender served me extremely well, although I did have to replace the gearbox main bearings, rebuild the steering box, repair the radiator and several other things, it gave me great pleasure. This was my wedding and honeymoon vehicle, and my father scrawled in the dust on the spare wheel cover, 'Dust Married'. Gwynn and I travelled Southern Africa flat, with only a spade, a fan belt, a tool box and not much else. The Defender is an extremely capable vehicle, but in all but the most extreme off-road conditions, performance, even with the latest version, is so far behind other, more modern designs, I can only think of one reason for owning one today; and that is that it always manages to look just right.

1996 Range Rover Classic auto (used)
1 year, ±35 000 kms

After I was sponsored a Toyota Prado 3.0 diesel for a year, I wanted a Range Rover again, so I purchased one of the very last 'Classics', with the 3,9, V8 engine. A nice vehicle, but the electronics and air suspension didn't give me a lot of confidence, and I only did two long

My second Range Rover was a disappointment in that I didn't trust its electronics, especially the air suspension. I only took it on two extended safaris before selling it for a G-Wagen.

distance trips in it. I was soon yearning for something a bit tougher. I had very few accessories fitted to this vehicle.

2000 Mercedes 290 GD auto (used) 3 years, ±75 000 kms

What an amazing vehicle: The G was a revelation: Better than a Defender off-road, better than a Discovery on road. I had ARC make me some fuel tanks, but they proved very unreliable. Also, I was introduced to the concept of a 12V fridge/freezer which was a 40L Engel: Safari life had never been so good. The vehicle was reliable (I did nothing but maintenance to keep it going) carried a load well and was an absolute pleasure. Financial pressures combined with an over generous offer meant I sold it at 127 000 kms with worn out shocks.

JACQUES MARITZ

The G was a revelation: Good on road and fantastic off it. My first 4x4 with an auto box proved to me how auto transmissions can be an absolute pleasure off road.

1996 Land Rover Discovery 3,9 V8 auto (used) 1 year, ±25 000 kms

The most disappointing vehicle I have ever owned. It had 66 000 kms when I bought it and it went well and was reliable, but this Disco is an ergonomic mess: It is cramped, and has a poorly designed and small packing area. Good off-road, pretty good on road as well, but just not a particularly nice vehicle to live with. Maybe it was the brilliance of the G that affected my reaction to it. But the Disco remains an ideal, inexpensive vehicle for first time four-wheelers.

Of all the 4x4s I have owned, the Discovery was the most disappointing, mainly because it is an ergonomic mess.

2002 Toyota Land Cruiser FJ79 4.2D Converted to double-cab. ±26 000 kms

My first try and a double-cab was a mixed success. I chose the diesel because of fuel consumption, but this turned out to be a bad decision. The conversion by Meanos, to which I added OME suspension, Baillies 170-L tank and Outback racks and roller drawers. This was the first time I have let myself loose on all the accessories out there and I had a ball. But the extra weight meant it was underpowered and I didn't enjoy driving it much. Neither did Gywnn, so I sold it at 26 000 kms after it was an important feature of my first 4x4 TV series.

My first try at a pick-up double cab and first Toyota was a mixed success.

2001 Mercedes 290 GD auto (used) 2 years, ±65 000 s

Another G meant I felt at home again, but this wasn't to last. G-Wagens are very rare, so I bought this one into SA from Lesotho. No matter how hard I tried I could not register it in SA, so I had to return it to Lesotho and sell it. This one was one of the very last RHD G's built and had heavy-duty springs with better clearance and was untouchable off road. I fitted a Proto roof-rack and rear ladder and Outback roller-drawers. Before I sold it I took it on an extreme off-road drive - and it

proved to me yet again, what an outstanding off-roader the G is, and it isn't just its diff locks that makes it so great!

Toyota Land Cruiser 105 GX 4.5 (new) 2 years, ±41 000 kms

The Cruiser 105 is fantastic and I soon fell in love with this vehicle. I selected XJS suspension and shocks as I felt it was time I made a comparison between OME and XJS. I also I fitted a TJM bull bar and Outback roller drawers and roof-rack. I was very happy with the modifications. I also had the head worked, in an effort to lower the very high fuel consumption, but nothing seemed to make a difference, although it became the most powerful vehicle I had ever owned. But the fuel consumption made it a lousy overlander. This was a real pity, because it has everything else going for it.

High consumption which cannot be rectified meant that the 4,5, 105 Cruiser is not well suited for remote expeditions..

2007 Toyota Land Cruiser 76-wagon (new) 18 months, ±34 000 kms

Call me a sucker, but this time I went for the newly introduced Land Cruiser 70 wagon. It is only available in the 4,2 diesel, but with less weight, I was willing to try again. The 70 is cramped, and passengers in the back often complained. It's practical and gives a wonderful sense of unbreakability, but the ride is hard, and the drive is just like a bakkie. I found it to be a better performer than the pick-up. I added ARB bull bar, OME suspension and my usual Outback roller drawers and roof rack. I sold it after only 18 months.

I enjoyed the 76-wagon because of its simplicity, but wasn't content with the hard ride and handling.

2005 Toyota Land Cruiser 105 GX 4.2D (used). + 3 years, ±90 000 kms

I had to try one last time to get the Cruiser right: and I think I may have done it. For some reason it is a better performer than the 70 wagon and has the brilliant chassis with comfort and fantastic overland performance built in. I fitted ARB bull bar, OME suspension, Outback roof-rack and roller-drawers (my old, favourite) and BF Goodrich tyres, which I now only use. I fitted a low-pressure turbo-charger and performance wise, it is fantastic.

The 105, 4.2D was and absolute joy.









2011 Toyota Land Cruiser 78 Troopy, 'The Ultimate World Cruiser'.

In 2011 I developed and built something special. This is my attempt at creating what would be for me the ultimate in overland vehicle. It had to combine reliability, liveability and comfort. Combining these three attributes was not easy. It took two years from conception to reality and was the feature of several episodes in two TV series, namely Four-Wheel Drive seasons three and four, broadcast in 2012 and 2013. It's what I now drive, and I'm loving it. (mid 2014)

PAUL MARSH

Sponsored press vehicles

I have been in the fortunate position to have been given short and long term loans from vehicle manufacturers. Two stand out. In 1999 I was given a Prado-90 turbo-diesel for a year. This vehicle was brilliant and proved to me that vehicles did not need to have solid axles to be great in the bush, and that one could enjoy comfort and robustness in the same vehicle. The vehicle was taken on numerous trips and used for the making of many of my early 4x4 instruction videos and DVDs. Another was a Discovery-4. This was used for the infamous expedition over Baboons Pass and for my TV series, Four-Wheel Drive season-3, produced in 2012. I thank those manufacturers for their generosity.

DAVE VAN GRAAN

3.4X4 ACCESSORIES

BODY MOUNTED ACCESSORIES

SUSPENSION MODIFICATIONS

AUXILIARY TANKS

AUXILIARY LIGHTING

GAUGES

ELECTRICS

ROOF RACKS

RAISED AIR INTAKES

MISCELLANEOUS

4XOVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

DON'T BE FOOLED into thinking that without a fully-equipped vehicle you'll not be able to make trips into the wilderness. My advice is to head out as soon as you can, without too much gear to begin with. Only then will you be able to avoid spending unnecessary cash on unnecessary gear. So get out, and then get reading here.

BODY MOUNTED ACCESSORIES

BULL BARS

Bush or bull 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 frustrated civil engineers who, during their working lives, always wanted to build suspension bridges. Today things are more sensible and most bull-bars sold are lighter in weight and look better too.

Top: A-bars protect the radiator from front-on impacts and are handy for mounting additional lights. Bottom: Bars need not be heavy to protect the front of the vehicle. The mounts are more important and must be able to absorb any impacts.

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

- *Is your vehicle equipped with air bags? If so, only an air-bag compatible bull-bar is acceptable. Non-approved bull-bars may prevent correct deployment of an air bag.*
- *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 – as much of the strength in its design are in its mountings.*
- *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 head lamps 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. Many cannot be retrofitted with a winch!*
- *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 bodywork on the other side of the vehicle. Wrap-around bars are more prone to this.*

- *Painted bull-bars require periodic repainting and look cheap.*
- *Alloy A-bars are light and protect the radiator and nothing else. They make good mounts for driving lights.*
- *Brand new untreated aluminium bull-bars look dull over time.*
- *Powder coating is corrosion and scratch resistant and surfaces also look good.*

SIDE STEPS AND ROCK SLIDERS

There are two schools of thought: Most after-market side-steps, unless designed by people who actually go off road, are a hindrance to off-road driving because they lower the clearance. Some are so badly designed that they jut out from the vehicle's side, smearing trousers with mud or dust and do not assist access at all. The other thought is that because side steps are the first thing to get damaged, they do a good job protecting the more valuable bodywork under the doors. After a few years of straightening them, remove them and replace them with something more robust.

Rock sliders are purpose designed side steps that replace running boards. Not only do they not get easily damaged, they are (or should be) strong enough to enable the vehicle's weight to rest on them.

Rock-sliders, a name derived because they are tough enough to ward off rocks and protect the vehicle which is their primary job. They should protrude enough so that they protect from sideways impact and double as a side step.

Bumpers and Towing Equipment

Tow-bars, bull bars and bumpers frequently adversely affect a vehicle's ability to traverse uneven ground. Fitting centres, enthusiasts and while less common these days, the manufacturers themselves make this mistake. Keep all such modifications as close to the bodywork and as high as possible to prevent degrading the departure and approach angles. When de-bogging 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 Chapter-7.

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 gets in the way, in a big way, off-road.

SUSPENSION MODIFICATIONS

Most modern 4x4s are equipped with suspensions better suited to road conditions than off-road work. Modifications are often necessary to increase ground clearance and improve payload. Also, vehicles that excel off-road may need softening up for road use. Trouble is, not all spring and shock manufacturers make well-researched products and many a disappointed traveller has cursed a salesman. Bilstein, Koni, Old Man Emu and TJM and others make high-quality systems but above all, make sure you purchase them from a competent professional who is able to select an appropriate spring/shock combination. It can be tough to make a wise choice because it seems, new brands enter the market each year. Some are good, and some are terrible. Small operators, or backyard mechanics with limited knowledge are often those chosen to launch new, untried products. They sometimes do it because they get good incentives from the supplier, not because they understand the product.

Selecting heavy-duty springs

If you are inexperienced, you are going to have to rely on the supplier to guess the payload requirements of your rig. They should ask questions and estimate the spring rate required. And this is vital. If they guess, you could be disappointed and have to spend more to get it right. There is a tendency for customers to ask for a springs that are too heavy for their application. If the store suggests hard springs, then unless you are always fully loaded and the vehicle spends 90% of its time in the bush, question this decision. It is probably going to be too hard and very uncomfortable. And too hard a set-up can damage the chassis. For 90% of customers, the light to medium springs are more than adequate.

Fender guards protect the flat bodywork from damage from mechanic's tools, feet (climbing into roof-racks) and general wear and tear.

Toyota Land Cruiser 78 fitted with EFS suspension increases under-body clearance by as much as 60mm. When fitted, it not only increases clearance but improves suspension travel, which in turn improves off-road performance. Beware of going overboard with too much clearance as the result will be compromised stability and safety.

Payload improvement will happen, no matter the spring type. But the ride improvements are most noticeable with leaf spring vehicles such as the old Hilux or Land Cruiser pick-up. Not only will the new springs smooth the on-road ride, they often vastly increase the axle articulation.

Beware of springs that have similar ratings, look the same, but are much cheaper than the well-known brands. They are cheaper for a reason, and there are some well marketed brands of replacement springs out there that are very bad indeed.

Spring assisters / Air springs

To improve a vehicle's payload, heavy-duty springs are the answer. But sometimes, these springs cause the ride and handling to become unbearable when the vehicle is without a load. One solution is to fit springs that are such that with a full load, they are not quite enough to carry it. Then air springs are added to help them along. The result is a vehicle that can handle a full load, but when empty is still comfortable and rides well. They can be fitted with a air compressor and tank, enabling the air helpers to be adjusted quickly and without much effort. They are also perfect for those towing because the helpers can be inflated precisely so that the tow bar is horizontal. The only extra maintenance required is that for a really long life, they should be kept clean. I highly recommend them.

Firestone Air Springs are a brilliant solution for a vehicle that needs a lift when heavily loaded or towing. But they should be regarded as helpers, and should not be used to aid springs that are under-rated for the load they have to carry.

Problems caused by suspension mods

The most common problem caused when the vehicle's ride height is increased is over-sensitive steering and most likely to occur with a suspension lift of 50mm or more on a solid front axle. This is caused by a change to the camber angle and must be corrected with special camber-correction bushes.

The angle at which the prop-shaft universal joints operate is also increased by a suspension lift, often resulting in accelerated wear or vibrations. Other items to check are the brake hoses. There must be ample length to cope with additional axle travel made possible by the new, longer shock-absorbers. However, mismatching components: taking shocks from one manufacturer and springs from another, is a common cause of premature failure of after-market suspension components. The stretch of the shocks and the height of the springs must be matched properly and not by guesswork.

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 have paid enough attention to shock absorbers.

Working 4x4s need gas shocks. For example, my own Land Rover 110 went through two sets of standard shock absorbers within 30 000 kilometers. Once the second set had worn out, the first being replaced under guarantee, I replaced them with Bilstein shocks. When selling the vehicle after clocking up 130 000 kilometers 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.

Torsion bar suspension problems

When fitting gas shocks it is essential that the suspension setup is checked and adjusted if necessary. Not centralizing 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. Secondly, torsion bars set to increase clearance can create problems when the shock absorbers central or neutral position is altered. In this position the shock absorbers can't work as they should. The resultant poor ride is then blamed on the shock when the real culprit is the backyard mechanic who thought he knew better than the vehicle manufacturer about how the torsion bar should be set.

New, imported vehicles can suffer from tired torsion bars. Because they are often lashed down to the bump-stops in crates for months, when they are delivered the suspension has 'sagged' and must be reset.

Why gas shocks?

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 is able to pass through the valve easier than pure oil, which means that the shock will lose its effectiveness, to the point where the ride becomes uncomfortable and unpredictable.

Gas shocks are pumped with a small quantity of inert gas. This gas cannot mix with the oil and so the main reason why shock-absorbers become soft as they get hot, is eliminated. Shock-absorbers on a heavily loaded 4x4 on a rough 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 (that was me in 1987), 'cooked' a gas shock by racing to get to the accident scene. The shock was blackened by heat and destroyed.

I have used four brands of gas shocks in the 10 4x4s that I have owned including Koni, Bilstein, TJM and OME. All are excellent.

Gas shock absorbers are, in my opinion, the first accessory that should be considered for a working 4x4. The improvement in handling and safety are, in many cases, extraordinary. When I hear reports of bad handling when carrying a load, or skittish behaviour on gravel, even with a new vehicle, the answer is so often simple: Fit a set of good quality gas shocks. Not only do they improve the ride, they last two to three times longer than standard shocks.

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 steering control arms.

The effects of worn bushes can be vague steering, a vehicle that steers itself when driving straight, instability, an 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 research into new age plastics and graphites. The advantages of polyester are long life and a stiffer suspension which aids stability and safety. A little more vibration is sometimes transmitted to the driver but this is rarely noticeable and they frequently cost less than genuine parts.

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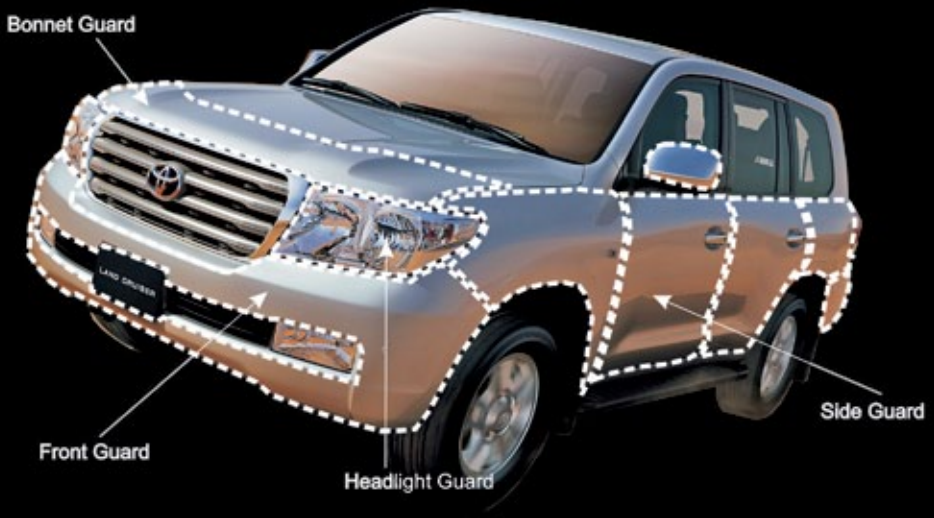

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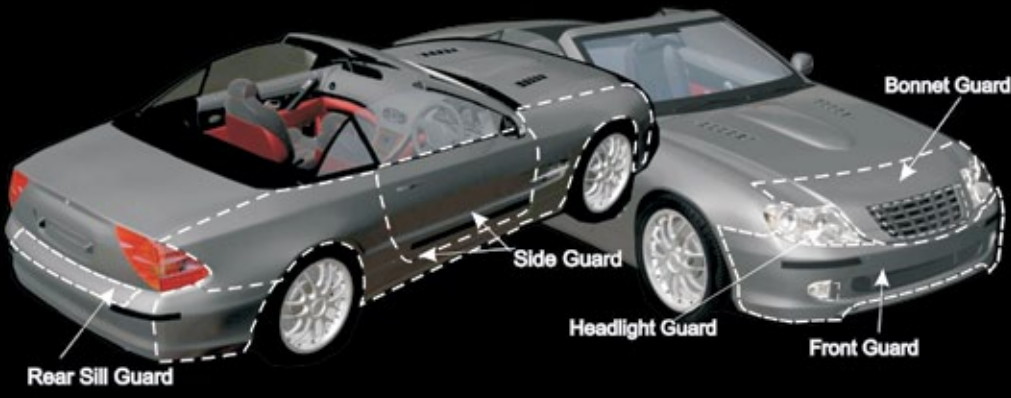

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Andrew White, author of 4x4 Guide Books

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Roof rack mounts for Jerry cans must be strong. Make sure there is absolutely no play whatsoever and that the can cannot move, even slightly in its mounting. If it can, and the conditions get very rough, the Jerry can can rip itself free.

Fuel tanks

Easily fitted to most larger 4x4s, these are the best way of increasing vehicle range in a safe, odour free way. But, some materials used in the construction of fuel tanks, even by reputable safari equipment manufacturers, is ill-advised. Many stainless steels are brittle and should not be used for any tank, fuel or water, that is bolted to the chassis. Because every chassis is designed to flex, any tank bolted to it will flex to a degree. If it does not, it will damage the chassis, and if stainless steel flexes, it tends to crack.

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 (pick-ups), 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. Be aware that electric diesel pumps are notoriously unreliable.

It is important to use proper fuel hose when fitting tanks as ordinary hose will soon become brittle and crack. To my horror I have seen 'competent' 4x4 equipment fitters use ordinary plastic water piping in a fuel tank installation. It lasts about a year before breaking up. Industrial hose suppliers sell fuel hose considerably cheaper than auto spares retailers.

Greaseable shackles take the maintenance challenge out of leaf-spring suspension. Most suspension makers offer them.

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 Jerry cans are therefore advised. When purchasing Jerry cans, 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 Jerry cans, if in good condition, are cheaper and can have new rubber seals fitted and be repainted. (I advise not crossing a border if they are painted military drab)

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

Top: Polyester bushes reduce the rate of wear and permit easier articulation of springs.

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 and corrugations.

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. However, 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. However, 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. 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.

Tanks fitted in the load bay of station-wagons can be semi-permanent with a tap fitted. Pictured left, I fitted this system to my Land Cruiser station-wagon. The convenience of a fixed tap is hard to beat.

Jerry cans should be accompanied by a Jerry-spout; a pouring spout that makes decanting much easier. I suggest the rigid types for general use and a flexible type for narrow-aperture fillers of unleaded fueled vehicles.

Considerations when piping from water tanks:

- *Secure all exterior water taps with small padlocks to prevent theft.*
- *I suggest wrapping rubber bands around the locks to prevent them being damaged.*
- *By attaching a tyre valve to the top of a tank and pumping in air, the pressure can create a shower. The pressure will force water out of the pipe. Beware of over-pumping or you may split the tank.*

Bottom: Fitted to a Land Cruiser FJ-79 this Baillies Offroad tank carries 170 litres and extends the diesel vehicle's range to a whopping 1500 kms. A similar tank is also made for the Land Cruiser 80 and 100.

AUXILIARY LIGHTING

OE headlights are good for a lot of conditions and masters of none. If you intend to travel at night in the Third World where dogs, chickens, and cattle are a constant danger, you are going to need high quality auxiliary lighting. But don't overdo it! Lights on winch bars severely impact the cooling of the radiator - much more than you think

Routing fuel from auxiliary tanks can be done using an electric pump or selector valve. I prefer the selector valve option because of the notorious unreliability of fuel pumps.

Driving lights

Driving lights supplement the vehicle's own lighting, giving a moderately 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 visibility but to make the vehicle more visible to others.

There are few things as convenient around a camp as a fixed tap on a vehicle or trailer. The tap used is a Cobra lockable garden tap.

Long range / spot lamps

Long Range lights penetrate ahead, the range of a typical quartz-halogen light being three kilometers. Specialist lighting such as the metal-halide 900 000 candle-power units made by KC Hilites are rated at over 18 kilometers. Long range lights are characterised by a prism-less lens. My own light are KC, and after using Cibies for years, thinking that they were cutting edge. I discovered that they under-perform both IPF and KC by a fair margin.

Metal halide technology

Metal halide is technology where a special bulb runs at very high voltage. A ballast powers each lamp and these lamps throw light brighter and whiter than all the rest. There is a short delay as the system charges itself when switching on which, with the newer systems, is not more than a few seconds. They are pricey and systems that convert halogen or xenon lamps to metal halide are available. This is a more economical way of getting the benefits of the extreme brightness of metal-halide.

Permanently mounted water can with fixed tap as fitted in the back of my Land Cruiser.

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 vast 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

Sealed beams are waterproof and very robust. Incandescent sealed beams are not as white as quartz-halogen and their other disadvantage is that when the filament fails or the lens is damaged, the entire reflector and lens units must be replaced. As a general rule these are no longer fitted to new vehicles.

Fitting auxiliary lights

Auxiliary driving lights must be fitted in conjunction with a relay directly linked to the high/low beam switch, so that they automatically switch off when the head lamps are switched to low beam. Poor performance and unreliability can be avoided with quality connectors and relays and multi-core copper wire with a core diameter of over 3mm.

Light shields

Light shields protect against flying stones and bushes. White ones that clip over driving lamps are a pain. Why, for decades have light makers made them white, so they have to be removed for the lights to be used? It seems so obvious that clear ones will do the job just as well. However, it's important that the light guards can be removed easily for cleaning. Hinged steel mesh guards are a good alternative but broad-spread slats are not effective against flying stones.

Rear flood lighting

It is also a good idea to have a small floodlight permanently attached to the rear of the vehicle. Highly efficient, LED types are preferable.

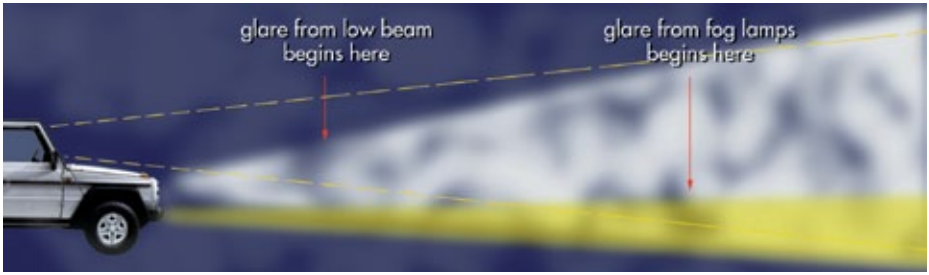
Rear lighting is really useful when you:

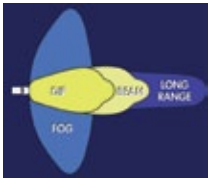
- *Arrive late at a camp site.*
- *Hitch up or unhitch a trailer in the dark.*
- *Perform a tricky reversing manoeuvre.*
- *Undertake repairs to a second vehicle.*
- *In addition a 12-volt fluorescent tube with a long cable is ideal for working on a vehicle thanks to the broad, even spread of light.*

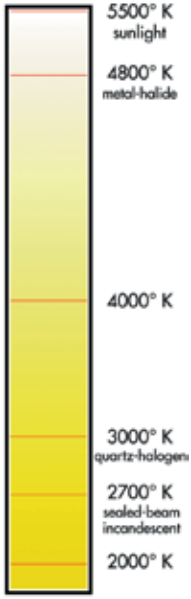
KC Highlights make a brilliant and well made spot light: Definitely one of the very best performers on the market. I suggest pencil-beam driving lights to supplement the vehicle's head lamps.
Keep them compact so that they have minimal effect on engine cooling if fitted on the bull bar.

GAUGES

Monitoring engine performance while travelling far from home is a good idea. Twice I learnt the hard way. The first occasion was when my oil pump failed in central Botswana on the return leg after two weeks in the bush; and the second was a blocked air filter when a gauge monitoring the exhaust gas temperatures would have prevented a damaged turbo.







Exhaust Gas Thermometer (EGT)

Monitoring the temperature of the exhaust gases (EGT) is highly recommended for all turbo-diesel vehicles, especially pre 2005 models. When the exhaust gas temperature exceeds 700°C, turbo damage results within a short time. Causes of high EGT are: high fuel-air mixture, blocked air filter and pushing a turbo-diesel engine too hard, for example towing up a long hill on a hot day. In this way the gauge indicates that damage is being done to the engine. I highly recommend this gauge, especially if you use your turbo-diesel to tow.

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 gauge is more common in newer vehicles.

Oil temperature gauge

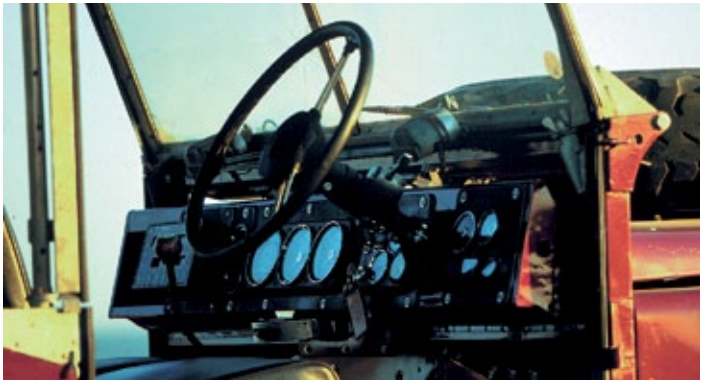
The signal is transmitted to the gauge via an electrical sender unit. This gauge is a really good idea for when traversing heavy sand or towing. Know the safe maximum oil temperature for your vehicle and never exceed it. 120°C is the maximum for most vehicles.

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. 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.

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 you find that your ammeter tends to run towards the negative when running electrical equipment, with the engine running, then you need a heavier-duty alternator.

Mad Man Engine monitors

The Mad Man engine monitor, pictured left, is a collection of engine gauges all in a single unit. It measures battery voltage, engine running time, oil temperature, oil pressure and water temperature. An audible alarm can be set on each measurement, warning the driver if any move outside the pre-set parameters. It works very well and my only reservation about fitting one is that because some pipes have to be cut for the sensors to be inserted, if not done well and checked periodically, can affect the vehicle's reliability. But a early warning of oil pressure or water temperature could easily save a huge repair bill.

ELECTRICS

Batteries

This is a highly specialised field and not ever mastered by those that 'dabble', as some 4x4 equipment retailers and off-road trailer manufacturers do. Boy, have I heard some nonsense advice being shared by some 4x4 equipment retailers on this one!

There are two types of battery applications that concern us: 'Float' and 'Cyclic'. Typical of a float application is an ordinary car battery, where once the vehicle has started the current is replaced quickly as the vehicle drives. Cyclic on the other hand is when a battery is

Mad man Engine monitor. A very nice piece of kit.

charged and then used with no or little charge being replaced. Such an application is common to the 4x4 scene when a vehicle arrives at a destination with its batteries in an almost full state of charge. The fridge and lights run through the night and in the morning the battery has lost a significant amount of its charge,

When selecting the type of battery, ask, what is the application, float or cyclic? 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 sulfate, causing irreparable damage to the plates. An apparent loss of capacity is noticed and after a short while total failure results. Should a battery designed for a cyclic application be used in a float charge mode the result is stratification of the electrolyte, mossing of the plates and a large amount of active material falling off the plates becoming sediment. This sediment eventually causes an internal battery short-circuit which cannot be reversed.

Battery charge and temperature

A battery's charge is also affected by temperature. A rule of thumb for this is as follows: A battery is rated at 25°C; for every degree below 25° the battery will lose 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.

Deep-Cycle and High-Cycle Batteries

Delco Voyager is typical of a flooded cell, fully sealed battery that requires no topping up. A built-in hydrometer allows an easy check of the state of charge. It is less suitable for use as a regular vehicle battery as its cold-cranking current is often not high enough to start big diesel engines. They are semi-deep-cycle types. Advantages are that they can withstand a fair number of discharges without internal damage. The major disadvantage is that if more than ±60% of the current is withdrawn, the battery does not readily accept replacement current. So, in reality, a deep cycle or semi-deep cycle type, can only reliably deliver about half of their rated capacity.

Rear flood lamps are indispensable when arriving at a campsite after dark. No doubt soon, there will be LED based lamps for this purpose that do not draw high current.

High-cycle batteries are those normally found in engine bays, ideally suited to starting car engines. They have high cold-cranking current. This means that if pushed, they can delivery very high current when needed. But if they are deep discharged, they are quickly damaged internally. However, even if they are deep discharged, they are able to accept replacement current more efficiently than semi-deep-cycle flooded cell types. They are also around 40% cheaper.

Gel and Orbital Batteries

Gel batteries are now made large enough for marine and overland use. While gel battery technology is not new, the larger types are using something called lead-crystal technology. The different types go far beyond the scope of this book. Suffice to say, their performance is like nothing seen before. They can be slam-dunk discharged and will accept a recharge without problems, and that means that the rated amperage is almost all usable.

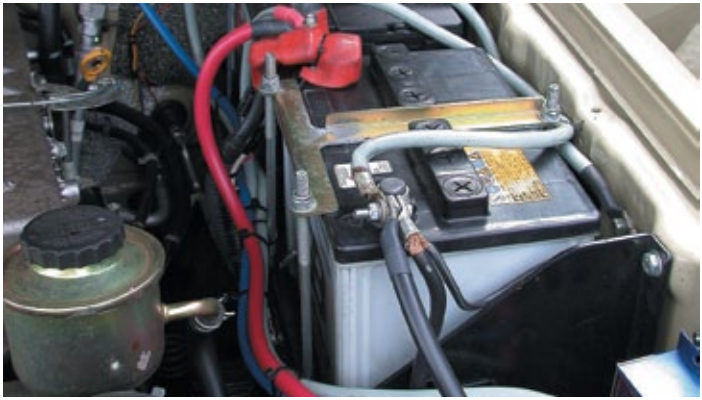
Orbital batteries, like the Yellow-Top and Blue-Top are batteries made for specific purposes and are true deep cycle types, with varying cold-crank abilities. They are more expensive but without doubt more efficient that normal lead-acid plate batteries.

Stop worrying about the milliamperes better efficiency of one freezer over another and focus on how this current is going to be put back and how long is it going to take. This is the important question.

DUAL BATTERY SPLIT-CHARGING SYSTEMS / BATTERY ISOLATORS

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 additional batteries to run the auxiliaries while the vehicle's primary battery remains unaffected. These second battery systems must be able to cope with the cyclic nature of the application. Deep-cycle types are designed to cope with the larger discharge and recharge cycles than normal vehicle batteries.

When designing your vehicle's system, pay most attention to the question: How is the current going to be put back and how long is it going to take? There are dual battery systems, some that work with some batteries, and others that don't seem to work well at with any. Understanding the problem is important, as some 4x4 equipment suppliers do not understand it at all.



This double battery mount shows a safe way of mounting dual batteries. The positive cables all run along the inside while the negative cables on the outside. This is done so if there is an accident, the likelihood of a short circuit is reduced.

Charging Deep-Cycle Batteries

Lead-acid batteries, be they float or deep-cycle types, have recharging characteristics that 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 can appear to be lifeless. The reason is directly associated with input voltage. Ordinary car alternators produce between 13.8 (E.g. Bosch - English & German vehicles) and 14.2 volts (E.g. Nipon Denso - Many Japanese vehicles). It is not enough. This is because when the battery voltage is low, when the charge is initialized, unless the charge voltage above about 14.6 volts, only a small amount of current is accepted by the battery. After some hours of charging, the battery voltage slowly increases, and in doing so, requires a lower input voltage to accept the current. And so on. Once the battery is in a state of about three-quarters full, its voltage is enough to receive all the current it needs.

This is a typical 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. The daytime temperatures are high and the fridge has been running about 70% of the time. The operator knows that the battery charge must be getting low but he or she is not too worried because there is a dual battery split-charge system fitted. He or she decides to take the vehicle for a short run, or idle the engine, to charge the auxiliary battery. The battery voltage, although high enough to keep the freezer working has dropped off the 'high current accepting plateau', ±11,8 volts. The engine is run for a two hour game drive; plenty of time, so the driver thinks, to recover the battery with the 80-amp alternator fitted. But, over this two hour period the deep-cycle battery has accepted half an amp for the first hour, one amp for 30 minutes and 20 amps for the last 30 minutes – a total charge of 10 and a bit amps. However, the operator is under the false impression that he has a fully or almost fully-charged battery. Night falls and on goes the electric lights while 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 started to thaw. The operator is baffled and curses the battery supplier because he thinks he has been sold a bad battery. The fact is, he has been sold the wrong combination dual battery system and battery type for the cyclic application he is using.

Another great and practical idea is to fit a navigation lamp on the centre console or dashboard. A red light means that it can be used and not interfere with the driver's vision. This one was bought at a boating supply store and is fitted with an LED bulb.

Battery split-charge / recharge solutions:

- *Auto-relay. E.g. Gemini. More expensive, automatic, fairly efficient but not suitable for deep cycle deeply discharged batteries.*
- *A great big heavy duty switch. E.g. Marine type switches. Simple inexpensive, reliable, subject to user error or forgetfulness.*
- *Diode-based battery isolators. Simple and inexpensive but so inefficient that they are not worth considering.*
- *Solid-state chargers DC-DC chargers are superior to all systems provided that they are designed to charge deep-cycle batteries.*

Auto-relay split-charging systems

These systems, by far the most complicated, charge all batteries in the circuit and with a monitor unit fitted, tell the user the state of each battery. Those that read just the voltage are pointless, and need to read in increments of one-tenth of a volt. These systems do not alter the charge voltage so do not solve the semi-deep cycle recharge problems discussed. They are fully automated, which is a plus. Their efficiency varies and some are very inefficient. For example one of the better units works like this: Input voltage in this case is 14,1-volts from a Nipon Denso alternator. Voltage through components drops 0,3 volts. Loss through wiring and connectors, another 0,5 volts. Voltage to the battery is at 13,3 volts. Delco deep-cycle batteries optimum charge voltage is above 14.6 volts. Not even close!

High-current manual switches

Marine switches are switches able to carry the heavy charging currents produced by alternators running at full revs, sometimes over 100 amps. When used as a way of splitting the charge between two batteries, they are connected in parallel so when the alternator charges the one, the second battery gets the same charge. There is little voltage drop, as long as the cables are thick enough and the connectors good. On the down side, if one of the two batteries is bad, it will discharge the other and if the operator forgets to switch the main battery off at night when the freezer is running, there is the risk of flattening both batteries.

Left: A marine type high-current switch. They are available in two and three-way designs. Right: Ctek DC-DC charger is an excellent limited current charger.

Constant current DC-DC chargers

The idea behind a 12-volt to 12-volt charger is that no matter what the engine speed, the charge current remains constant and the charge to the second battery comes directly from the charge of the first battery. The results are almost all positive. Firstly, a constant rate of charge is very good for the battery and the battery's life is extended. Secondly, the original charging cables are not changed in any way, so the alternator cables need not go through additional switches and relays to charge the main battery, which is the case with almost all other systems. (Wherever there is a switch, some voltage will be lost).

Modern DC-DC chargers, like the Ctek, perform brilliantly. Because of clever electronics, from a company that specialises in battery charging, that increases the voltage, it overcomes a deep-cycle's tendency not to accept charge until the voltage exceeds 15-volts. Because they are current-limited means that the cables running to and from the unit need not be overly thick. This saves weight and cost. Having had many split chargers in my various vehicles, and having three of them fail while on safari, I am now using a Ctek DC-DC charger, and I've found it to be excellent. The disadvantage of DC chargers is that their output current is limited, and therefore the full charging capacity of the alternator cannot be taken advantage of. For most overlanders, this is rarely a problem.

Tips to better battery charging:

- *Use heavy cable, solid-crimped connectors (Not soldered).*
- *Make the cables as short as possible. For every one metre of cable length, the core diameter must be one millimeter. For example: Three metres of cable should have a core diameter of 3mm.*
- *Set the freezer to switch off at no lower than 11.8 volts if you can.*
- *Never put a battery in a trailer without the biggest connector you can find. Don't even consider the tow-hitch connector as the voltage drop is far too high.*

Running cable to the back of the vehicle to additional batteries is an option for pick-ups. It is essential that the cable be fused, as illustrated below, to prevent battery fire in the event of a short-circuit.

Keep it simple

Because this is a complex subject, and few understand it completely, when selecting a system, my advice is to keep it simple.

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 the electrolyte from freezing as in most cases this destroys

the battery. Batteries must be fully charged beforehand and must be disconnected from all loads, however small.

220-volt 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 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. Current draw reached 10-amps at 12-volts (120-watts).

While modified-sin-wave inverters are suitable for computers, printers, televisions and hi-fis etc, they can damage the power supply after extended use. You may notice that they emit a buzzing sound. Pure sin-wave inverters are required for scientific equipment and are now much cheaper than they used to me, and while more expensive than modified sine wave inverters, are worth the extra cost.

Portable generators

Despised by all those who work hard to get into the bush, away from noise and stress, portable generators are an unforgivable annoyance. Because they can be easily replaced by alternative power sources that are silent, more ecologically friendly and cost no more, I see no reason why these are used, except in cases where life support systems require

It is when camping in the wilderness and you want to stay in one place for an extended period, that the battery type, usage and charging systems become of most interest to the 4x4 explorer.
This is my own Land Cruiser, built in 2012. It has a 1000 mile range, carries 270L of fuel, 200L of water and a battery system with solar recharger that with just 50% sunlight during a typical day, will keep its fridge freezer and lights running.

I've built and installed a flat aluminium tray and laid it on the dashboard of a number of the 4x4s that I have owned. Only really suitable for flat dashboards like those found on Defenders and Land Cruiser pick-ups, a dash tray serves as an ideal place to attach, with Velcro, battery chargers for cameras, laptops and cell-phones. Trays like this are not yet available in the shops so you will have to make it yourself. Or maybe some equipment maker may get an idea from this and begin making them.

high electric current. Running a TV is no excuse: why not then stay at home? As a result, I see no place for portable generators in the bush.

ROOF-RACKS

Roof-racks have evolved from utilitarian galvanized 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-8.

I have fitted roof-racks to all ten 4x4s I have owned and so roof racks have become part of my everyday life. I have had good ones, troublesome ones, noisy ones and ones that are just right. What follows are some insights into roof-racks which will hopefully enable you to select one right for your purposes.

With just two of us in the vehicle, a simple lightweight frame onto which two spare wheels were bolted was all that was needed for this trip into the western Kalahari, 1987.

One of the most important elements of roof-rack design are the feet. If the feet are too narrow it will cut through the vehicle's roof gutters. With vehicles designed to twist, such as Land Rover Defenders, full-length feet can damage the roof. If full-length feet are fitted, the rack must be designed to twist with the vehicle.

More and more vehicles are being produced with gutterless roofs and this, at first, posed a challenge for rack designers. Ask your dealer to show you how the rack will be mounted and make sure they mount a plate inside the roof onto the part of the roof designed by the vehicle

Bottom; top row: Overhangs like this nearly always result in overloading the front roof pillars and a cracked windscreen. Look closely at the picture on the left. Bottom row, right: Outback's low-profile rack design incorporates an alloy rack with anodized steel feet and clamps. Bottom row, left: Proto once permanently attached a ratchet on the feet. Brilliant! I can't understand why other rack makers don't do the same .

manufacturer for the mounting of a rack. On some vehicles this means removing the interior roof lining, which is time consuming and while not the easy way, the only way. Some rack makers still use Riv-Nuts, (a nut that is fixed in position like a blind or pop rivet) although they have been proved many times not to be strong enough - while the rack makers blame overloading.

Weight and load limits

Vehicle manufacturers sometimes supply a recommended maximum permitted roof load. This figure is based on two he strength of the roof supports and the ability of the suspension to keep the vehicle on its wheels in the event of a violent swerve. Once a raised suspension is fitted to a vehicle, the maximum permissible roof load IS REDUCED, not increased, as some claim.

Did you know that the maximum permissible roof load on a Land Rover Defender is just 75 kgs? Some claim it is 150 kgs. Given the Defender's handling, I reckon it's 75 kgs. Most vehicles are around 100-150 kgs. The highest roof loading specs of 200 kgs are Mercedes G-Wagen, Toyota Land Cruiser 70 wagon and Nissan Patrol.

The results of overloading a roof rack begin with a cracked windscreen, maybe broken springs, bad handling due to too much weight on the front springs or even complete loss of vehicle control.

Bottom left: Front Runner low-profile rack.
Bottom: African Outback's more traditional rack design. Roof-racks are not all created equal. For example: If you want to sleep on the rack, if the slats are too widely spaced, it's very uncomfortable. Also, if a hook cannot grab underneath, the rack cannot be used with ordinary bungie-chords.

RAISED AIR INTAKES

If you intend to drive on long stretches of dusty roads or through deep water, an extension to the air intake is highly recommended. 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. The benefits are more than just protection from water and dust. The air is cleaner up high and therefore air filters last 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.

Above: Frames from my TV show when I made a comparison between a vehicle with a Safari Snorkel, and one without. Go to www.4xforum.com to download the video.

There is some contention as to the effectiveness of a snorkel in dusty conditions. In 2003, during a trip into the Richtersveld shooting one of my 4x4 DVDs I did a simple test. (Images from the video are seen below left). Two vehicles, one a Colt and the other a Land Cruiser were used. The Cruiser was fitted with a Safari Snorkel, the Colt had its standard air intake behind a headlight, a common location on many vehicles. Both vehicles were new, with about 7000 kms on both odometers. The drive through the river beds was particularly dusty (see photo on the previous page). The idea was to compare the air cleaners on the final day of the trip.

The results were startling. Each filter was knocked against the front wheel to release dust trapped in them above a white towel lying on the ground. The top three photos shows the snorkel-equipped Land Cruiser. The filter was dusty but still good for thousands of kilometers. There were no stones or sand in the filter bowl. The bottom two photos is the Colt's filter and reveals the dust and sand lying on the

white towel. The last frame shows sand being poured from the filter cup. I would estimate the unprotected filter had fifty times more dust imbedded in it than the filter protected by the snorkel.

MISCELLANEOUS

Body Protection

How many times have you heard, "I would never take that big, beautiful vehicle into the bush to get scratched". The reason not to take them into the bush has just vanished - literally. An elastic, plastic sheeting called VPS (Vehicle Protection Shield) is the answer. I tried it on my Land Cruiser and after numerous trips through the Kalahari, the bodywork is as pristine as it was when I bought the vehicle This remarkable product can be applied to any bodywork area: For a 4x4 used in conditions where stones may chip and thorn bushes are likely to scratch, I suggest paying particular attention to the front roof supports, front fenders, doors and the leading edge of the bonnet. Once applied, it vanishes. It is clear, is guaranteed not to fade and dust falls off it faster than it does on nude paintwork, so the vehicle appears to stay cleaner for longer. It also protects against vandalism and careless shoppers in car parks. Not cheap, but will add considerably to a vehicle's resale value. A really impressive and practical product. (www.vpsprotection.co.za) Beware of some copies: Many products are out there making the same claims. I have not found a single one nearly as good. Some are laid in narrow sheets, which looks terrible.

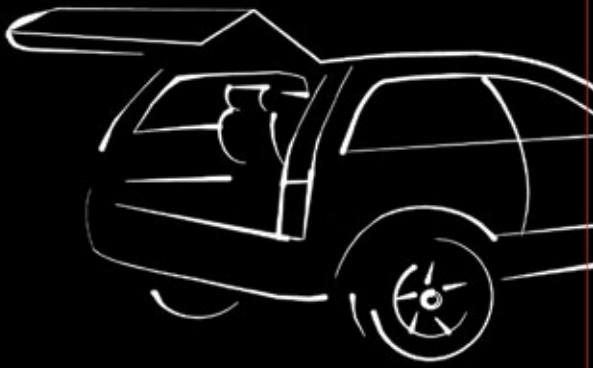
Radiator grille grass nets

When you travel over grassland, fit a protective net over the radiator grille, but know that most grass seeds find their way to the radiator from underneath, not straight ahead. A grille net should prevent grass seeds choking the radiator and the resultant overheating. This includes the intercooler radiator (see picture on the right) . Fine plastic mesh used to make swimming pool scoops works well when layered double and shade cloth also works well. One-size-fits-all grille nets sold in 4x4 stores are sometimes not particularly effective because they do not go low enough.

THIS IS VERY IMPORTANT: Because grille nets severely restrict the passage of air to the radiators, inefficient air-conditioners, extreme under-bonnet temperatures, damage to batteries and engine damage can result when a grille net hinders airflow when travelling at high speeds and high power settings. If the vehicle could run as efficiently with the restricted air-flow caused by a grille net, the manufacturers would have fitted smaller radiators and saved on costs. Your vehicle needs every bit of airflow it can get when moving. I recommend taking grille nets off at speeds over 60 kph, especially on hot days. Vehicles

Below: On a trip through the Kalahari the grass seeds became so severe that my grille net was inadequate, the seeds making their way to the radiator beneath the net. The solution for a short part of the journey was to attach shade netting across the front of my vehicle. One-size-fits-all grille nets made by companies like SecureTech need to be modified so that they drop to well below the radiator, under the bumper. The standard ones often don't go low enough.

TAKLA
PRODUCTS



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towing trailers in thick sand should only fit a grille net if absolutely necessary, especially when speeds are low.

Seat covers and interior protection

The way I see it, seat covers are intended to perform two functions: Improve comfort and protect the seats. Comfort is 100% subjective, so I am not going to say another thing. But protection is not. I believe priorities in this regard are as follows: 1. They must be waterproof to be effective. Water-resistant is not enough. 2. They must be washable and must not shrink when machine washed. 3. They must be tear-resistant and if they are cut, the tear should not easily spread and repair should be easy. 4. They should look nice and not attract dirt.

There are several seat cover manufacturers in South Africa and I have had experience of three of them: Takla, Melville and Moon and Escape. Of them the Takla canvas look-alike cover called CanTech fits all these priorities the best and I can highly recommend them.

Takla CanTech seat covers and foot well and Tak-Mats carpet protection in my own Land Cruiser.

Mud flaps

Mud flaps both look good and protect the vehicle and trailer. Vehicle manufacturers, all of them, put horrible, feeble flaps that do not do a very good job. Mostly they are too small and when they are a

Left: Mud flaps made of conveyor belt. The chain is pulled up and locked with a plastic tie to prevent the flap snagging and being ripped off when off-road.

reasonable size, like on a Defender, they are made of material so thin that the rushing air blows them out of the way.

Making your own flaps is easy. Use conveyor belting or heavy rubber matt about 1-1,5 cms thick. Cut it with a utility-knife and make some simple aluminium strips as mounts. Simple, effective, cheap.

Roof consoles

Outback Products of Australia make a roof console suitable for most popular 4x4s. They are ideal for the fitting of a two-way radio and for better overhead lighting. A more practical alternative is the locally made Alu-Cab console. These, like mine pictured above, are brilliant for customising and fits a radio plus an inverter for charging camera batteries, and my binoculars and bird book.

This is a roof console made by Alu-Cab. I purchased one and then modified it for my own needs, adding a speaker for the 29Mhz radio, a LCD screen for the back seat passengers and a 220-volt inverter for charging camera batteries. This type of console is better for personalizing than the more common, Outback type, which although may look more professional, does not have the versatility of this one.

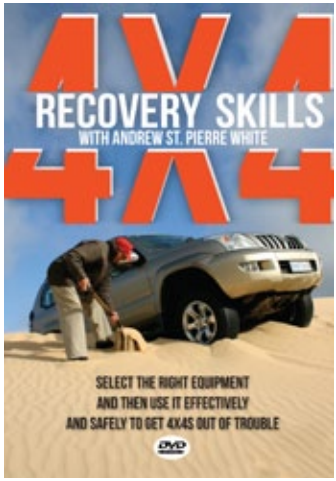
TRAILER WIRING

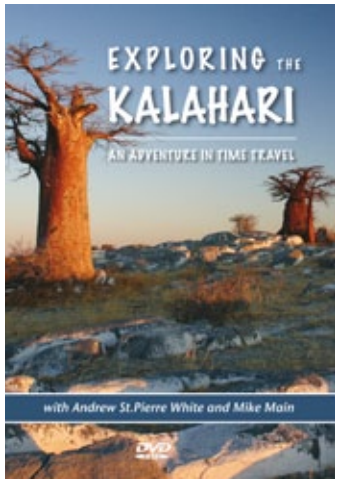
This is a vehicle's standard wiring diagram for a towing socket. DO not use the current passed through trailer plugs and sockets to charge trailer batteries because the plugs are not designed for the high current required. If you do, the battery will never reach a full charge.

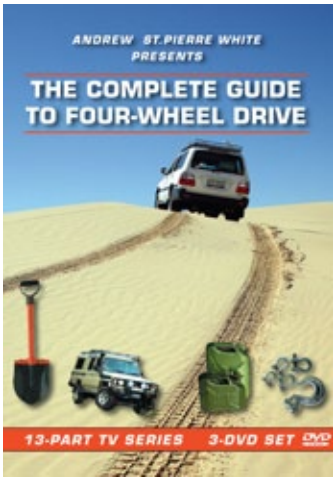
Back view of a 7-pin towing:

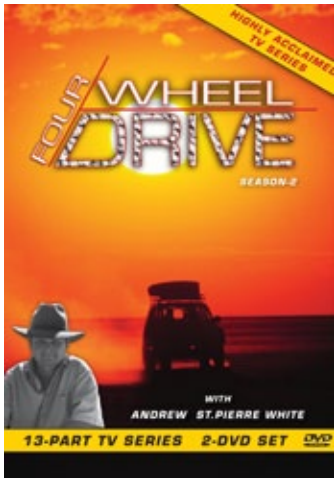
1. *Left-hand indicator*
2. *Power point.*
3. *Earth*
4. *Right-hand indicator.*
5. *Right-hand tail light.*
6. *Stop lights.*
7. *Left-hand tail light and number plate.*

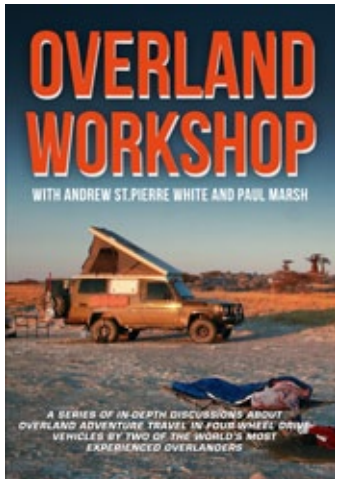
- *Protect with a fuse of no more than 25 amps.*

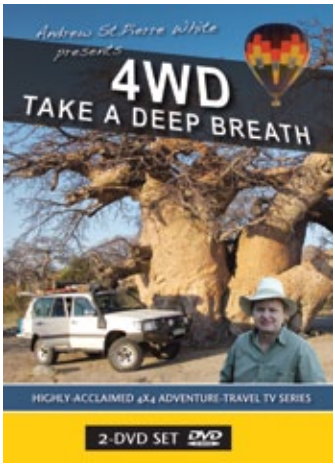


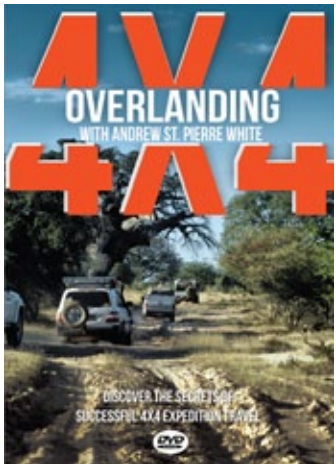


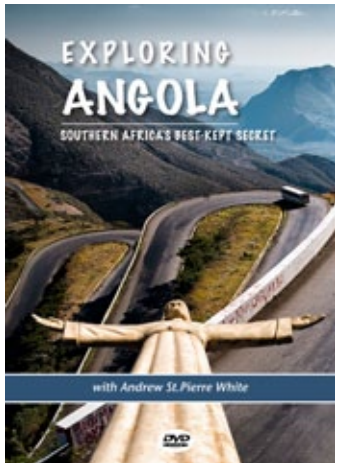












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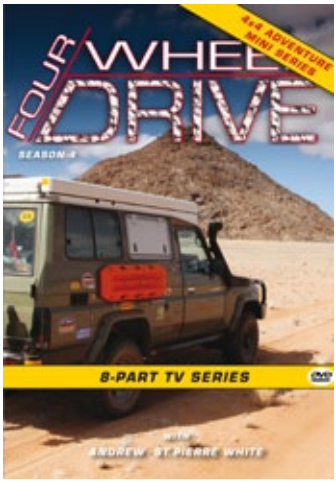

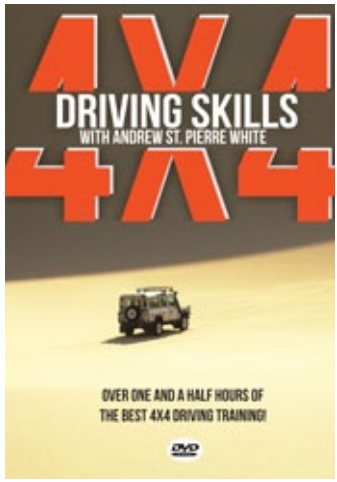

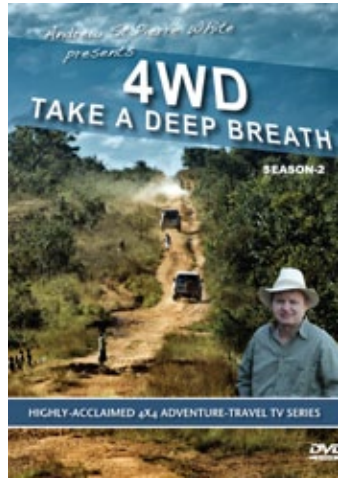

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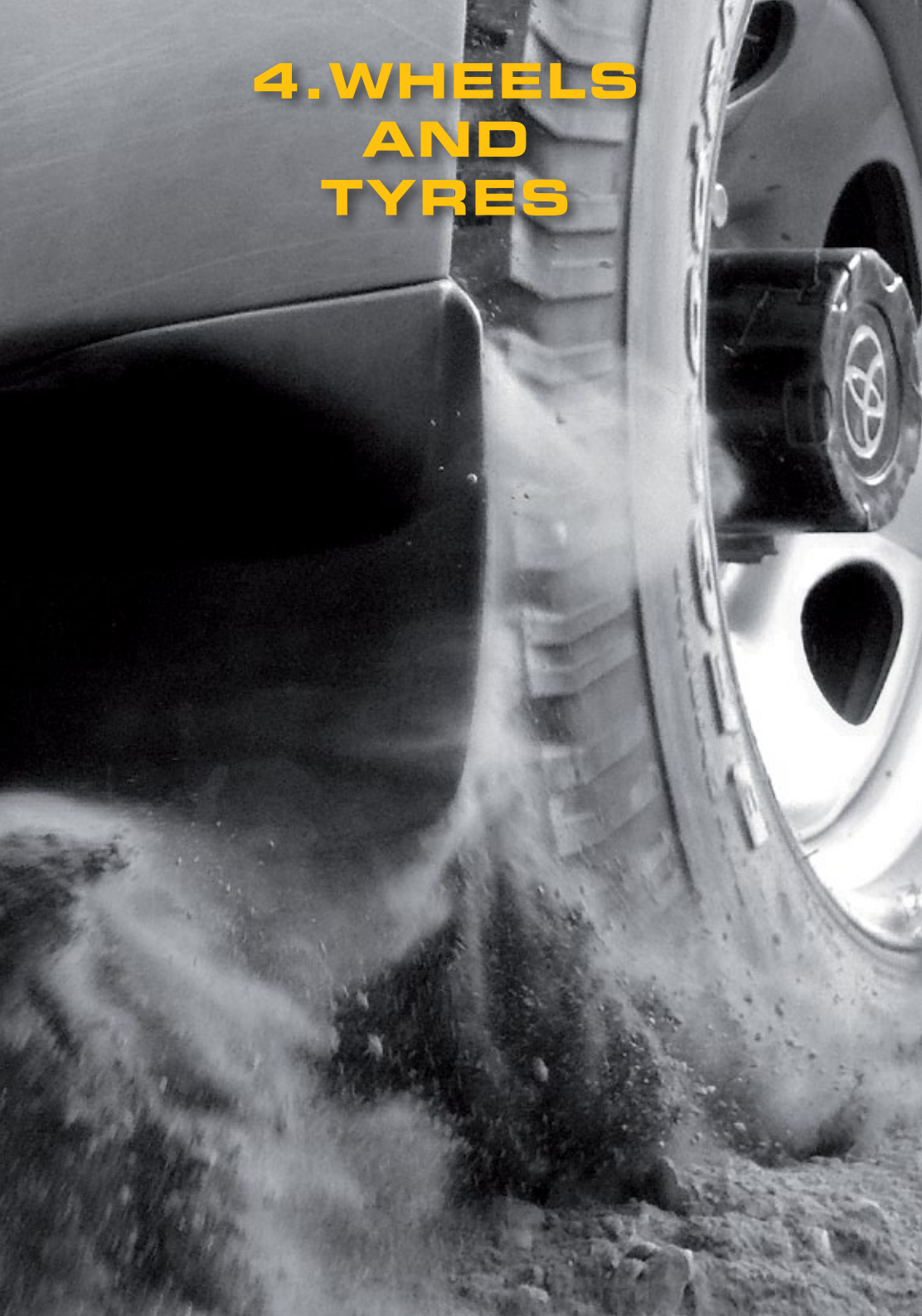
4. WHEELS AND TYRES



TYRE SELECTION

TUBED VS TUBELESS

RADIAL VS CROSS-PLY

SPARE WHEEL LOCATION

WHEEL RIMS

PUMPS

REPAIRING A PUNCTURE

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In the realm of 4x4s, no factor, other than perhaps the driver's skill, affects a vehicle's performance as much as the tyres. And it is not just the tyres themselves that are important, the type of tread or the flex of the sidewall. More significant is the pressure in relation to the terrain being driven.

I reckon, for every 10 mechanical problems that occur on outback adventures, eight of them will have something to do with tyres. Selecting the right ones for the job and then taking good care of them can mean the difference between success and failure on an expedition.

While motor manufacturers go to a great deal of trouble to research what tyre will work best for a particular vehicle, they determine which tyre will be adequate for the most number of buyers. As a result many 4x4s, particularly luxury station-wagons, are delivered with tyres completely unsuited to rugged expedition or off-road travel.

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 ambient temperatures will be encountered? Some tyres made in China cannot tolerate the heat of an African summer.*

Tyre Pressures

Tyre pressures and their effect on a vehicle's performance is a critical part of off-road driving, and is covered in chapter-5.

TYRE SELECTION

Typical of a mud tyre is an open, chunky tread designed to clean itself as mud clogs the treads. Self-cleaning only works to a point, and even the best mud tyres eventually clog, particularly if the mud is full of clay.

Mud tyres

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

Mud tyres can work well in sand as the deep tread seems to aid traction here too. Also, many mud-terrain tyres, such as BF Goodrich Mud Terrains have a particularly flexible sidewall, and therefore give better than average mileage and performance when used for extended periods running at low pressures.

Snow tyres

Generally speaking, mud tyres with reduced pressures work in compacted snow conditions. Virgin, powder snow requires huge balloon tyres, that would also be good in sand, at very low pressures.

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. 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 the 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 during 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,

The disadvantages of low-profile tyres are best seen when driving in sand, when lowering the pressures cannot be avoided. In this case, low-profiles do not deform as much as high-profile tyres.

A self-cleaning mud tyre at work. When mud is full of clay, no matter how good the cleaning properties of a tyre may be it will become clogged and lose traction.

almost all of the advantage gained by a tyre's width is counteracted by the fact that broad tyres have a much higher rolling resistance than do narrow tyres. This is due to the tendency of a tyre moving over sand to build up a wall of sand in front of it. The wider the tyre tread, the higher the wall. Eventually the vehicle's progress is 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.

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 better suited to sand. The craft which the Ford was attempting to pull out was a lightweight ski boat with a 30hp outboard. Once the tyre treads had clogged the vehicle became useless. My vehicle was fitted with 205X16 radial mud and snow Michelins 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 slip way.

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.

Then there is a case of the Darien Breakthrough expedition where two Range Rovers travelled from Alaska to Cape Horn in 1972. The wide tyres caused major transmission failures in the thick jungle conditions of Central America. When the tyres were swapped for much narrower ones, speed increased and breakdowns stopped.

There seems to be no definite conclusion when is comes to mud tyres and tyre width. What is conclusive though, is that a self-cleaning tyre does make a significant difference to performance in mud. Tyre pressures are dealt with in depth in chapter-5, 'Driving'.

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.

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 safari, mud for the occasional rainy spell that turns the tracks into a slippery mess, and rocks on the family weekend 4x4 outing. 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, because you can't tell by just how they look.

How important is side-wall thickness?

Sidewall thickness is important in preventing tyre damage, no doubt about it, but very few radials are made with more than two plies in the sidewall. A few, such as BF Goodrich ATs and MTs, have three plies, but these tyres, as good as they are, don't necessarily get fewer sidewall punctures than others with two. Why is this? I believe that it has as much to do with the thickness of the sidewall as it does with its shape.

Sidewalls that have a block shape, as opposed to rounded, tend to protect themselves better as the shape deflects obstacles when the tyre rides over them. A rounded crown will permit sharp objects to penetrate or damage the sidewall even from underneath.

I do know that the fact that I now have three plies on my BF Goodrich AT's sidewalls, gives me more confidence than if I had two.

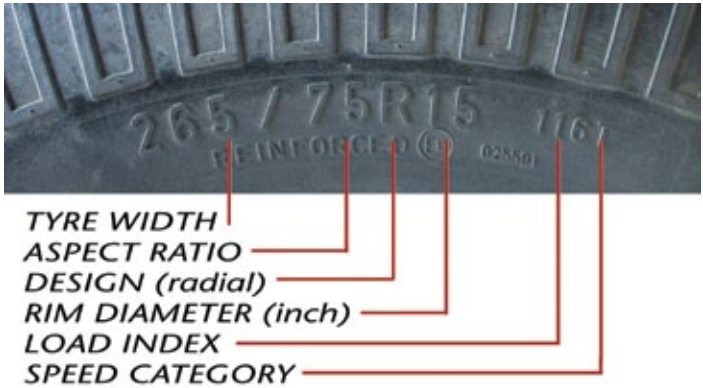
Summary:

- *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.*
- *Not all tyres are alike when it comes to staying on the rim when deflated. Ask around as to which models work best.*

Speed load and temperature

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 and is significantly reduced.

In my experience, I reckon, for every 10 mechanical problems that occur on outback adventures, eight of them will have something to do with tyres. Selecting the right ones for the job and then taking good care of them can mean the difference between success and failure on an expedition.



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

LOAD INDEX TABLE					
LI	**KG**	**LI**	**KG**	**LI**	**KG**
97	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

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

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. Heat damage to tubed tyres is less frequent but will result in sidewall over-flex and delamination. Again such a tyre is irreparable.

TUBES VS TUBELESS

The question of tubed or tubeless is much debated.

Tubes versus Tubeless

- *A tubed tyre running at reduced pressures for long periods generates more heat and is more prone to damage and punctures.*
- *A tubed tyre is easier to repair in the bush than a tubeless, when on a split rim or rim with narrow flange because they are easier to remove from the rim. However, tubeless tyres can often be repaired with a simple plug, not usable with tubes.*
- *Tubes do not strengthen the tyre or help prevent punctures, if anything, the reverse is true.*
- *If a tubeless tyre is deflated for use in heavy sand conditions that require excessive throttle, the tyre may move on the rim. The result is total deflation.*
- *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.*
- *Blowouts can tear a tube to pieces rendering it useless, so if you use tubed tyres, carry several spare tubes.*

The most common terrain encountered by a 4x4 is corrugations and rough gravel. Tyre failures are common, particularly with luxury station-wagons shod with tyres that puncture easily and are unsuited to the hot, punishing conditions of the outback.

Fitting inner 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, normally 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.

RADIALS VS CROSS-PLIES

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 flange to flange (the flange 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.

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.

SPARE WHEEL LOCATION

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

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.

Under the rear overhang

A spare wheel hanging behind the rear wheels in many cases reduces ground clearance, sometimes seriously (e.g. Toyota Land Cruiser SW). In this position, it is vulnerable to damage, sticks can puncture it, and should the vehicle bog down, the spare wheel can make things worse. A spare wheel makes an excellent base for a jack and even a good anchor if it is buried, but can become inaccessible when mounted here. In addition, if it is stolen or falls off, it is unlikely that anyone will notice until it's too late.

On a roof-rack

While only light bulky objects should be carried on the roof, a spare wheel carried here 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 used for sitting in when game viewing and is the ideal location to carry a three-legged pot. Keep in mind the average steel rim and tyre will weigh in excess of 35 kgs, so it may take two people to lift it on and off the roof-rack.

On the rear door and purpose-built spare wheel carriers

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. 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.

Purpose-built wheel carriers are available for a range of vehicles. Being separate from the rear door they can also be a useful place to carry other equipment such as a spade, jack and even a cooking grid.

Purpose-built spare wheel carriers are not only useful for carrying up to two spares, but can be used for attaching other equipment too. For example: firewood, spade and hi-lift jack.

Left: Swing-out wheel carriers can be added to a limited range of 4x4s, and for ordinary daily use, are bulky and can be quite inconvenient. Right: One of the advantages of carrying a spare exposed on the back is this: A CampCover wheel bin - the most convenient way of carrying refuse and cooking grids, I have yet found. Left below: Onca's swing out wheel carrier on my Land Cruiser.

On the bonnet

Looks really cool on a Defender, but putting a spare on the bonnet isn't very practical and is only really possible with the Defender. Problems can arise when the bonnet release knob is pulled from inside the vehicle as the bonnet often does not release due to the added weight. It can therefore be difficult for a single person to open the bonnet. Forward vision is also restricted and safety in a head-on collision is seriously compromised. Removing the wheel and replacing it requires some physical strength and will scratch the bonnet's paint work. The only advantage of this position I can think of is that it offers excellent weight distribution.

WHEEL RIMS

Magnesium alloy rims

Some mag rims are weak and unsuitable for heavy off-road operations, for example the standard mags supplied with the Mercedes-G 463-series. But many are quite strong enough for most uses. Their disadvantage comes when they are bent, when they are much more difficult to repair and a hammer and a tree stump isn't going to bend them straight: It will just break them more. Steel is the better, but heavier and uglier choice for those wanting uncompromised strength and durability, but in 90 percent of users, it will make little difference one way or the other.

Steel rims

Steel rims are constructed in two parts: A pressed steel centre boss and a rolled circular bed for the tyre. These parts are either riveted or welded together, riveted 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 full number of wheel nuts (See pictures below) 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, e.g. bending of the outer flange. This can be straightened using a shifting spanner and light use of a hammer. Make sure the flange is returned to its original shape and the distortion has not been transferred along the flange. 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 flange 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 a tyre from a rusted rim. One solution is hot-dip galvanizing but beware of deposits on the tyre flange requiring smoothing down. Red-oxide paint or sand blasting and powder coating are possible alternatives.

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. 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. To prevent tube damage, when a tube is fitted onto a split rim, a protective gaiter consisting of a ring of shaped rubber must be inserted between the rim and the tube.

For years I used this: Two inexpensive Volcano pumps piped in tandem. I had the benefit of dual redundancy and a fast pump at a low cost. The day of expensive pumps like ARB and Thomas is at an end: For less than half the price, a well-made Chinese alternative will do the job as fast and just as reliably. But don't buy the cheapest you can find - there are still units that are better at converting sound into heat than pumping a tyre.

An extreme case of neglect. These were the right side front and back wheels of a Toyota Hilux photographed in the Kalahari, September 2006.

A flat tyre can happen at the most inconvenient moment. Here, on the banks of the Chobe River in Botswana, a hidden log rolled over and sent a spike through the side wall. The trouble was that we had been watching some very large crocodiles in the very place only minutes before.

PUMPS

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.

When selecting a pump, the volume of air pumped is the issue, not the pressure. Look for a high CFM (cubic feet per minute) or LPM (litres per minute). Most imported pumps indicate CFM. Anything under 1 CFM is going to be slow. Anything over 1,3 is going to be reasonable. Not many perform better than 2 CFM. The pressure rating is not important as long as the pump can reach 4-bar. Note: The volume of air must be measured under pressure. Some pump's specifications look outstanding until they are applied to a half-pumped tyre and then they fall off dramatically.

Foot pumps

Electric pumps are fairly reliable, but if they break down they are not easy to repair. It's therefore advisable to carry a foot pump as a backup. Foot pumps are perhaps a little less strenuous to use than hand pumps, but their use in sand can be awkward. They should be placed on a plate or tarpaulin to keep sand from entering the mechanism.

Tyre Deflators

Solutions to the dilemma of letting tyres down quickly have plagued mankind for oh, at least 25 years. Tools range from the long fingernail, a twig or matchstick, the tip of a Leatherman or penknife and recently auto deflators like the Staun, which is the best of them. Screw them onto the valve of each tyre and they deflate each to a preset pressure. But I have found something I like even more: The ARB EZ-deflator. It is very fast, very convenient and safe: there is no guesswork that each tyre is at the desired pressure (pictured left).

Pressure gauges

The most accurate and reliable pressure gauges are not digital. The best ones are the more expensive analogue gauges that have a clear gauge measuring in a wide arc, pressures up to but not exceeding 4-bar. The reason for this is that gauges designed for trucks will measure accurately at high pressures, but inaccurately at low pressures. Off-roaders need accuracy between 0.2 bar and 3 bar.

ARB make a special low pressure gauge for off-road enthusiasts.

REPAIRING A PUNCTURE

Tyre maintenance tool kit:

- *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*
- *Spare valves and valve tool*
- *Pressure gauge*

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.

Plugs are not designed to mend holes, but this is proof that with enough of them, in this case 18, a large hole can be temprarily repaired. This tyre is only then suitable for emergency use.

Repairing a puncture - tubeless

These instructions are for repairing punctures while the tyre remains on the rim. 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 reamer into the hole and move it in and out a few times to roughen the edges so the adhesive will stick. Insert the plug and

Tyre damage is common off-road. Be prepared to repair it yourself or at the very least have enough tubes, patches and tools so that someone can do it for you.

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 - tubed

These instructions are for punctures that cannot be repaired with the tyre on the rim, 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.

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 flange and the rim. Breaking the flange (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 flange 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 flange, 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.

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 flange 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 kinetic 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.*

Advice when fitting tyres

I rotate tyres every 15 000 kms to even out wear. Balancing should be done every 35 000 kilometers or thereabouts. With heavy 4x4s, only when balancing is radically out is the vibration serious enough to be transferred to the driver. I always oversee the operation when tyre fitters replace or rotate my tyres. I make sure this is done properly: All the tyres, including the spare, are fitted with metal valve caps to keep out mud and dust. I make sure the wheel nuts are not over-tightened. This is very common. If you are concerned, do the final tightening yourself. The average 4x4 wheel nut should be torqued to approximately: 66 - 74 ft/lbs equivalent to 100 - 110 Nm. The good fitting centres set theirs to 120 Nm, which I think, is a bit too high.

It can be tempting to buy the cheapest puncture repair kit you can find. But some of the products coming out of China are of a poor quality. You need a good quality, comprehensive repair kit. It should be near the top of any overlander's equipment priority list.

5.4X4 DRIVING

USING FOUR-WHEEL DRIVE TRANSMISSIONS

TYRE PRESSURES

DRIVING SKILLS

4X4 DRIVING SCHOOLS

4XOVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

THE DEFINITION OF OFF-ROAD DRIVING

Many drivers, often novices, regard the term 'off-road' driving as exactly that: Driving off the road. The truth is, nothing could be further from the truth. Off road driving means, more often than not, driving on tracks and roads where ordinary vehicles are unable. Driving over virgin ground is an unforgivable crime to conservationists. The passing of just one vehicle through virgin bush is enough to create a track, and once made in semi-desert or desert regions, it takes decades to fade. The result of thoughtless drivers literally going 'off-road' has not only resulted in numberless unsightly vehicle tracks crisscrossing the landscape but also many areas once open to travellers, are now permanently closed. I implore you: stay on existing, well-defined tracks. If a track is vague, it may be trying to mend. Find a well worn track and follow that. Let's pay back the debt we owe to our beautiful planet and not drive without inward thought and consideration.

DRIVING OFF-ROAD IS very different from any other kind of driving. It can be very enjoyable but can also be very frustrating, especially to a beginner who may find him or herself suddenly stuck in conditions that appear at first sight to be easy. Although there are basic rules to follow when driving off-road, the combination of road condition, tyre pressure, type of suspension, driving style and a dozen other factors can have a marked impact on a vehicle's performance. What follows are guidelines to safe and enjoyable 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 a flat field, when the nose of the vehicle suddenly dropped away and I 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. As we drove back and over a rise to my stricken vehicle, it came into view, looking 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. 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 4WD TRANSMISSIONS

Driving a 4x4 is great fun. No matter what vehicle you drive, as long as it has low gearing and reasonable clearance it can be a source of never ending enjoyment. The driving techniques in this chapter are those that I use and are by no means the only correct techniques. The secret to good off-road driving is to watch others. When a driver clears difficult obstacles with low engine revs and with little or no wheel spin you can bet they are good drivers and are worth watching. Remember, not all experienced drivers are good drivers! And, forget all you learnt from watching Camel Trophy on TV. Those were mostly cowboys showing off for the cameras.

It is safe to say that the majority of 4x4 drivers do not use four-wheel drive as often as they should. There is a misconception that driving in four-wheel drive can damage the transmission. This is true only for driving on dry tarmac in locked-up four-wheel drive, and even then damage is gradual and while it's happening the driver is warned by an unnatural vibration. Don't be scared of using four-wheel drive!

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. While researching a book in 1994, I was loaned an Isuzu KB260 for a trip into the Maluti Mountains. After the road ahead was blocked by a swollen river I was forced to about turn and head back. It was getting dark and to make matters worse it started to rain. In two-wheel drive the Isuzu handled fine but I wasn't comfortable because although the surface was firm, occasionally the back would slide out. Then I locked the hubs and engaged four-wheel drive. The Isuzu now drove as if on rails and I felt happy that we were travelling in complete safety. We did not need four-wheel drive but it improved handling so much that we increased our speed from ±50 kph to about 80 kph. Fuel consumption increased marginally and I calculated that for the 60 kilometers we travelled that evening, at a conservative 5% increase in fuel consumption, I spent an extra 92c on fuel! The increase in fuel costs is so small while the increase in safety so huge.

Driving all four wheels offers better all round safety, handling and improved tyre life on anything but a perfect road surface. So my first bit of advice is: *Engage 4x4 not because you need it, but because it's there. And, safety is everything.*

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 and you will be able to engage four-wheel drive from inside the cab at a moment's notice. It is a bit like wearing a seat belt: One does not wait until you need a seat belt before putting it on.

Seat belts should be worn although many find that inertia belts 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. I recommend keeping them off 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 hold it lightly enough to let the steering wheel slip through your hands should it have to, gently coaxing the vehicle to go in the direction you wish.

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

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 and expensive body damage can result. I do not subscribe to the opinion that it's okay for a vehicle designed for off road use to get damaged occasionally.

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.

ENGAGING FOUR-WHEEL DRIVE AND LOCKING DIFFERENTIALS

Part-time 4WD

Engage four-wheel drive in conditions where you feel that a two-wheel drive vehicle may spin a wheel and struggle to get through.

Permanent 4WD (Centre Differential Lock)

Lock the centre differential if there is any danger that any of the vehicle's wheels will lose traction and spin. Also as a safety measure when travelling at high speed on gravel or wet, oil-slick tar. Lock the centre diff whenever low range is engaged, no matter the conditions.

'Super-Select' 4WD (Mitsubishi)

Engage four-wheel drive, centre diff unlocked in ALL conditions other than smooth dry tarmac. Locking the centre diff as above.

Rear Axle Differential Lock

Lock the rear axle differential in conditions which are severely undulating, when wheels lift well off the ground.

Many off-road drivers tend to lock the rear diff the moment things become challenging. This robs them of a chance to learn and hone their skills. Just because wheels lift off the ground it doesn't mean that a rear locker is needed. It just means that a rear locker will make it easier. Try your skills, use the push-pull technique (see axles twisters later in this chapter) and try and get through. If you find it is impossible or you feel that the vehicle is being stressed, go right ahead; stop the vehicle, engage rear diff lock and drive through. I recommend this approach because bad driving techniques are easily masked by a locked rear diff.

In flat soft sand axle diff locks can hinder progress due to the under-steer they cause. This under-steer causes the turn of the front wheels being exaggerated creating a very high rolling resistance of the front wheels, halting progress. Always stop the vehicle before engaging. Failure to do so can wreck the differential.

The Transfer Gearbox

Part of what makes an off-road vehicle special is the transfer gearbox, the second gearbox in which an additional set of gear ratios is available for off-road driving. The transfer gearbox reduces the overall gearing, giving a new set of ratios that are changeable by the gears of the main gearbox. For example, a 5-speed gearbox plus the transfer box provides the vehicle a total of 10 forward gears, and two reverse gears.

What makes an off-roader special is the second gear lever. Top: Pajero's second stick selects high and low range, locked four-wheel drive. Bottom: In the case of 'soft-roaders', the gear lever is often accompanied by another switch. The yellow knob on this Freelander's stick engages Hill-Descent Control.

Avoid excessive throttle openings when in low-ratio first or second as the high 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.

Levers on part-time four-wheel drive transmissions:

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

Levers on full-time four-wheel drive transmissions:

- *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).*
- *ABS on/off. (Off-road conditions where engine compression is used to slow the vehicle)*

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". In this neutral position no power goes to either prop-shaft. Neutral is used when the engine 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.

Free-wheel front hubs are there to save fuel and serve no other purpose whatsoever. They can only be fitted to vehicles with part-time four-wheel drive transmissions. When locked the vehicle can be driven in two-wheel drive over any surface, including tarmac, without fear of damage to the transmission.

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 100 kilometers. 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 and use more fuel.

I once did a trip to confirm this. Having driven my Land Cruiser FJ79 from Johannesburg to Cape Town (±1500 kms) three times, and had measured its fuel consumption each time, on the fourth drive I left the front wheel hubs locked for the entire way. I anticipated a slight increase in consumption but it turned out less than even I had thought: Approximately 0.2 liters per 100 kms higher than the already established average; an extra three liters for the entire trip.

Driving with the hubs locked does not damage the transmission. Some think that they must be unlocked when driving on a tar road. This is untrue. I suggest locking them once the long, high-speed tar driving is complete and the gravel and off-road driving lies ahead. In this way the driver will be able to select four-wheel drive from inside the cab. Then, when the trip is over, and you are on the road to go home, unlock them to get any fuel savings that may result.

ELECTRONIC TRACTION-CONTROL (ETC)

Traction control, fitted to many modern 4x4s, is an electronic traction enhancing system developed to improve traction by taking the energy created by tractionless, spinning wheels, converting it into pulling power which is then transmitted to wheels with good traction by use of the ABS brake system or hydraulics. The driving techniques for vehicles with traction control are not the same as for those without.

The fundamental difference in driver technique is in the use of the accelerator. The technique of easing the throttle during wheel spin will cancel out any effect that ETC may be having. In this case ETC might as well not be there. Should the driver keep the throttle open, a well set up ETC will activate, braking the spinning wheels and transmit power to the wheels with traction. Therefore it is safe to say, if you have a vehicle fitted with ETC and a fully-locked up four-wheel drive system, both techniques will work. Of course the beauty of this is that should the first technique fail, try the second. The best of both worlds!

As technology in traction control advances so does the effectiveness of these systems. Some of them, for example the one fitted to the Jeep 2005 Grand Cherokee, is so effective that it is almost impossible to spin a wheel. All four spin, or none at all. The system is so 'clever' that it takes much of the fun out of difficult off-road driving.

Discovery-2, one of the first vehicles with Electronic Traction Control. As an observer it appeared as if this was a huge learning curve for Land Rover and the entire 4x4 world has reaped the benefits of their experience. Their mistake was the removing of the centre diff. I guess this is the price of being one of the great pioneers of 4x4 technologies as Land Rover continues to be.

Novice off-road drivers frequently underestimate the effect tyre pressure has when a vehicle is off road.

ELECTRONIC SAFETY DEVICES

Modern 4x4 are endowed with safety features not dreamt of a decade ago. One of the most common has a remarkable effect on off road performance. This is the anti-skid system, sometimes called ESP. It is remarkable how it will correct a slide on corrugations or during a violent swerving action. The first one I drove was fitted to a VW Touareg. Here is what I learnt: When on uneven ground select the suspension height to 'off-road' and set the shocks to 'sport'. This prevents bottoming on big bumps. And, turn off 'ESP'. With ESP turned on, the Touareg likes to go in a straight line; try and turn and it bogs itself down. Since then I have driven several, one being the Fortuner. It does much the same thing and if left on, in thick sand, quickly bogs the vehicle down immediately the steering is turned. Most ESP systems will switch off when low range is engaged. Check your vehicle's ESP equivalent and experiment the next time you go out.

TYRE PRESSURES

Part of the preparation for driving off-road is the checking and then deflating or inflating the vehicle's tyres to alter the tyre footprint to adapt the flotation and grip.

There are few subjects in the world of 4x4s that are under such constant debate. In all six editions of this book, I have revised my opinions because every time I go out and drive, and watch vehicles perform in varying terrain, my own opinions change. At this time, these are my findings:

The top tyre print represents a tyre pumped at normal operating pressure. The lower tyre print illustrates what happens to the tyre print at half the pressure. It is longer and slightly wider. The increased footprint area means that the pressure on the ground is reduced (Less sinking) while the area of tyre contact is greater. (More traction)

Adjust tyre pressures:

- *When traction is marginal such as on steep, undulating climbs or tricky, lumpy descents, shallow slippery mud and general off-road driving, tyre pressures should be reduced by ±20% of normal operating pressures.*
- *To reduce the shock effect of tyre impact when driving over rocks, pressures should be reduced by ±25%.*
- *To improve comfort, safety and stability on corrugations, pressures should be dropped by 15%-20%. Be careful of dropping pressures too low when carrying a load because low pressures can also result in reduced directional stability, and while making things more comfortable, reduced pressures may also cause handling difficulties.*
- *Likewise, excessively high pressures, set because of a heavy load or trailer, can also adversely effect handling, especially noticeable on gravel corrugations.*

- *If conditions require protection, such as on sharp rocks and in conditions where the tyre sidewalls are threatened, then I recommend dropping the pressures by as much as 30%. The trouble is, the lower the pressures the wider the sidewall will bulge, thereby making it more vulnerable. Also, clearance is reduced. But like a balloon, which is easier to pop when fully inflated than when soft, a hard tyre is more vulnerable to damage than a soft one.*
- *If conditions require flotation, tyres should be deflated. On sand tracks where speeds are 40-50 kph drop pressures by 15%.*
- *On sand that is extremely soft, tyre pressures can be dropped to as low as 0.5-bar. HOWEVER, at this pressure, the risk of a tyre coming off the rim is high. Steer cautiously and drive slowly. Some tyres will not permit such a low pressure as the bead design will not keep the tyre on the rim. In this case, 0.8-bar is about as low one can go. Tubed tyres can be reduced to 0.3-bar safely.*
- *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 loss of air. For this reason pressures can be dropped lower than with tubeless tyres.*
- *At any pressure lower than normal, speeds must be kept down to prevent tyre damage, especially if you are using tubed tyres.*
- *Excessive speed with reduced pressures, with tubed tyres will quickly wreck the tube and a blowout is likely.*

TYRE PRESSURE SUMMARY	
SURFACE CONDITIONS	***PRESSURE REDUCTION***
Sealed surface	*100%*
Gravel / Corrugations	*10 - 15%*
Rocks	*15 - 20%*
Mud	*25%*
Sand	*50 - 60%*
Emergency tubed - tubeless	*0.35 bar. - 0.6 bar.*

You don't need lots of cash to enjoy driving a 4x4 off-road. This is a 1973 Range Rover, all of 34 years old - almost as old as the driver.

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. Never try to turn around on a slope that is more than 25°.

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 depress the clutch. The techniques for descending slopes with a firm base and those with a slippery base differ, as follows:

The procedure 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 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.*
- *On all but the steepest slopes 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 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.*
- *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.*

The critical safety issue when climbing or descending steep slopes is not to depress the clutch in the event of traction loss or stalling.

- *NEVER change gear during a steep descent without your foot first pressing the brakes. 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.*
- *When descending on very slippery ground, the 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.*
- *With auto transmissions, use the brakes from the beginning of the slope, control the speed with the brakes and do not let the engine race.*

Ascending a steep slope

When confronted with a steep slope to climb the driver must decide: Do I need momentum or control? For example in the case of climbing steep dunes, speed and momentum is the essence whereas climbing a rocky slope, traction is the most important element. A higher gear and speed will provide momentum but if the slope is bumpy this will cause the wheels to bounce, resulting in loss of traction.

The procedure is as follows:

- *Engage four-wheel drive, lock the centre differential and make sure the 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.*
- *Select your line. An even, steep slope is better than an axle twister at a flatter angle.*
- *Do not rush the slope. As the vehicle hits the slope at a too high speed energy is absorbed and the result is a vehicle that begins the slope on the rebound. It is at a disadvantage from the beginning. Rather apply firm accelerator the moment after the front wheels begin the climb, and not before.*
- *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 fails 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, drive the slope with a little more speed. Revise and change your line.*
- *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. E.g. Corrugations.*
- *With auto transmissions, the technique is the same, although a mid-slope gear-change is possible.*

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.

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 with 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. 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.*

- *Accelerate 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 high 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 four-wheel drive 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 a vehicle fitted with broad tyres better suited to beach use where the shallow treads quickly clog and sit on the surface without any grip. In most cases mud requires lower than normal tyre pressures.

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 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 loss of momentum.*
- *Avoid doing anything suddenly. Keep your actions smooth and your steering wheel dead ahead if possible.*
- *There are two techniques to be tried: Even and constant power application. Don't accelerate when wheel spin occurs and don't decelerate when the vehicle accelerates. Keep the power application constant. This is often the easiest and most effective technique for beginners.*
- *Another effective technique is to look for traction. To do this, when 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 the speed constant.

- *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.*

In order to assist the tyres get traction from the sidewalls, try swinging 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.

When driving in thick mud with broad tyres designed for flotation 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.

Steep mountain slopes in slippery 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

Excessive speed is an all too common mistake when driving in mud. However, sometimes wheel spin can be used as an advantage. Here the clogged tread is cleared by a spinning wheel.

travelling on a track that slopes away at its edges, drive slowly and carefully stay in the middle.

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 often in mud, and will also work in reverse. If attempted in sand however, it usually digs the vehicle in deeper.

SAND DRIVING

Sand driving encompasses dunes, tracks and the beach.

These rules can be applied when driving in sand:

- *Shadows in the morning and evening make driving easier.*
- *Engage 4WD well before you need it and lock up your transmission.*
- *Deflate your tyres according to recommendations earlier in this chapter.*
- *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 flotation. 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.*
- *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. When 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 may 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 I recommend low range third and fourth. While second and third high range is also fine, selecting low range is advisable because if a rapid change-down to second or even first is needed is can be done in a hurry – no need to stop, and change from high to low range.

Correct gear selection in dune driving is crucial. Start off in low second and progress to third and fourth. Avoid changing gear mid-slope as in most cases it will degrade the vehicle's momentum enough to stop it completely. However, 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 hitting the slope with extra speed was not an option. 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 Land Cruiser, with much more power and momentum at his disposal, did the entire climb in second gear. In situations like this a gear change may be required and vehicles with more power require less effort to drive. The critical driving technique was not just the gear change, but timing it over the corrugations where the wheels would lose traction anyway.

The author and one of his earliest attempts at dune driving (1990). It is great fun as the learning curve is very steep. And the great thing about dune driving is that many SUVs, without low range gearing, are capable of tackling all of the dunes that the 'heavies' can handle.

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 pointing slightly downhill.*
- *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 if it's not too steep and low-range second if it's hair-raising. The higher gear will mean a faster drop but will prevent the sand under the vehicle falling faster than the vehicle. If this happens the vehicle will slide sideways, and that is a very bad idea.*
- *If it does start to slide accelerate firmly. Don't let the slide continue! Slides on dunes turn into a roll-over in an instant. Too much speed going down a dune slope is safer than going too slowly.*

Side slopes on dunes

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. 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 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 drivers had tried to get out of a deep track. They had swung the wheel hard over and when nothing happened turned it even more. All of a sudden the front wheels hit something solid and the vehicles left the track so sharply that they rolled over.

Don't fight the steering when driving sand tracks. This tendency causes the front wheels to crab, slowing progress and consuming excessive fuel.

ON THE BEACH

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.

Beach driving recommendations:

- *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.*
- *Give way to anyone who appears to be having difficulty, and watch out for children.*
- *Too low gear ratios will induce wheel spin unless the driver is very careful about how he applies his right foot.*
- *Use low range. A quick change down is then at hand. Be alert, beach driving can be extremely hazardous to your insurance premiums.*
- *In South Africa, a blanket beach ban has been imposed and vehicles found unlawfully on a beach can be confiscated.*

WADING

Top: Slow and cautious, the correct technique for 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).

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 must 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 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.

It's easy and very tempting to go too fast when wading through deep water, because higher speed can increase the depth from 'safe' to 'close to hazardous'. In addition, the volume of water being pushed ahead of the vehicle requires lots of otherwise unneeded traction. If the bed is soft and slushy, the tyres may lose traction only because the vehicle is being asked to push a ton of water ahead of it. Going fast is often the very best way to get stuck in this situation. Drivers often confuse the need for speed with the need for momentum. They are not the same thing. Go slow, maintain an even speed and DO NOT accelerate, especially if the vehicle feels like it is slowing.

GILLIAN STEER

While driving in deep water can be fun, it takes a heavy toll on the vehicle. Damaged oil seals, corrosion acceleration are just some of the costs, not to mention the chance of severely damaging the engine should water enter the block. I for one avoid deep water whenever possible.

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 carburetors. 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 oil pump. 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 a petrol engine ingest water into the cylinders it normally stalls before any serious damage is caused. This however is not the case with diesel engines – they are often destroyed if this happens.

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.

Axle Twisters

When a series of ruts and troughs follow each other it's often referred to as an axle twister. Driving axle twisters without a rear diff lock requires a technique I call push-and-pull. During a trip to the Linyanti in 1990, I was confronted by a broad mud flat where the elephants had walked. When they had been

there it was wet and their huge footprints made hollows as deep as my knee. All across the flats were thousands of these footprints, now made as hard as rock, baked that way by the October sun. A speed over three kph would have left my Land Rover in ruins so the push and pull technique was used.

The push and pull technique:

- *Engage four-wheel drive/lock the centre diff, low range 1st or 2nd.*
- *Assuming the right wheel enters first, let it drop into the hole. As it bounces upwards apply the accelerator gently.*
- *The left rear will fall into a hole. As this happens the front right wheel may leave the ground. At this time the rear wheels are pushing.*
- *As the front right wheel falls, (this is critical), ease the accelerator. The front wheel, as it strikes the ground must not spin. It will, if it is not spinning, grip. Now the front wheels will pull.*
- *As the front wheels pull, apply gentle accelerator.*
- *The rear wheels will move through the holes, probably one will leave the ground. As it does so, the left front wheel may lift and then fall.*
- *The process of easing the accelerator as the wheel falls begins again.*
- *Using the push and pull technique with too much speed will make it too difficult to apply as well as bouncing wheels and traction loss.*

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 tricky. In this situation, axle differential locks 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.

Above: Driving V-shaped gullies.

Packing rocks to make a descent easier. Bottom: Packing rocks to ease the angle of a rock ledge.

Rough bush 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. 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.

Boulders and river beds

Engage 4WD and lock the differentials, even though you may think you do not need it. Select low-range first gear. 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 pick-ups. To avoid striking these, make sure that the wheels ride over the higher boulders, clearing the axle and chassis.

Use the rocks around you to reduce departure angles, assist a wheel to climb a step or prevent the vehicle running out of clearance.

Thumbs folded inside the steering wheel rim can get hurt when driving over rocks if the front wheels hit a rock hard and the steering kicks. Keep them on the outside.

SALT PANS

Driving over salt pans is a nerve-racking 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.

Before you venture across the pan, skirt around the edge to find 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 25 cms 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 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

GILLIAN STEER

High speed driving over the flat pan surface is exhilarating but dangerous. A sharp turn can result in a roll-over if the outside wheels dig in even a little.

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 prop-shaft 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.

Gravel roads

Long stretches of gravel roads present their own dangers. Firstly engage four-wheel drive and lock the centre diff if you have one. DO NOT lock the rear axle diff. 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.

Some desert roads are made from a substance called calcrete that appears 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.

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 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. Swerving and hitting the trough sideways could roll the vehicle.

One more piece of advice: if you are travelling on a busy and dusty road, turn your headlights on and stay visible through the dust.

Corrugations/washboards

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 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. This tendency is dramatically reduced when in four-wheel drive.

Loading a vehicle does tend to dull this tendency, but an overload will have the opposite effect, in which case over-steer increases dramatically. Early Land Rover Discovery and old Range Rover are particularly prone to this. By fitting gas shock-absorbers this tendency is reduced.

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 the Third World 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 first time I had 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 second and third for over six hours. During this time we covered only 25 kilometers and fuel consumption measured 45 liters per 100 kilometers. 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. Tyre pressures should be dropped as if driving in slippery mud. 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 0.3 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

In shallow, slippery snow, tyre pressures should be dropped as if driving on slippery mud: About 50-60% of normal road pressures.

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.

Operating a 4x4 in snow and sub-zero conditions:

- *When a vehicle is parked for long periods, lift the windscreen wipers or 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 engage low range first gear.*
- *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.*

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 exacerbated 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, overloading or a twisted inner-tube. Engaging four-wheel drive or locking the centre diff on gravel roads will reduce the chances of control loss caused by blowouts by 80%.

Driving Skills DVD. The consensus among off-roaders worldwide is that this is one of the best 4x4 training videos in the world (This is not my opinion) Almost two hours of training demonstrating how effective the video is for teaching off-road driving. Highly entertaining, shot all over Southern Africa in some beautiful, remote places you'll watch it again and again. Also available in most bookstores and wherever good 4x4 equipment is sold.

6.RECOVERY

WINCHES

RECOVERY ACCESSORIES

KINETIC/SNATCH STRAPS

JACKS

SAND LADDERS

ANCHORS

RECOVERY TECHNIQUES

4X OVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

Using recovery gear is more common sense than anything else. Here a trooper cannot move because it has come to rest against a boulder. The high-lift jack was used to move the boulder away from the vehicle while the Jeep used a snatch strap to tug the boulder clear.

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.

Vehicle recovery equipment makes up a large proportion of a typical off-road load. The following covers the 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 tends to be an overrated piece of off-road recovery equipment. This is because a winch relies on anchor points, which in so many 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

Namibia, October 1984. The most memorable time that I ever became bogged down: Alone in the Namib, without any idea of how to use the little bit of equipment that I had with me, and an October sun beating me to death. Two and a half hours of digging was the only way out of a mess that, had I known about tyre pressures, would never have happened in the first place.

and dig the vehicle free than to create an anchor and use a winch. In severe cases, both may be needed. So, consider the winch only after you have acquired the other equipment needed to back it up. Once this has been acquired a winch becomes the backup, and not the other way round.

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.

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 by shortsightedness or carelessness.

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).

Selecting an electric drum winches

The most common type of winch is the electric drum winch, manufactured by companies such as Warn, T-Max and Pro-Winch. 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. 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. Some are supplied with remote switches; a very dangerous concept. (The reasons are given later in this chapter.) The switch allows the winch to wind forward and in reverse.

Selecting a suitable winch is not easy; but this may help. For 90% of users, 90% of times when they use their winch it is to get someone else out of difficulty. Very rarely is a winch used for self recovery. Also, 90% of winches fitted to 4x4s are used less than once a year. Given these facts, why spend lots on a winch? It doesn't make sense. For this reason, when I build overlanding vehicles for clients, I suggest the following: Get a winch that will do the job and no more. Most 4x4s can get away with a 9000 lbs pull. Don't go for a stronger winch because they are heavier, and it's located in a place where extra weight is not welcome. You wouldn't spend more on your insurance policies than necessary, so why spend more on a winch, which for most 4x4 users, is only insurance anyway. For those few who do radical trails where recovery is common, then spend away, because cutting corners here, isn't a good idea. Buy the best and buy the biggest.

Capstan winching underway.

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. The rope for the capstan must be stored elsewhere as there is no provision for storing it on the winch.

Hand winches require brute force. If you are small and travelling alone, think of something else! Must be used with a snatch block.

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 higher 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 8000 lbs on the drum, about 6750 lbs with a single layer of cable down, about 5800 lbs with two layers of cable down and only about 5150 lbs with four layers. For a winch to be useful to extricate a fully laden medium-sized 4x4 from deep mud, a winch of no less than 8000 lbs rated pull is required.

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 inexpensive. 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.

A hub capstan winch.

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. A third option is to buy a winch plate and do the installation yourself. This is most cost effective.

With so many winch brands now available, it has become a tough choice. I still think that Warn make some of the best winches on the market. Warn also make a budget winch called the Tabor, which are great value and quite good enough for the average 4x4 user. LAS Pro-winch is another excellent quality budget winch.

Hand winches

Relatively light and inexpensive and very versatile, hand operated winches are effective for situations where winching in odd directions is required as the winch can be made to pull in any direction required. 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. The snatch block, described below, increases the pulling power of the hand winch and is an essential accessory.

RECOVERY ACCESSORIES

EQUIPMENT:

- *Spade.*
- *High-lift jack and jacking plate.*
- *Five-metre chain + grab hook.*
- *Kinetic strap.*
- *Gloves.*
- *Air-jack with repair kit.*
- *Q20 or similar.*
- *Safety straps of a length of ski rope .*
- *Two large bow shackles for attaching straps.*
- *Two large D-shackles for attaching chains and straps to vehicles.*
- *Two small D-shackles for linking chain.*
- *Tree protector/ winching strap to attach to an anchor.*
- *Snatch-block to increase winch pulling power or change the direction of a pull.*
- *Sand ladders/PSP/Maxtrax to assist self recovery.*
- *Winch (vehicle-mounted or portable, electric, hydraulic or manual).*

Another option is the removable winch. This illustrates a Warn 9000 winch being temporarily fitted to a rear bumper that has been modified to do the job. Winching backwards is now possible.

Top: Secure your winch hook using this clever clamp that squeezes into the winch rollers.

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.

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.

Top: D-shackles. Middle: Clip-shackles are unsafe for recovery use. Bottom: Bow-shackles are the most versatile and useful shackle. The working load must be indicated. Beware of cheap Chinese junk without the maximum load marked.

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.*
- *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.*
- *Clip-shackles designed to snap closed are unsuitable for vehicle recovery and can fail even in light duty operations.*
- *NEVER use two shackles to join two kinetic straps together. If one strap should break the attached shackles become a deadly missile.*

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 to the recovery tackle.*

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 kinetic straps to chains and anchor straps.*
- *Attaching snatch-blocks to tree straps.*
- *Attaching kinetic straps to vehicles.*
- *Always place the strap over the bow section and the chain or snatch block over the bolt.*

Snatch blocks (winch pulleys)

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.

Double-line pulley or snatch block.

Using a snatch block has the following advantages:

- *Doubles the pulling power.*
- *Winching from difficult angles.*
- *Overheating of electric winches reduced.*
- *Current draw is reduced and therefore kinder to batteries.*

Rings, eyes and tow bars

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 kinetic straps. Therefore when a kinetic strap is used, both towing eyes must be used. 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.

Tow bars should not be used for vehicle recovery. Original vehicle manufacturer tow bars are generally stronger than those fitted by tow bar fitting 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.

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.

The first piece of safety equipment is a pair of inexpensive leather gloves. Make sure they are not too tight and should come off the hand easily.

This is the ideal towing attachment, that can be used for towing and recovery. NEVER attach recovery cable or strap to the ball. It is not designed to carry the load and if it fails the results can be fatal.

Spades/Shovels

Apart from the shovel being the most important recovery tool, it must be designed right – garden spades work, but not nearly as well as those designed for the job.

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 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 – and, they get lost.*
- *It should also be painted a bright colour because spades are often left lying in the bush after a recovery operation. Some have luminous strips on the shaft which is an excellent idea. Many spades are lost at night.*
- *Find a way of attaching your spade in a convenient place, like on the sides of a roof-rack. 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.*

A spade is not a spade when it comes to off-roading. This one I developed after a month of testing. Shorter than normal, with a smaller, pointed shovel head seemed to work best in most situations.

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/tree protection

When using a tree as an anchor; cable or chain will cut into the bark and this can kill the tree. Also, attaching the hook back onto the cable weakens the cable and will damage it. To protect the tree and cable an anchor strap must be used and with a pair of shackles forms one of the most important components of the recovery kit. They also can be used in a multitude of other ways in all kinds of recovery situations.

Anchor straps are best made from polyester and must have no stretch, so a worn-out kinetic strap should not be used. Purpose-made anchor straps are available from 4x4 equipment outlets.

Chains

An anchor strap is broad non-stretch polyester.

I suggest you carry a length of chain in your recovery kit. Chains are an excellent addition to the complete recovery kit and a length of three 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 8000 kgs 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.

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 (breathable) bag.*

Chains are not a 'must have' component of a recovery kit, but they are extremely handy. Here they are used to attach a winch cable to both towing eyes of the vehicle being used as an anchor.

Safety straps

The purpose of a safety cord is to prevent a missile being created should anything in the recovery setup break and must be considered whenever a recovery operation is set up. Laying a blanket or towel, or rolling a strap around the cable is quick and easy but not foolproof. I suggest purpose made safety loops. They should last a lifetime because they are only stressed in the event of a breakage. Developed by John Rich of Stoney Ridge and Secure-Tech, many good 4x4 equipment stores sell them.

A purpose-made safety strap will prevent injury should the kinetic strap or the mount break. Safety straps of some kind are essential for safe recovery operations.

Tyre chains

Chains linked to form a ladder and wound around each tyre are particularly useful when driving in snow or clay 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.

KINETIC/SNATCH STRAPS

A recent Australian magazine tested a range of kinetic straps in the lab and from the results it appears that there is more to selecting a kinetic strap than meets the eye. A strap from one of the most respected names in 4WD, came just about dead last, breaking well below the advertised load while others stretched more and exceeded their own claims. Reliable word-of-mouth recommendations are the way to go.

Kinetic or snatch straps are elasticized towing straps used to extract a vehicle by another vehicle. The tow vehicle moves under power and using energy stored in the strap, exerts huge pulling forces to move the vehicle from its bogged predicament. The kinetic strap is the single most innovative invention for the off-roader in the past twenty years.

Selecting a kinetic strap:

- *Don't go the 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 3000 kgs. A breaking load factor of four should be estimated. Therefore: 3000x4=12000 kgs minimum breaking strain is required.*
- *A stretch of 20% is sufficient, 30% is better.*
- *Kinetic straps should be more than six metres long. The longer the strap the longer the stretch and the working life. Nine metres is ideal for most applications.*
- *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 that break. Buy the best quality gear.*

Kinetic 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 the strap was cleaned.*
- *An average strap doing one hard pull stretching to its full capacity needs between 6 and 24 hours to recover (to 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 kinetic strap 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 with the small amount of stretch left in it may not be ideal.*

More facts about kinetic straps:

- *Genuine kinetic straps, those made for the job, are polyamide, not polyester.*
- *The more moisture, the longer the stretch but the breaking strain is decreased.*

- *Cargo carry straps (broad green straps) sometimes sold as kinetic straps are often not suitable and when used, shock-load the vehicle and attachments.*
- *Sand and grit in the webbing accelerates the wear and decreases the breaking strain.*
- *Kinetic straps with a built-in indicator filament (a strip of coloured material is woven along the length of the strap. When it breaks the strap is 'stretched out'). These have been outlawed in most countries because the system is unreliable and must not be trusted.*
- *Kinetic straps cannot be told apart from non-stretch straps unless they are labelled. Novices beware: Using the wrong strap could be disastrous. Only experts in polyamide technology would be able to tell the difference by just looking.*

The high-lift jack, the single most versatile piece of recovery equipment you can buy. But get to know how to use it before you really need it. It can also be highly frustrating and quite dangerous.

JACKS

High-Lift

The high-lift jack is one of the most useful off-road tools available, 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.

COMPARISONS: HI-LIFT VERSUS AIR-JACK	
AIR JACK	***HIGH-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 familiarization in order to use effectively*
Safer. A vehicle can fall off an air-jack but it's normally a slow, safe affair. If it's punctured it pops like a balloon and the vehicle falls heavily.	*Can be dangerous in many ways as it is unstable and the jacking arm can spring up and injure.*
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. Some models can also be inflated with tyre pumps.	*Extremely versatile can be used for winching, lifting, pushing, clamping and many other less obvious purposes*
Subject to puncture by stones, thorns and a 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 the mechanism. Lubrication solves this problem*
Reliant on the engine to operate	*Independent power source (biceps and back muscles followed by chiropractor)*
Small punctures can be repaired	*Spare parts readily available. Simple to repair and maintain*

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 the mechanism 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.

Mounting a high-lift jack on a bull-bar may be convenient, but it is extremely dangerous. Even in a minor front-end collision, the jack becomes a lethal missile. As tempting as it is, don't mount any heavy object ahead of the windscreen. Even a spare wheel mounted on the bonnet has been proven to be dangerous.

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 easy to use and do not require much physical strength to operate.

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 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 by and large unsuitable for off-road use, as they jam easily as dirt clogs the threads and are unreliable and break with heavy duty use.

Jacking plates

When using a jack, other than a balloon jack, on soft ground a plate is needed to prevent it from sinking while the vehicle

An effective recovery kit should include kinetic strap, anchor strap/tree protector, pull strap, snatch block, bow shackles and gloves.

is being raised. 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. Jacking plates such as the one illustrated are available at 4x4 stores. For me, I just take along a heavy 50cm pine plank.

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.

SAND LADDERS

Sand ladders/traction aids are purpose made articles that are placed under the wheels to aid traction. They are made from plastic, rubber, steel or alloy. The generic term, 'sand ladders' can be confusing as they are designed to work in mud, sand and wherever a vehicle can bog down. Some work, others don't.

PSP (perforated steel plate)

Perforated steel plate (sometimes made from aluminium) was developed by the British in the second world war when they were used to assist vehicles in the mud and to build runways on slippery ground. They are bulky, heavy and awkward to use. They are highly effective in sand and all types of mud. Grip is often superior.

Trac-mats

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. Less digging is required to lay them and they do not kick up and damage the vehicle as sometimes happens with rigid types. However they have a higher tendency to 'shoot' under the vehicle as power is applied. They are also more compact, easy to stow and in most respects more versatile than rigid ladders.

Rubber mats

Lengths of rubber mat normally used as industrial flooring are being sold as de-bogging aids with various names. They are cheaper than metal, fairly effective in sand but utterly useless in mud. Rubber does not grip on rubber when wet.

Plastic 'ladders'

In an attempt to bring sand ladders at a budget price, various plastic alternatives have been introduced. A rigid type (illustrated top right) perform reasonably when dry but not well when wet. In mud their performance is not good. Others, not cheap but properly designed are Max-Trax, pictured below right. These are very effective, in both dry and wet conditions.

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. Some designs interlink for bridge building. Word of mouth recommendations are advised for these individual designs.

Top: Plastic sand ladders are a budget alternative. They work reasonably in sand but not well in anything wet.
Bottom: Flexible 'tank tracks' are very effective but a bit awkward to transport. Work in the wet and dry, second only to Max Trax for versatility.
Left: PSP, or perforated steel plate has the look, but are not very versatile and there are better traction aids on the market.
Bottom, right: Max-Trax comes from Australia and is one of the most effective tractions aids ones.

COMPARISON: PSP PLATE VERSUS MAX-TRAX	
PSP	***MAX-TRAX***
Bulky to transport. Steel is particularly heavy.	*Packs one on top another; lighter and easier to transport.*
Must be periodically flipped over so that a bend does not set in.	*Do not distort and a bend does not set in easily.*
On uneven ground plates tend to kick up and hit the vehicle.	*Does not bend after use on uneven ground, but can be broken if abused.*
PSP plates are longer than Max Trax.	*Later version can be linked together.*
Excellent grip, wet or dry.	*Excellent grip, wet or dry.*

RECOVERY TECHNIQUES

Vehicle recovery is more about common sense and using your equipment smartly. Should your initial attempts fail, stop, have something cool to drink and try to analyze why the vehicle cannot be freed.

The golden rules of vehicle recovery:

- *Stop spinning your wheels the moment it appears you are stuck. Trying too hard only makes things more difficult. Every unnecessary rotation of the wheels digs the vehicle in deeper.*
- *Are the tyre pressures right for the conditions? If not, change them.*
- *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 look 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.*
- *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).*
- *Adapt your equipment to be used in more ways than meets the eye.*
- *Never use a tow ball with a winch or snatch strap. Should it break it will become a lethal missile.*

Using a spade

Using a spade to dig out a vehicle may appear like 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 kinetic strap or winch is to be used, always clear a path with your spade.

The tyre pressure gauge is one of the most important recovery tools you own. The very first thing to do once a vehicle is bogged, is to check the tyre pressures and drop them if they are too hard for the conditions. Do remember though, dropping the tyre pressures will also reduce the clearance.

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.

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.

Winching with a double-line pulley and a strap draped over the line as a safety device. The snatch block halves the pulling speed while doubling the pulling force.

SAFETY STRAPS

Purpose made safety loops are a relatively new addition to the range of 4x4 recovery equipment. They are used to arrest the cable or strap in the event that it, or the mount on the vehicle, breaks. They are attached by looping themselves over themselves. No shackles are used. The pictures on the left illustrate how they are used. These loops are so effective that no other items need to be draped over the cable. A set of two loops is required.

SAFE USE OF WINCHES

The first safety rule when using a winch is that ONE individual must be put in charge of the winch. This person will be the ONLY one to touch the switch – and the ONLY one handling the recovery of the winch cable once the winching operation is complete. This is why remote switches are dangerous. Ignore this advice and it is only time before someone loses some fingers.

Winches are potentially hazardous:

- *Before winching have everyone stand well clear. The slingshot effect caused by a cable break under load can cause serious 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.*
- *Be aware of the condition of the winch cable. Damage, as illustrated on the left, severely reduces the breaking strain of the cable.*
- *Never stand in the 'V' of a winching layout under tension.*
- *If you are not in control of the recovery operation, avoid stepping over a strap or cable after it has been attached, 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.*
- *When a winch gets hot, let it rest.*
- *Ensure that the winch cable does not bunch on one side.*
- *Look after the winch cable and pack it tightly on the drum when finished.*
- *NEVER have one person hold the switch and another feed in cable. This is the single most common cause of injury during winch recoveries.*
- *NEVER USE REMOTE WINCH SWITCHES. THEY ARE DANGEROUS!*

Bottom: Make sure that there is at least five turns around the drum before winching. Damaged cable is the best reason for wearing gloves.

ANCHORS

A recovery rig with multiple stakes. The more bits of chain, different sized shackles and lengths of strap you have, the easier it is to construct a complex rig.

Natural anchors

Natural anchors are anything that you find suitable to attach a cable to – trees, rocks or 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 man-made anchor of any reliability can be made without a lot of effort.

Anchor construction tools:

- *Heavy hammer*
- *Iron standard/s or purpose designed stakes*
- *Danforth boat anchor*
- *Chain, shackles and anchor strap*

Creating an anchor:

- *Drive steel stakes into the ground at 45° and about two metres apart and then, using straps and chains, attach the cable to the stakes as close to the ground as possible. Create 'Vs' between the top and bottom of each stake. (Pictured top right)*
- *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. The Danforth (pictured right) is bulky and overly heavy for expedition use.*

When attaching the winch hook, make sure the bend is toward the ground. In the event of breakage, if attached in this way, it tends to shoot downwards into the ground and not up, potentially hitting someone.

- *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. After burying the spare wheel, dig out from under the vehicle making sure that no earth is supporting the vehicle's weight. This is a last resort because burying the wheel is very hard work and despite perseverance it is often a waste of time.*

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 earth 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.

RELEASING A VACUUM

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.

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.

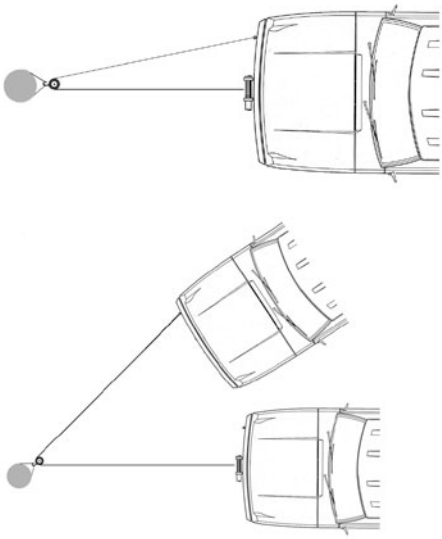
USING HUB CAPSTAN WINCHES

It is easier to run the cable from the anchor to the vehicle, and not the other way. The cable is guided through a groove in the capstan and secured with a knot or buckle. If you are using rope then it should 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. 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.

USING A SNATCH BLOCK

The snatch block is a heavy-duty single-line pulley. It is used to increase the pulling power 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 one day your winch will be under-powered for a job and a snatch block will be necessary.

If you have a winch fitted you will be in a good position to help another vehicle that has bogged down.

To prepare for winching:

- *If the area is slippery, anchor the winch-equipped vehicle by chaining it to a tree, a second vehicle or by digging holes into which the front wheels will be driven.*
- *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.*
- *Clear a path in front of the wheels of the bogged vehicle and remove any obstacles in its path.*

A cable guide enables the user to feed winch cable onto the drum without the risk of trapping fingers in the fair lead. A simple, inexpensive tool which few off-roaders appear to carry.

- *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 anything 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 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 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.

The winch cable is passed through the snatch block and is then returned and attached to a towing eye on the vehicle.

USING KINETIC STRAPS

Kinetic straps are dangerous but highly effective. Because of the immense loads that a kinetic strap can store and release, breakages of the strap or mounting points during this kind of recovery can injure or kill. So often kinetic recoveries are done without a lot of thought as to what the consequences might be in the event of the failure of one component or other.

The pulling vehicle must be similar in size and weight to the vehicle being pulled.

Important rules for using kinetic 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.*
- *Always use safety loops on both ends.*
- *Do not compromise on the security of attachment points. Use both tow eyes if the vehicle is fitted with them.*

Attach the kinetic strap to the front or back of the bogged vehicle. Consider first which will be 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 strap 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 are doing the work, but the vehicle's momentum and energy being transferred through the elasticity of the strap.*

Unfortunately, if the bogged vehicle is badly stuck, something will break. If it is an attachment it becomes dangerous to both bystanders and drivers.

Never use shackles to join two kinetic straps together. Omitting the stick or grass will result in a knot that cannot be undone.

Double kinetic-straps used together.

Having the towing vehicle move off with excessive speed does not increase the pulling force. However, doubling the length of the strap together with a higher speed does 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 the end of strap B and pass it through the loop of strap A*
- *Place a stick or even a thick bunch of grass in the new loop made. This is so that the knot cannot over-tighten.*

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 to be repaired.

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.

USING A HIGH-LIFT JACK

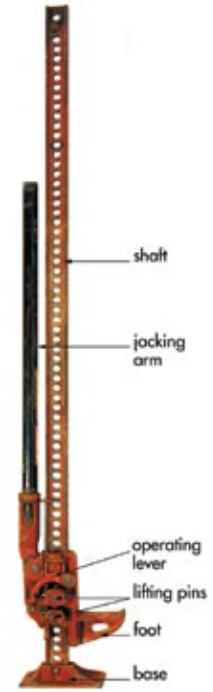
There are few bogging down situations that cannot be overcome with a high-lift jack, a spade and a strong back. The high-lift jack is without doubt the most valuable piece of equipment that an off-roader can carry. The jack discussed here is the American standard brick red-coloured unit that has been around for many decades. Although there are competitive 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 completely that jacking has been the only way out.

A typical high-lift jack point added to a vehicle.

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 will locate 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*

Top: An ARB jack adaptor. Bottom: A unit designed not only to work as a jack adaptor for jacking points but also to enable a wheel rim to be jacked. While this is a good idea in principle, jacking a wheel can damage the rim.

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 full extent.*

High-lift jacks can be dangerous.

- *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. Pictured on the left.

Jack and push

Imagine that 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 front and rear axles.

Spare tyres attached to the tailgate may have to be removed or swung 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. Unlike the air jack, the high-lift jack is perfect for this technique but beware that vehicle body damage can result if carried out carelessly. Whatever you do, practice with the high lift before you need it!

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 dug in the most deeply. 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 wheel-spin, 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. Avoid wheel spin.

In soft ground, jacking the vehicle up and then packing firmer items (rocks, sand ladders, dry earth etc.) under the wheels for better traction is the most common self-recovery technique. Wet grass doesn't help, but just about anything else does.

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

When the ground is soft, a jacking plate is needed to stop the jack from going down, instead of the vehicle going up. Anything will do: a spare wheel, a log or rock. Purpose built jacking plates are, in my view, a waste. Just take along a short, stout plank instead of spending on a heavy, cumbersome item that could get lost.

An air-jack is not as versatile as a high-lift but is can be used on vehicles without adaptation. The best air-jack on the market today is without doubt the Takla Air Jack.

Below, top: Full-length Hi-Lift jack jacket. Below, bottom: Jack nappy.

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

The traditional Hi-Lift out of the USA is still the favourite despite its habit of jamming under load. It's a valid criticism and to prevent this the lifting mechanism must be kept clean and well lubricated. Have a can of Q-20 handy and at the first sign of slicking, give it a good spray. If the jack is carried on the outside of the vehicle, some method of preventing the mechanism being coated with dust should be devised such as the jack-nappy, a washable nylon sleeve that covers the mechanism.

USING AIR JACKS

The jack and pack technique is the same as with the high-lift jack. The jack and push technique is different. Unlike a high-lift, two people are needed to operate an air jack.

Air bag techniques:

- *The air jack must be slid under the vehicle with none of it protruding. In the field this is often very difficult. If the jack has part of itself protruding it will bend and bulge as it is inflated. This can burst the bag and topple when the vehicle's weight is on it.*
- *Place rubber floor mats between the bag and the vehicle. Be careful of protrusions, stones and thorns puncturing the bag.*
- *Close the valve on the bag.*
- *Insert the inflator into the exhaust pipe and rev the engine.*
- *A vehicle will become very unstable during jacking.*
- *If there is a hole in the exhaust system, pack it away and try something else.*
- *If you just push the vehicle off the jack there is every likelihood that the bag will get punctured. Instead, deflate the bag as the vehicle is pushed.*
- *Over-inflating the bag produces the most hideous bang. It's probably dangerous. The best bags are fitted with pressure release valves.*

USING SAND LADDERS

An experienced driver will call for a sand ladder before too much digging is required. 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 and jacking will be required. Do not dig a little and then attempt to drive out. So often this is a waste of time – if the

MaxTrax are one of the better traction aids available, but they can break, so give some thought as to how you use them. They are not strong enough to be used as a 'bridge'.

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.

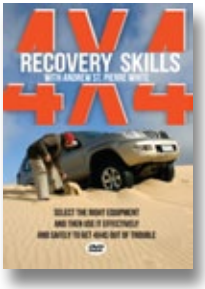
Dig channels in front of the wheels that appear to have the least traction and lie the ladders in front of them. If in doubt as to the wheels under which to lay the ladders, select the front wheels, since once the vehicle gets moving the rear wheels will also get the benefit of the extra traction (assuming 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 too, 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 a spade. 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.

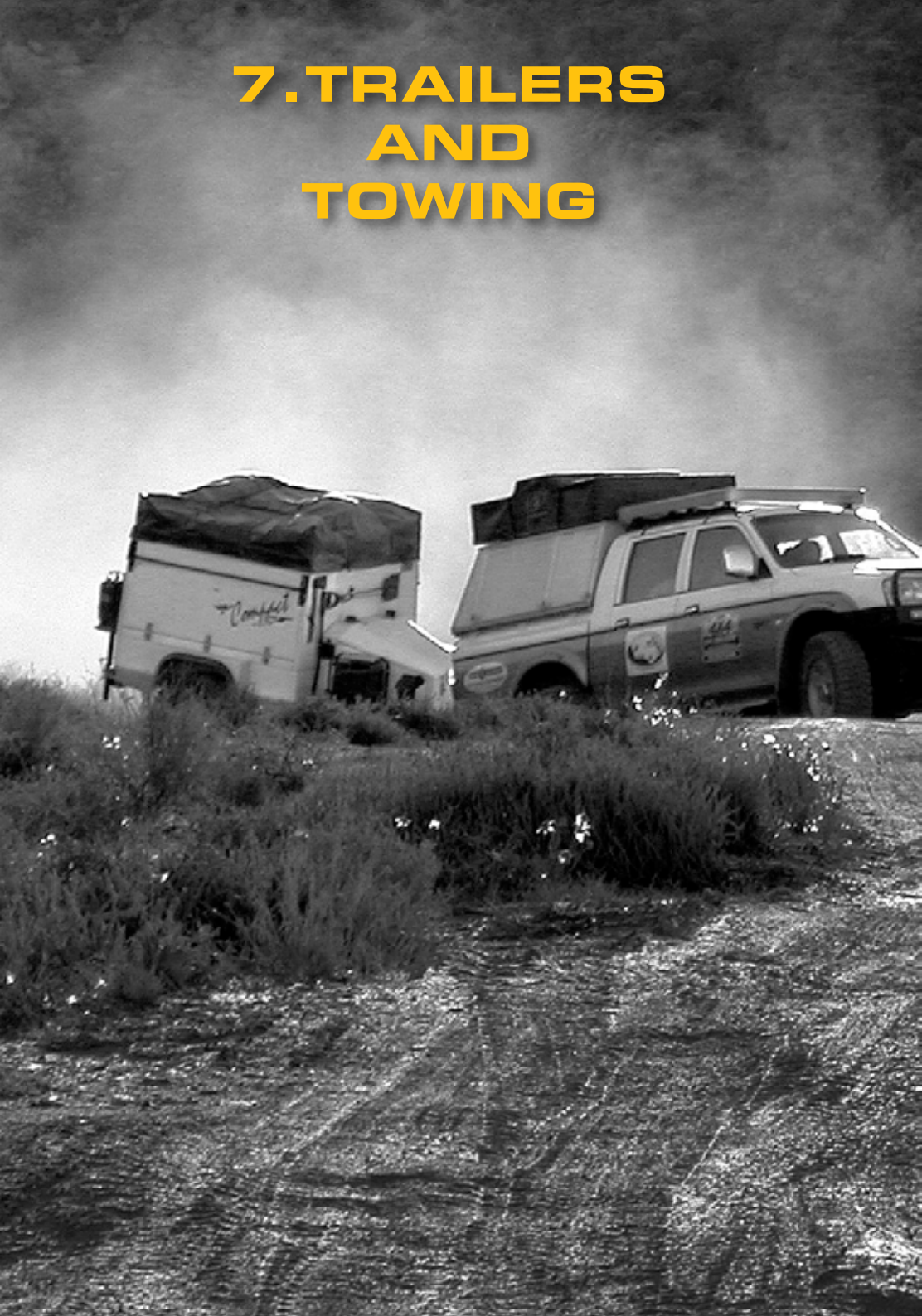
RECOVERY DVD VIDEO

To complement this chapter I have made a one-hour 4x4 Recovery DVD. It covers just about all the elements in this chapter. Video is such a good tool for 4x4 training but off-road, nothing is ever the same each time we go out. This is much in evidence in the video as not all the recovery techniques work first time, even with the 'experts'. Highly entertaining, often funny and highly informative, it will have you glued to your seat. Available from Outdoor Warehouse and wherever 4x4 equipment is sold.

Many of the techniques discussed in this chapter have been captured on video and are available as downloads from www.4xforum.com. Alternatively, the author's DVD, 4x4 Recovery, presents all the video clips, together. This is probably the most comprehensive collection of recovery techniques yet demonstrated on video. Log onto www.4xforum.com to order.



7. TRAILERS AND TOWING



TRAILERS VS ROOF-RACKS

TOWING EQUIPMENT

TRAILER DESIGN

TOWING ON-ROAD

TOWING OFF-ROAD

4XOVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

The step to buying and towing a trailer on outback trips is a big one. Many find success in pulling a trailer while a similar number use a trailer for one trip, get back home and sell it.

While trailers are a practical alternative to roof racks for carrying bulky safari equipment on overland trips, they are also over-used. By this I mean that a trailer offers so much extra space, that the space is often used because it's there, not because it's needed.

The off-road trailer market blossomed in the nineties and at one time there were over 60 off-road trailer manufacturers in South Africa. Today there are 10 major manufacturers.

One of the problems with trailer manufacturers is that because their products are becoming so complex (freezer battery systems, water tanks and plumbing, etc.) the designers have to be experts in so many fields, which most are not. Often the result is a great trailer, built by mechanical engineers, with a poor electrical installation designed by the same engineers who do not know enough about the auxiliary installations. As a result, much of their development is by trial and error, often at the expense of the buyer.

An off-road trailer is not just a trailer with big wheels. Many designs have failed, and the failure has been paid for, first by the user in the middle of the bush with a broken axle, and then the manufacturers who have to pick up the pieces to rebuild their businesses. The most well known example of this was the debacle with Rubex rubber torsion axles. Three manufacturers fitted these axles and found that the axles broke after off-road use, after which they stopped using them. Then along comes a manufacturer entering the off-road trailer market with an off-road caravan. It was fitted with a heavy-duty example of the same axle. Despite warnings they went ahead. Axles broke all over the country. Then my book and some magazines reported the events. We were threatened with lawsuits and some magazines wrote apologies, in my view, changing the truth to lies to appease the complainant.

South Africa has some very good trailers and trailer accessories. Quality is generally very good with only a few poor quality products remaining in the market. This chapter will hopefully assist you in making the decision to either buy or not buy a trailer, or when selecting a trailer choosing one that will be a practical addition to your off-road experience.

TRAILERS VERSUS ROOF RACKS

Off-road trailers must be designed and built to withstand extended outback travel: Sand, mud, rocks, ridges, troughs and axle-cracking corrugations.

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.*
- *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 items 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 is required when driving off-road and reversing.*
- *Trailers 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.*

TOWING EQUIPMENT

Tow hitches

Beware of tow bars fitted by independent fitment centres. Four-wheel drive vehicles often stress their tow bars in excess of what would be considered normal towing operations.

Ideas about tow-bars:

- *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 pull a trailer with a mass of no more than 3500kg. 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.*

TRAILER DESIGN

During the years I have received a great deal of conflicting feedback from many trailer manufacturers over what I have written. Nevertheless I must report it as I see it. These are my opinions and are based on what I have heard through the bush telegraph about trailers; what makes them good, and what breaks when they break. My own experience of trailers amounts to towing large yachts, horse boxes and travelling with people who dote on their trailers. I do not own an off-road trailer and have no desire to. I would rather drive a bigger vehicle or carry less.

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. Rubber torsion bar suspension is not an option, no matter how "heavy-duty" the axles is claimed to be. They all eventually fail in off-road use.

Leaf springs 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, steel tube or heavy channeling, extending all the way to the rear spring shackles. Springs mounted directly onto a stiffened load box are rarely strong enough. Breakages also occur at the joint between the A-frame and the load box and this should be reinforced.

Axle breakages often occur not because the axle is not strong enough but because the mounts aren't. Should the mount slip or break the axles shifts and the wheels no longer run true. This creates a build up of heat in the bearing which eventually ceases. When this occurs the hub shaft snaps from the overload. The failure is due to inadequate strength in the mount and not the axle's ability to carry a load.

Shock absorbers need to be fitted to leaf spring-sprung trailers. I recommend their use for two reasons; shock absorbers reduce bounce and reduce shock loads to the axle. Vertical wheel travel is of little importance in trailer design but the ability of the axle to absorb shock and not bounce is.

Desert Wolf's axle location design is probably the best: A radius arm locating the axle independently from the spring. Nothing, not even spring failure, will cause the axle to run off true.

Tow hitch

The tow hitch is a critical component and badly designed ones break! 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. Light-duty tow hitches welded onto the chassis draw-bar, which is the cheap way to build them, are not strong enough rough roads and many have failed in the bush.

Key to the strength of the draw bar is the trailer coupling. The type seen below attached with high-tensile bolts is recommended. Welded couplings are not strong enough for heavy off-road work.

Wheels and tyres

To improve stability on bush tracks the wheel track should closely match that of 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.

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. Trailer components that seem to deteriorate first are attachments such as hinges and clamps. These should be stainless steel and attached with stainless bolts. When looking at the many South African off-road trailers, most manufacturers have placed rust prevention high on their priority list.

Stability at speed

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. The longer the tow ball to trailer axle distance the easier it will tow in all conditions other than severe off road.

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. 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.

Trailers need to be dust-proof. Some less well-designed trailers are not, which is another reason to select a well respected brand.

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.

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. And what is more, raised jockey wheels have the habit of rattling loose and many have just fallen off, even though they were well tightened.

Echo is one of the pioneers of off-road trailers and build a range of unusual and sometimes highly practical designs. They also build highly customised trailers for their clientele.

Trailer-top racks and tents

A tent on a trailer is a excellent, practical idea because the tent need not be taken down when going on a game drive. The trouble is that unless the trailer has side access doors you are unable to get to the trailer's contents once the tent is erected. A tent does raise the trailer's centre of gravity and those with raised tent platforms tend to be a bit top-heavy.

ECHO 4X4

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.

In Chapter-8, I discuss in detail why it is a bad idea to locate a freezer in a trailer and why it's even a worse idea to fit a battery in a trailer. Briefly, the long cables and trailer connector cannot take the current and the system works at very low efficiency. Freezers

and batteries must remain in the vehicle. However, a series of power points and a fluorescent light fitted inside the lid and connected to the vehicle electrics is very handy.

Consider that the more you fit into your trailer, the heavier it will become and the more difficult it will be to handle in the bush.

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 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 behind it. Consider carefully where the optional extras you choose for your trailer are fitted. Nose-cones storage boxes and boxes on the mudguards are very handy and must be dust-proof and lockable. Jerry can mounts on a trailer must be low down to keep centre-of-gravity 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'.

Are off-road caravans really worth it?

In 2010 and 2011 I was exposed to off-road caravans, trying and testing Jurgen's Safari range. My conclusion is a simple one: I reckon, if you are going to tow a heavyish off road trailer then it might as well be a caravan. For me, trailers are a hassle, more than they are worth. But that's just me. For others, this is definitely not the case. Compared with large off-road trailer tent combinations, a caravan is: easier to set up, more convenient to operate, has most conveniences built in, is far more comfortable and weatherproof and no more of a challenge to tow. Now, when I see complex trailer tent combinations I feel sorry for the owners; a caravan is so very much nicer to own and use. The Jurgens products are well built, cleverly designed and very, very robust. Since this experience I now see off-road caravan owners in a completely different light.

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 the analogies are taken.

TRAILER DYNAMICS

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 exerted by the tyres bringing the trailer behind the vehicle again. Understanding this simple principle 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 as 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.

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.

If you drive through Third World African countries, carrying two warning triangles is required by law. Roadblocks will check this and fines are levied. In some countries,like Mozambique, any vehicle pulling a trailer must wear warning stickers back and front.

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's 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.*
- *Estimate the trailer's C of G at 10 – 20 cms ahead of the axle.*
- *Concentrate heavier articles over the axle thereby reducing inertia.*
- *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.*

TOWING OFF ROAD

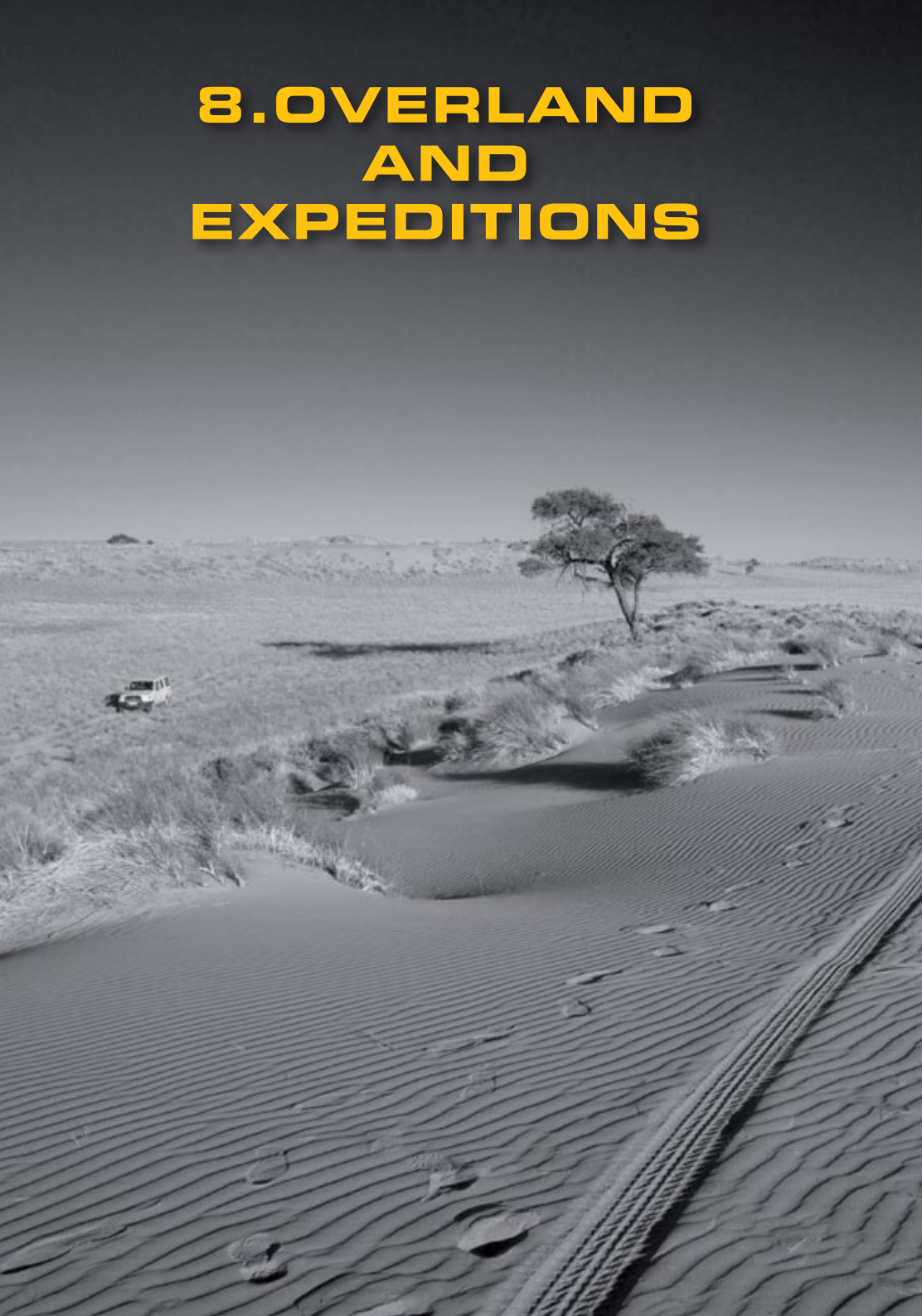
A vehicle's ability on slippery ground is degraded significantly when pulling a trailer. The forces exerted by a trailer off-road are similar to those on-road but are amplified. Instability and control problems can manifest themselves at very low speeds.

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 needs 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.

8. OVERLAND AND EXPEDITIONS



TOO MANY THINGS

VEHICLE PACKING

CAMP REFRIGERATION

SOLAR RECHARGING

CAMP LIGHTING

BUSH CAMPING

WATER AND SURVIVAL

CONSERVATION

CONVERSION TABLES

PACKING LISTS

4XOVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

Primary containers must not be too big so as to make things difficult to load and off load. Popular boxes are Wolff Packs (top), blue trommels (middle). All can be customised to personal needs. Custom made aluminium boxes though expensive will last a lifetime and for delicate articles, nothing beats a Pelican case.

TOO MANY THINGS

In my opinion many outback explorers take too many things with them. Proof is the enormous growth in the number of heavy-duty, high clearance trailers now on the market. These are popular because many people take equipment with them because they can, not because they need to.

When I began my explorations into the wilderness with my parents and brother in 1972, our vehicle had no fridge, a single spare wheel, a fan belt as a spares kit, a small toolbox, four chairs, a small table, some cardboard boxes with food, two fuel cans, two water cans and a huge family tent all packed into a Range Rover - without a trailer or even a roof-rack. It strikes me that the pleasures of the outback include a release of stress: Stress comes with things. Why not leave them at home and instead of spending time with 'things', spend the time doing what the trip is all about in the first place: Enjoying nature and family. Too many things just get in the way.

This chapter is all about the many 'things' that may, or may not, make safari life more convenient. But I would like to see a movement to a more relaxed way of safari; less showing off about the fancy things and more of what is really important.

VEHICLE PACKING

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.

Containers, whether steel, plastic or cloth should have flat sides for ease of packing and lids must be dust-proof. A good example is the Wolff pack or the smaller Gumo boxes. They can be made dust proof with strips of foam stuck into the lids. They are ideal for carrying breakable items such as torches, 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 in the far reaches of the load bay and forgotten.

All containers, especially those made from metal, should be lined with closed-cell high density foam to prevent damage to the contents. Even tools, because of 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 blocks, they MUST be repainted, preferably white. Items such as military heavy-duty canvas bags or tarpaulins should be dyed black or blue.

Tying larger articles down inside the vehicle is also advisable. 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. Tie down rails are the answer.

Top: A roller- drawer system makes a practical base from which to customise the load bay of a station-wagon or double-cab. Bottom: Front Runner makes a unit that is designed to carry traditional storage boxes such as the Wolff-packs, that can be removed - in many ways more practical than fixed drawers.

Ideas

- *A basin has many uses such as bathing, washing clothes and dishes, draining oil and collecting water.*
- *A cast iron pot, or poitjie, 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.*

Above: The AutoGraph4x4 box. Exactly the same size as the Wolff-Pack ammo box but without the horrble clips, wasted space, annoying lids and is lockable, dust-resistant and unbreakable. They cost about twice as much as the Wolf-Pack but lasts many times longer, and increases packing space.

Above left: Not all roof-rack bags are waterproof! So test yours before you go and trust bedding in one. Right: Containers for safari should also consist of what I call, 'convenience containers', those that carry items needed on the road or at a single overnight stop en route. Centre is a brilliant bath bag design by Howling Moon and right, another clever one by Camp-Cover.

- *Make a protective canvas sleeve for the cooking grid and stow it on the roof.*
- *Pots should be designed to fit into one another to save packing space.*
- *Although non-stick frying pans tend to get damaged on safari consider how inexpensive 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.*

Packing Systems

A packing system is one of my favourite accessories. It transforms the inside of a vehicle and is not only great for extended trips; it's great as an everyday practical accessory. The best packing systems are over-engineered because through time and shaking, poorly built units begin to rattle. Roller drawers are also excellent for security as they can be locked. Roller drawers designed for standard boxes such as Wolff packs are also available. They are less expensive but no less practical.

Made from rubber thong and plastic clips, a simple roof net can be constructed and built into pick-ups and station-wagons. It is perfect for the storage of light bulky items such as sleeping bags, blankets and pillows.

Items to help with roadblocks

In some countries in central and east Africa (including Zambia and Tanzania) road-blocks are an unavoidable hazard. Items for low-key bribes are ball-point pens, cigarettes, T-shirts, a pair of plimsoles. Have a few of them visible when approaching road blocks. Soldiers manning road blocks may ask for a smoke. Obliging them aids with negotiations. In the Third World these are often worth more than money and if items are offered as a gift they are less likely to be construed as a bribe.

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 bottles such as

those commonly used for cooking oil quickly develop cracks and the flip top lids pop open, 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 - but make sure they seal first!

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 (In a series-3 Land Rover), 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

As an important safety measure, roof-racks must be considered as light-duty bulky gear carriers and all the heavier equipment should be carried inside the vehicle. This will keep the centre of gravity as low as possible. Heavy roof-racks are dangerous. Keep heavier articles as far forward as you can so as to lessen the load on the rear axle and distribute the weight evenly.

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. Bungee 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. Beware of roof-rack bags as

Roof-racks are meant for carrying lighter bulky loads such as mattresses, chairs and tables. A roof-top tent adds considerable weight, often 35-40kgs on the rack, reducing how many additional items that can be safely carried.

Left: Roof top tents, as a general rule, are as much effort to pitch and pack away as ground tents, but quicker to erect. But there are a few that stand out as very easy to set up and close down. One such is the African Outback Penthouse. I used this one on a 60-day expedition to Namibia, Angola and Botswana in 2010 and it was the envy of all around me.

The world's quickest ground tent is the surely the OZ-Tent. They call it the 30-second tent, but I think this is an exaggeration! It's more like a 27-second tent. There is no doubt that a dedicated bunch of people designed this tent because everything about it is well thought out. It's material is light but not too light, the zips are excellent, the idea is brilliant and make it a pleasure to use and the quality is as good as I have seen in any tent in my life. The only drawback is that it is bulky. I love mine! Bottom: proof that not all tents are made the same. This one was loaned to me for a safari and I struggled with it from day-1 and never managed to get in back into the under-sized bag it came in.

some, believe it or not, are not waterproof! Waterproof ones are ideal for carrying bedding etc, but the others are pretty pointless.

When packing Jerry-cans 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. Purpose made Jerry-can brackets are made for most roof racks and are practical and inexpensive. My last bit of advice on this: Don't overload the roof and regret it when your vehicle rolls!

Roof-Top and Ground Tents

To me 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. Unless it is housed in a hard case, in my view, there is little convenience of a roof-top tent over a ground tent. This includes the perceived convenience of a tent on the roof. When a roof tent is covered by a waterproof polyurethane bag, packing it away can be a tiresome chore and mostly more time consuming than a regular dome tent. It is also quite strenuous to pack away because it is normally done while trying to balance standing on the back tyres, with dust, now mixed with dew making one's clothes very dirty. I've owned two brands and did not keep either. Given the choice, I much prefer using a less cramped, lighter, more convenient ground tent.

However, many people still prefer them, and will face choosing the best. I recommend looking for sturdy construction and ease of packing away. These are by far the most important factors in enjoying this product. Those built with very light poles and lightweight fabric move around a lot in the slightest breeze and in windy conditions, sleeping in it doesn't come easily. This is partly because the tent is held aloft and therefore more susceptible to weather. Manufacturers are trying to make their products lighter but few have succeeded because these light-weight products don't last and they often leak.

Roof tents with rigid housings are far nicer in every respect, other than price. While they can be a little more difficult to get in and out of because of the lip of the case, they are easy to erect and much easier to pack away, which can often be done by just standing on the rear tailgate and pulling them down, folding in the fabric as you go. Not all brands offer this ease of use, and should be avoided as the main advantage over fabric covered tents is missing.

Select the widest tent available. Two smallish people often find roof tents cramped. I find the rigid cased tents more spacious, although actual measurements dispute this. Perhaps its the shape that allows more movement inside. The best fabric-covered roof tents

are Ezi-Awn, Hannibal and Howling Moon. The best rigid tents are Big-Country Outback and Alu-Cab. Hannibal's fibre-glass clam-shell design is a good product, but a little cramped. The Italian Maggiolina tent is light in weight but a bit dark and dingy inside, with insufficient ventilation and not worth its high price tag. There are also some badly designed tents on the market, so ask around before buying.

Before you purchase any 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 it is too small. If the carry bag (ground tent) is tightly packed, it's a guarantee that it will be a huge struggle to return it to its bag, which is the problem with 90% of tents sold today. And then there is the OZ-Tent. If you are tired of the hassle of pitching and packing away your tent, this is the undisputable answer to your prayers.

COMPARISON: ROOF-TOP VERSUS GROUND TENTS	
Roof-top tent	***Ground tent - bow style 3-man***
Secure from wild animals, to a point. A rapid evacuation from the area is not possible.	*Less secure from wild animals although they are not a real danger, more a perceived one.*
Secure from insects and scorpions. Security from mosquitoes depends on tent quality.	*Keeping the flap zipped up is more important. Security from mosquitoes depends on tent quality.*
Even the large ones can only sleep two adults, and even then it's cramped. Leave the bags in the vehicle.	*Tents advertised as 3-man bow tents can easily accommodate three adults and their bags.*
Takes a shorter time to erect, perhaps 20%. Easy to unpack. Some are awkward to pack up and return to its cover. Some are easy.	*Often less effort to pack away, depending on the make.*
Must be collapsed and packed away fully before the vehicle can be moved, for a game drive etc.	*Self-standing. More convenient.*
If the ground is not level, the vehicle can be made level with rocks etc.	*If there is no level ground or it's covered with rocks, too bad!*
You have to be a bit of a contortionist to get dressed and undressed in a roof top tent.	*You can almost stand up.*
If you move around a lot, the vehicle rocks to and fro. Warmer.	*The ground can be very hard and cold.*
The mattress and sleeping bags can be left inside as the tent is folded away, saving space in the vehicle. A huge advantage.	*Tent must be emptied when packed away.*
Heavy. Reduces remaining weight permitted on roof. Lifts the centre of gravity.	*In comparison, lightweight and can be carried anywhere.*

CAMP REFRIGERATION

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. There are three types: Compressor, heat-exchange and thermoelectric cooler.

Compressor fridges

Most compressor freezers run on both 12 and 220-volts. Because they are controlled by an adjustable thermostat, current draw is more efficient because it maintains the fridge and its contents at a constant temperature. The colder the setting, the higher the current consumption both in attaining the desired temperature and maintaining it. Space utilization varies from efficient to down right bulky.

Thermoelectric coolers

Thermoelectric coolers run on the Peltier principle 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 thermoelectric can also be used to warm up food. Apart from a small fan, thermoelectric 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; only running it when the engine is running, drinks that are cool and not cold and no chance of freezing anything. But being a similar price to a regular cool box, they are excellent - keeping cool while inside the vehicle and being portable for a day outing.

Below: Typical of a Peltier system heat-exchange cool-box is the Bush-tec. It's inexpensive and effective as a cooler that should be run only when the car is running. They do not keep drinks as cold as some would like, so ice-blocks should be added if you want your drinks to stay icey.

Heat Exchange Freezers

Powered by LP gas and by 12-volts and 220-volts, heat-exchange fridges are inefficient when run off 12-volts, fairly efficient off 220-volts and highly efficient running on gas or paraffin.

The versatility of power source means that in situations where they remain in one location for a long period when battery charging is not possible or practical, they keep working. In a vehicle they must, for safety reasons, work off 12-volts. However, when in a moving vehicle or trailer under electric power they do lose efficiency and depending on outside influences, may not freeze. When set up in a fixed location they must be levelled, the flame centred, the regulator set and a yearly cleaning. They have no thermostat so when working off 12-volts the current draw, which averages 7-8 amps is not controlled, I.e. it runs 24-hours a day. This makes them hugely inefficient on 12-volts.

SELECTING A COMPRESSOR FRIDGE/FREEZER

Engel, Snomaster, ARB and National Luna currently make the best portable fridge/freezers anywhere. Minus-40 used to make a good product, although they were very bulky, and Weaco still make a fair product but that is inefficient by modern standards, in terms of both insulation and current consumption. There are a few other makes that are appallingly inefficient and don't perform even to their own specifications under real hot, humid conditions inside a vehicle.

My advice is to look for solid word-of-mouth recommendations. Secondly, as mentioned in chapter-3, I believe that it's more about how the current is put back into the battery than how much is taken out.

Because 12-volt compressor freezers are by far the favourite for the 4x4 operator, I will confine my detailed discussions to this type.

Top: Engel 80-litre, a highly efficient fridge/freezer. Middle: Very popular 40-litre Engel. For years Engel made the best camp freezer, but not any more. Now, manufacturers like Snomaster and national Luna make fridge/freezers that are more practical, just as reliable and in many cases, cheaper.

Beware of false current draw claims

It is so easy for freezer manufacturers to claim exceptionally low current consumption for their products and tout theirs as better than the competitor's. This is how it is done, without lying: Make a statement like: Current draw 2,5 amps @ 12 - 24 volts. Such a freezer is likely to draw 3.5 amps @ 12 volts, 2.5 amps @ 18 volts and 2 amps @ 24 volts. Because a healthy, charged battery will operate between 12,5 and 13,8 volts, in this way the figures published look better than they really are when the freezer is used out in the field.

FRIDGE/FREEZER BUYERS' GUIDE

Most of my testing has meant taking each of these freezers on an extended trip where I used them as most buyers would - in the bush. These are impressions and the data has not been gathered using scientific controls. I have scored marks out-of-five indicated by stars.

ENGEL 40L fridge/freezer: ☆ ☆ ☆ ☆ ☆

- *Best current draw ±2,5 amps @ 12.8 volts. Excellent.*
- *±40mm insulation.*
- *Easy to operate single knob for adjustment. Can be knocked, i.e. adjusted accidentally.*
- *Time to freeze from turn-on: I would say extremely fast.*
- *Removable lid.*
- *One large basket with no dividers. (The least practical of all but the Pro-Cool)*
- *No internal light.*
- *Compact and good space utilization. Not as heavy as the Luna.*

- *Excellent record of reliability, spare parts supply and service backup.*
- *Priced average. Excellent quality. Reliable.*

ARB 47L fridge/freezer: ☆ ☆ ☆ ☆

- *Best current draw ±3,3 amps @ 12.8 volts.*
- *±40mm insulation.*
- *Easy to operate electronic keypad. Adjustable cut-off voltage. Cannot be adjusted 'accidentally'. The best control panel of all.*
- *Time to freeze from turn-on: I would say slower than average.*
- *Removable lid.*
- *One large basket with one divider - very practical*
- *Internal LED light.*
- *Compact and good space utilization. Not as heavy as the Engel.*
- *Made by ARB, which means spare parts supply are good.*
- *Priced average. Good quality. 47L capacity.*

NATIONAL LUNA 40L fridge/freezer: ☆ ☆ ☆ ☆ ☆

- *Best current draw ± 3,4 amps @ 12.8 volts.*
- *±60mm insulation. The best next to Snomaster.*
- *A little awkward to adjust settings (Needed to consult book to remind me how to do it) Cannot be readjusted 'accidentally'.*
- *Time to freeze from turn-on: I would say maybe the fastest.*
- *Not only a removable lid, it can be reversed. Nice!*
- *Two baskets. Practical size and shape.*
- *Internal LED light.*
- *Less compact, and heaviest of the five.*
- *Hella-plug external power supply. Nice!*
- *Excellent record of reliability, spare parts supply and service backup. Priced above the others. I am not sure if it warrants the higher price but excellent quality.*

WEACO 40L fridge/freezer: ☆ ☆ ☆

- *Best current draw ±4.0 amps @ 12.8 volts. By far the worst.*
- *±40mm insulation.*
- *Very easy to adjust settings. Unlikely to be readjusted 'accidentally'.*
- *Time to freeze from turn-on: not as fast as the others.*
- *Not only a removable lid, it can be reversed.*
- *One basket with divider. Practical size and shape.*
- *Internal light, cleverly designed and practical.*
- *Most compact; the smallest and by far the lightest of the five.*
- *Weaco has earned itself an excellent reliability record. The least expensive of the five, good value, and made chiefly of plastic so does not feel as well made as the others.*

SNOMASTER 40L fridge/freezer: ☆ ☆ ☆ ☆ ☆

- *Best current draw ±2.8 amps @ 12.8 volts. Excellent.*
- *±60mm insulation. The best next to National Luna..*
- *Very easy to adjust settings. Unlikely to be readjusted 'accidentally'.*
- *Time to freeze from turn-on: I would say in the middle of the group.*
- *No removable lid. LED light.*
- *Two baskets and very practical.*
- *Compact; about the same size as the Nat Luna.*
- *Optional remote temperature indicator is very nice.*
- *Designed in South Africa buy the people who once made National Luna and Engel fridges. Sold by many outdoor shops across the country. Snomaster is I think the best value for money of all 12V fridge/freezers made in South Africa. Excellent value and range!*

Additional ideas when selecting a compressor fridge/freezer:

- *Compact and efficient space utilization because space in a vehicle is always at a premium.*
- *Stainless steel looks better in the shop but deteriorates rapidly and before long looks shabby in the vehicle. Stainless steel is a particularly poor insulator so a stainless fridge will be less efficient.*
- *Buy new. Old designs are far less efficient as new technologies have improved designs significantly over the past five years.*
- *In the confines of a vehicle, a removable lid is a real bonus.*
- *Internal lighting is nice but not essential.*
- *Low-voltage cut-out is essential and 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. To prevent damage to the fridge, it must be secured.*
- *A slide out tray, on which to bolt the freezer, is really worthwhile.*

Setting up

Poor current flow caused by a combination of cheap connectors and thin cabling is the most common cause of problems with freezer installations. When the compressor starts up, the current draw, albeit only for a second or two, can soar to 15 amps. Use the best quality connectors you can find.

When calculating the cable core thickness required, divide the length by 1000. E.g., if the cable length is 3 metres (3000mm) then the minimum cable core thickness is 3mm and if the length is 4 metres then 4mm cable is required, and so on. This will ensure adequate current flow along the length of cable, no matter how long it is.

Having an electric freezer mounted in a trailer can cause big problems and is often inpractical. The current loss along the long distance renders it inefficient, unless powered through a separate heavy duty cable and connector. A battery in the tralier is an even worse idea. For the same reason it can't receive a full charge and, when the vehicle is taken for a game drive, the battery cannot reap the charging benefits of the engine running, unless everything is packed away and the trailer hitched on. And, worse, if you fancy a nice cold drink on a game drive... they're back at camp!

RUNNING VEHICLE FRIDGES

To prevent over-discharge of the vehicle's battery when the freezer runs at night it is essential to have a second battery and a charging system to split the two batteries. See chapter-3.

Calculating electric current draw

Because compressor fridges are thermostat controlled, current draw is as much dependent on the thermostat setting, quality of insulation, outside temperature and how frequently the fridge is opened as it is on the compressor installed and the electronics governing them. The quality of the cables and fittings also has a marked affect on fridge performance and current draw.

Preparation: (particularly important for heat-exchange types)

- *Do not remove the special heat-sensitive fuse on Engel Freezers.*
- *If practical, cool down everything in your household fridge before packing the vehicle freezer.*
- *Remove the plastic cling wrap around canned beverages, as the plastic will inhibit air flow and reduce cooling efficiency.*
- *Liquid is better stored in metal containers than plastic.*
- *Over-filling the freezer will have a detrimental effect on efficiency.*
- *Keep the lid tightly closed to prevent air escaping. An air-tight lid has a huge affect on fridge performance.*
- *By keeping the amount of time the freezer is opened limited, the freezer will consume less current and the contents have a better chance of remaining frozen.*

I do not advise fitting freezers or batteries in a trailer because:

- *Current loss occurs along the long cable and plug.*
- *If a battery is in the trailer do not charge it via the tow hitch electrical socket. A separate socket with a minimum of 6mm core cable is needed or the battery will never receive a proper charge.*
- *When you go on a game drive the battery will not be recharged, wasting valuable engine charging time.*
- *The contents of a trailer are shaken about far more than those in a vehicle. Freezers that ride in trailers over long periods can suffer ruptured piping due to vibration.*

A multi-tool is a real friend around the camp. I have used and owned several. and my favorite by far is my Leatherman Wave. But cheap multi-tools are just not worth it. My advice: Don't waste your money on a cheap multi-tool. If you have a limited budget and can't afford a good multi-tool, get a small Swiss Army Knife.

SOLAR RECHARGING

There have been significant advancements in solar technology in the past ten years and at last solar recharging is a practical and non cost-prohibitive method of charging batteries in the bush.

The reason solar has earned a bad reputation is because so many products are sold that simply do not live up to the claims made by those who sell them and the ignorant buyer who gets taken for a ride.

My experience with solar power began in 1991 when I wrote my first book while living in the Okavango.

Consider the following:

- *Do you want a solar system to lengthen your stay in a camping spot without having to start the engine to charge the batteries?*
- *Do you want to add 25% on your time there, double your time or stay indefinitely?*
- *If you want to add 25% to your time, you need to supplement 25% of your power consumption.*
- *If you want to double your time there, then you require a minimum of 50% of the current drawn to be replaced.*
- *If you want to stay indefinitely, then your solar system must recover more than 100% of the current drawn.*

A simple exercise

For example if you are running a 40-litre Engel and two lights, you need to measure the average current consumption over a 24 hour period. If that's too much stress to measure then try this: How long can you stay at one place without charging batteries? Let's say it's three days drawing current from one, 100 amp battery. This means that over one day 33,3 amps is consumed (100 divided by three days). To add one more day you need to add 33,3 amps to the battery and you must do it within three days.

Let's say you want to double your stay. If your consumption is 33,3 amps per day, then you must put back half of that, 16.65 amps in each 24-hour period. In effect you are halving the current consumption and doubling your stay. In the same way, if you want to stay indefinitely your system must replace 101% of the current drawn – a little over 33,3 amps each 24-hours.

The solar experts will probably baulk at this and what I am about to write, because it is too simplistic. I say, 'So what!'. It's my experience that solar experts are the opposite – too technical and often make claims that are relevant in the laboratory but are meaningless to 4x4 drivers like you and I who are looking for a simple solution to a technical problem. They may say, 'There is no simple solution'. Nonsense.

Outrageous claims

Let's take a 60-watt cell. This is a common medium-sized solar panel. 60-watts means that at the point that the sun is at its highest, and at the moment when it is shining directly at the panel it will, on a good day, when the panel is brand new, produce 60-watts, if you're lucky. 60-watts translates into 5-amps at 12-volts. The time that panel will

It's one thing to know what voltage your battery is currently at, but another to know what state your electrical system is in. The Batman battery monitor displays current, capacity used and voltage. It is more of a battery management system that just a meter..

spend delivering 5-amps, if it gets there at all is probably, on average, never. It will more than likely top out at 4,5 amps. All the other time the current delivered will be less, far less.

The angle at which the sun strikes a panel reduces the output current significantly, even if it's just a couple of degrees. So, a 60-watt panel is actually a 28.5-watt panel. Why? With eight hours of sunlight, the first and last two hours the oblique angle means that the panel is only running at an average of 15 watts. That means that for four hours out of the eight it produces just 1.25 amps-per-hour, a total of 5 amps. For the other four hours it produces an average of 3.5 amps per hour, totalling 14 amps. Add this to the 5 amps and the panel is producing 19 amps. That means that with just one 60 watt panel, that delivers 228 watts. Over the eight hours of sunlight the panel delivers 28.5 watts, replacing over half of the current I use over a 24-hour period.
So you see with this example based on what happens at my campsite on a sunny day, this surely gives you comfort that with a simple solar set-up such as I have, solar recharging is possible without spending a fortune. Fact is that I have worked a 60-watt Solarex crystalline panel for over twelve years and have had much joy and success with it.

Types of solar panels

Solar experts will talk about crystalline and amorphous panels and the advantages of both as well as voltage regulators and other devices. I will leave the details of these to them. For most 4x4 users this is not of any real consequence. What does matter is the amount of current they will generate in the environment in which we play and the cost-per watt.

Strapped to a roof rack, placed on the ground, leaned against a tree or bush with a few wires run down to a regulator and onto the battery system. As long as the meat stays frozen and the drinks are icy, that's all that really matters. My advice: Keep it simple.

Flexible solar panels are more robust that the rigid types but are generally about 20% less efficient..

Solar panels and their performance claims:

- *Look for panels with good low-light claims.*
- *Ratings must be measured above 13,8-volts. Some panels boasting high yields boost their figures by lowering the voltage to 12-volts or lower. Don't be fooled; a 12-volt battery at 12-volts is a flat battery! A healthy battery under load should never fall below 12-volts.*
- *Look at the ratio of current per cost. E.g. For every unit of currency spent I get X units of current (amps or watts).*

- *Beware of cheap Chinese trash. So many badly made panels stop working soon after delivery as they are unable to take the vibrations from being mounted on a vehicle. They are also far less efficient.*

Solar panels come in rigid and flexible types. Flexible units are more robust and practical for 4x4 use, but they are costly and inefficient for their size. Rigid panels are almost twice as efficient size for size, but are bulky and must be loaded flat on a roof rack and tied down very firmly. If they flex, even a little bit, they will break.

Fitting solar panels:

- *Forget about making fancy mounts so that the panel can slide out from a rack or trailer because the angle at which the sun strikes a panel reduces the output current significantly. 'Clever' mounts are not clever at all, because a vehicle or trailer cannot be easily moved to follow the sun. Rather have the panel/s loose, so that they can be leaned against a chair or tent, and then moved from time to time to keep them perpendicular to the moving sun.*
- *Electric cables must be heavy copper. Hand joins, bad connectors and thin cables will severely reduce efficiency. This is VERY important. This may not seem necessary because amperage is low, but it seems as if solar systems are very sensitive to this, probably because of the long distances from panel to battery.*
- *Advanced electronics available to help the solar panel deliver more current more efficiently are a nice to have but not a must have. For years I have run heavy cable from the panel, via a diode, to the battery. I can measure the battery voltage and can measure the current the panel is delivering. Without fancy electronics I achieve much. With electronics I can achieve more, but do I really want it?*
- *It is better to spend the money on heavy cables and the best connectors one can find.*
- *If the solar system has the potential to over-charge the batteries, a regulator is essential. Should you choose the simplest set-up, disconnect the panels at night or fit a diode in the circuit to prevent reverse flow during the hours of darkness.*

I have developed a plug-and-play solar charging system especially for use by the 4x4 explorer, based on flexible panels. Details can be found on www.4xforum.com. Look for the solar section.

Top: Paraffin lanterns are great if you enjoy fiddling around the camp, otherwise they have been superceded by far more practical, but less fun lanterns powered by batteries. Fluorescent lights are quiet and do not consume much electrical current, but are not nearly as efficient as LED. Below: Ultratech LED lantern on a clever tree-hanging clamp.

GENERAL LIGHTING

Lighting a campsite is a matter of personal preference as well as practicality. The two major considerations are the fuel to power each lamp and the likely location requirements.

Fluorescent and LED lamps:

- *Fluorescent lamps that run off the vehicle's battery consume ± 1-amp of current. If also running a freezer, electric current may be at a premium.*
- *LED lights consume about one-tenth the current of a fluorescent for the equivalent brightness. Incandescent bulbs are the least efficient.*
- *Location is limited as they are always connected to the vehicle or trailer via a cable.*
- *Ideal for locations that never change, i.e trailer lid, tent interior etc.*

Rechargeable lanterns:

- *Portable and practical because they can be recharged when the vehicle is back on the road and therefore does not drain unnecessary current from the vehicle battery while in camp.*
- *The gel batteries tend to stop working after about 50 charges. This is due mainly to the poorly designed and cheap charging circuits built into the average lantern. It is sometimes no more expensive to buy a new lantern than replace the battery.*
- *LED lanterns offer as much illumination, more reliability and with far less current draw. They are no more expensive.*

Above: LED-Lenser, variable-lens LED torches are the most practical torches I can think of.

Liquid fuel lanterns:

- *Nice to play with, very bright and fuel efficient, but noisy.*
- *Break easily and corrugated roads can shake them to pieces.*
- *Independent fuel source means that an additional fuel needs to be taken along.*
- *Provides a more orange light, which means that it has a lesser effect on the eye's ability to compensate to darkness when the light is extinguished.*
- *Can run for 8-hours (Coleman Kerosene) non stop.*
- *Dirty fuel can render them useless or at the least, troublesome.*

Candles: (Bush-Lite)

- *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

For years the only really good torch was a Mag-Lite. Now dozens of torch makers have copied Mag-Lite's philosophy; to build high performance professional flashlights for everyone. Many, if not most out-perform the Mag-Lite in terms of brightness and shape of beam although I have yet to find one to match Mag-Lite in terms of ruggedness.

I love torches and have collected them for years. I began collecting in 1985 when I bought my first Mini Mag-Lite when in New York City. I now have six Maglites, including their latest 3-D-cell LED; but now, I never use them. This is because there are so many better torches available. Take the new kid on the block: LED-Lenser. Taking full advantage of LED technology, LED-lenser has added the concept that a torch need not have a fixed focal beam. From their regular hand torches to their astounding head-lamps, all have a variable focus reflector. This is how a very bright and efficient torch can work as a general tool around the camp, with a broad, flat beam and the next moment a powerful searchlight. Their head-lamps are truly amazing. The one I now use regularly has a variable zoom and a variable lamp. I can turn it down and dimly light my food while enjoying a meal at a camp fire, and then at full brightness, it's almost as bright as a 3-D Cell Maglite brute. Truly amazing. During the LED revolution, Maglite, once the king of torches, appeared to have rested on their laurels for so long their offerings were pathetic in terms of price and performance. Strangely though, with their latest offerings, they have quite obviously fallen dead asleep and are about five years behind the competition. And yet they still sell well. I can't imagine why.

LED technology has come so far, that now the brightest and by far the most efficient search lights are LED. A fine example is the Led-Lenser X21. It's like the search-lights they used in London in WW2, but you can hold it in your hand.

LED lighting is a revolution in lighting for all applications, particularly for outdoor people, because it is so efficient. Top: Two Lumeno LED work lights for vehicles. Bottom: LED strips come in all sizes and are perfect for inside tents and under awnings.

My favourite boiler is the MSR Reactor. It boils two cups of water in about 30 seconds!

CAMP COOKING

Camp cooking ideas:

- *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.*
- *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.*
- *Camp baking can be done in steel bread ovens or in cast-iron pots. Build the fire in a shallow hollow on a flat rock. Before cooking remove the coals from the rock and position the pot on the rock, placing hot coals around, without too many of them touching the pot. Then place a few hot coals on the lid.*
- *Never cook inside a tent as it is extremely dangerous. Leaking gasses cannot escape and because most tent zips are plastic, if there is a fire, the zips melt together and occupants can't escape! And some stoves emit carbon monoxide, a odorless highly poisonous gas.*

Lighting fires with wet wood

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.

Compact gas canisters fitting with similarly compact stoves like this Kovea are for me better suited to overland journeys than large appliances fitted to large, heavy gas bottles.

Keeping warm at night

If you don't have a hot water bottle take a rounded rock, about 25cms 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 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. However, do not rely on finding suitable rocks in desert and semi-desert regions. Parts of the Kalahari, for example, are completely without rocks.

Sleeping inside the vehicle

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 gaining access.

Sleeping on the vehicle's roof-rack, 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. Still my preferred way of sleeping in the bush is in the open on a roof-rack – 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 helps a bit. (Inadvisable in malaria regions.)

A plastic folding basin - a brilliant idea for saving space.

Awnings

Awnings permanently attached to the side of a vehicle are what I call 'instant' awnings. They are a convenient way of creating shade in an instant. If you, like me, like to stop on a lonely road, drink something icy and simply stare at the surroundings during a break for lunch, then an instant awning is a real luxury. They come in the less expensive roll-up variety, in an enclosed tube like the Ezi-Awn and leg-less designs from Hannibal, LA Sport and African Outback. When selecting one, a 270-degree sweep of shade is many, many times more useful than those that just protrude from one side of the vehicle or trailer.

Top: Cooking grids are dirty and difficult to pack. Look for ones with fold-away handles.

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 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 unsuccessful attempt to put out the blaze, they were left without food, clothes and water with a 70-kilometer 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, Mercedes Geländewagen and a Nissan Sani and Patrol that have been lost in this way. Every vehicle must carry their own, easy-to-reach, fire extinguisher.

Axes, pagas and saws - the choice is tricky. I find a good panga is far more useful than a hand axe. And a light saw just as useful. I carry these two: a Silky Nata panga is brilliantly balanced and makes light work of even thick branches and firewood. And a Silky Zubat hand saw, which because of its blade design, tears through green wood with ease. Unilike cheap saws it doesn't jamb in wet wood.

Fire Extinguisher ideas:

- *Dry powder extinguishers are suitable for vehicle fire applications. Carry one of at least 2kg.*
- *CO2 Extinguishers are more potent and heavier. They can also be used for pumping tyres.*
- *Neglecting and failing to service fire extinguishers is common. Let's not be caught napping with a fire that destroys our vehicle.*

Insect repellents

Insect repellents come in many different forms. 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. 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. Mozi Wipes, wet-wipes impregnated with repellent, work very well.

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 effective and if worn around the ankles would also be very effective against ticks.

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,

Ideas for handling refuse:

- *Use paper plates and burn them in the camp fire.*
- *Do not burn plastic – it melts down but still constitutes litter. Put the small bits into cans, burn them and then toss them into the refuse bag, Burnt tins don't smell.*
- *Use bleach-free toilet paper and if possible burn it before burying it. Dig a hole as deep as possible – at least 30 cms.*
- *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.*

Collapsable camping bins made for campers. The day I take a dust bin camping - please shoot me!

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 dependant on colour, since most animals are colour-blind. Interrupted patterns that break up the human shape work best. Even bright blue 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 wind cheater.

Footwear

If you intend to walk, wear boots or sports shoes. Sandals and flip-flops are inadequate as they allow grass to cut the feet and are no protection against biting insects or snakes. At night, any closed show is 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.

Don't forget a good first aid kit.

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 plus codeine for stronger analgesia.*
- *Rehydration powder or tablets.*
- *Scissors.*
- *Sling and splints.*
- *Sticking plaster and wound closure strips.*
- *Thermometer.*

First-aid and snake bite kits

The value of a snake bite kit in the bush is questionable. Seldom is the small amount of anti-venom carried in a kit sufficient to help the patient in any significant way. More importantly, due to the toxicity of anti-venom, 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 often occur.

Outdoor Warehouse has developed an excellent first-aid kit designed for the 4x4 outback explorer. Pretty complete and well conceived, it should handle most eventualities while far from home.

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 reducing swelling.

Water and fuel cans are useful for many things around the camp. I prefer metal cans for water as , put next to the fire, they can be used as a simple but efficient hot water system.

Phutsi (Bot) 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 much worse.

Cooking equipment that fits into one another is a typical way where lots of space can be saved.

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.

Never carry all of your water in one container. If it should break, all your water will be gone. Ideally there should be a tank for drinking

Camp comode. This idea was born when I made a video and a friend, almost jokingly, explained how he had converted an ordinary camp chair into a comode. Someone saw the video and developed the product.

If anybody in your family or group has a problem with privacy when using the toilet or washing in the bush then purpose made cubicles such as this one are available.

water, and another for 'grey' water - that which is collected from unclean sources, that can be used for washing or showering.

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 or blue 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.

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.

It's a good idea to keep water in blue cans and fuel in yellow, green or red. Plastic makes the best material to carry water as it rarely causes an unpleasant taste. Don't carry fuel in plastic cans: You may get them mixed up.

Water storage and health

There are serious health risks associated with aluminium water tanks and while aluminium is an ideal material from which to build a tank, the health risks are severe. I understand that some plastics are also risky. Tanks should be built from stainless steel (high-grade) or food-grade plastic.

In tests that I conducted to see how long water can be stored before it goes green or becomes contaminated, these are my findings: In dark containers even bore-hole water (no chemicals) did not grow algae in six months. In containers where light can penetrate, in six months the water was still drinkable but there was a 'green' taste. Purified tap water after a year in a dark drum, was still drinkable. I flush my tanks a week or so before a trip and then refill with fresh water before I leave. I have never had any algae growing in any tank or can, light or dark, on any trip, even the longest.

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. 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. But by far the simplest and most reliable option is to full some Jerry cans with water and place them next to a large fire. It usually takes about 30 minutes for the water to become piping hot. Then a small submersible shower pump is used.

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, or the rougher the road, the cleaner your washing will be. The bucket is also useful for many other camp duties.

Sound Systems and Overlanders

Nothing in this whole wide world frustrates me more than having to endure the music of other campers when camped in a remote spot. Many years ago it was easy to find absolute solitude, but because of the plethora of 4x4s available today, it has become increasingly difficult. This means that finding a camp where no other people can be seen is difficult, but to find a place where no other people can be heard is even more difficult. It beats me as to why after all the trouble to get to a remote area, many visitors immediately turn on their radios. Surely the idea of this is to leave the city noise behind? May I suggest trying to live without music, play-stations, MP3 players and TV! Try it. The sounds of mother nature may not be as loud, but they are so much more life-affirming. And please, please, be sensitive to the wishes of others.

Heating water can be done cheaply by placing a steel Jerry can next to and down-wind of the camp fire. As long as the fire is a reasonable size, the water heats up very quickly. Another option, sometimes inconvenient during days that are spent travelling, is the solar heated camp shower. I feel that expensive and sometimes complex gas water heating systems are more trouble than they are worth. Bottom: Solar shower ready for use.

WATER PURIFICATION

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 separate. This sediment can be removed by pouring the water through a cloth strainer. No

While small, holding shovels are nice to have around the camp, they cannot double as a recovery tool as they are too small.

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.

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.

Top: Front Runner alloy prep table can be fitted to any flat-sided vehicle or trailer. Bottom: I made a similar table and attached it to the side of my Land Cruiser loadbay. It became a useful place to make a roadside meal or boil a cuppa tea in camp. My one was made of plywood with an aluminium frame.

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. There are many makes of filter pumps now being used as standard issue to the Red Cross throughout the world.

Filter pumps work 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. 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.

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.

Boiling water will kill many, but not all of the bugs in water that could make you or your family ill. Because there are many hardy viruses that will not be killed, additional purification methods should be used, especially if the water is taken from areas close to human habitation. If boiling is the only method used it is vital that the water be boiled for a minimum of 12 minutes.

Snake-Repel. I have no idea if it works - because if you think about it - how do you tell? Snakes aren't a bit threat to the overlander, although they can make life difficult if they are about.

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 antagonize 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 puff adder 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.*
- *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.*

Camping in areas where cattle roam will mean that tanpan ticks are lying in wait for cattle in search of shade as well as unwitting campers wanting to stay a while.

- *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. If a snake has made a home there it will have nowhere to run 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.*
- *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

Overlanding is a great time to discover a new passion. For me it was in 2008 when I discovered the awesome experience of having a really good telescope that actually finds planets, nebulae and star systems. This Celestron telescope is both powerful and portable.

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. Ticks called tampans 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. Avoid setting up camp under trees in cattle areas. These ticks can emerge from the ground in their hundreds!

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, although some of the better image-stabilizers can cope with some movement. 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.

In developing countries never photograph government buildings or employees and it's a bad idea to 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.

Above: Lumeno movement-sensitive security light for campers.

If you shoot digital, remember to add to your packing lists, items like camera battery chargers and spare memory cards. An updated and I think useful and complete packing list appears at the end of this chapter. Feel free to copy it and use it on your travels.

Maps

Choosing maps for navigation in remote areas requires some understanding and know-how. This is covered in Chapter-10.

Security

Water tanks and Jerry cans 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 Jerry cans 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 or have a shut-off valve inside the vehicle, especially in desert regions.

Security lighting around a camp in an area where unwelcome animals or people should be considered. Movement-sensitive LED strips are now available and can be placed at strategic places around the camp.

4x4 Overlanding and Overland Workshop DVDs are part of a series TV shows and covers the topic of successful overland expeditions, presented by the author. Find them on www.4xforum.com

INSURANCE

Many vehicle insurance companies do not understand the 4x4 lifestyle and as a result frequently do not properly cover vehicles and their owners when the vehicle is used off-road or in the wilderness. Conversely, 4x4 drivers either think that no matter what they do, their insurance will cover them, or that their insurer should know what the risks are and therefore will cover them. Either way, it is not uncommon for the insured to be shocked when a claim is rejected because the conduct by the insured is considered 'unreasonable' by the insurer. But what is unreasonable? I cannot answer this, but some of the pictures left illustrate what I would consider unreasonable. For example, sliding and hitting a tree while attempting a 30° angle on an off-road trail isn't. If your insurer is not aware that a 30° slope (to a novice a slope such as this is frightening) on a trail is just part of the excitement and thrill of 'normal' 4x4 driving, it may be considered 'unreasonable'. For this reason, specialised 4x4 insurance is as important as any equipment that you may purchase for your vehicle.

Make sure you are properly covered for your 4x4 activities, whether it be on a local 4x4 event or a safari to another country. An insurance product developed in conjunction with the author is available, covering all conceivable eventualities, even including repatriation of persons and vehicles from foreign countries.

PHOTOGRAHS CROSS COUNTRY INSURANCE

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 crisscrossing 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 to give names, but in one case, an individual 4x4 tour guide and outspoken champion of eco-friendly practices 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 South Africa's beaches have been closed! Surely more restrictions will follow?

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*

In 1991 one third of the entire Okavango grasslands were burnt as a result of careless tourist's camp fire.

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

- *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 take wood from a live tree, make a fire 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.*

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 of some off-roaders who 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. There are plenty of trails and obstacle courses where this can be done without damage to the environment, without creating a mess that following vehicles are unable to traverse and without offending anyone. Let's please be responsible for what we do with our 4x4s.

Once I was driving on a large dune field, ideal for experimenting with vehicles, tyre pressures and driving techniques. It was operated by experienced off-roaders who should know better. I was at the head of a group of novice drivers. 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. Amazingly, 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 should never mix. Unfortunately, I feel as I write this, that my words will be like a grasshopper trying to persuade an elephant 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 it as it ring-barks the tree and kills it.*
- *Look around the site of a recovery for spades, shackles and drink cans lying hidden in the bush.*

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 jerry-can)*
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

TEMPERATURE:

To convert celsius to fahrenheit – double it, subtract 10% and add 32.

PRESSURES:

Kg/cm2 and PSI from 0.5 to 3.4 kg/ cm2
LPM (litres per min) – CFM (cubic ft per min)

FUEL CONSUMPTION:

Miles/gal	km/lit	lit/100 km	Miles/gal	km/lit	Lit/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

PACKING LIST

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*	❒❒
Poitjie	❒❒	*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*	❒❒
Aluminium foil	❒❒	*Cling wrap*	❒❒
.....	❒❒	.....	❒❒

CLEANING

Dust pan & brush	❒❒	*Bucket and lid*	❒❒
Basin	❒❒	*Dish washing liquid*	❒❒
Dish cloths	❒❒	*Dish towels*	❒❒
Scouring sponges	❒❒	*Bottle brush*	❒❒
Sink plug	❒❒	*Wet-wipes*	❒❒

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*	❒❒
Tupperware jug & lid	❒❒	*Tupperware bowl*	❒❒
Plastic containers & lids	❒❒	*Thermos flask*	❒❒
.....	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

MEDICAL

Antibiotics (infection)	❒❒	*Antibiotic cream*	❒❒
Antipyretics (fever)	❒❒	*Antiseptics*	❒❒
Anti-inflammatories	❒❒	*Analgesics (pain)*	❒❒
Anti-emetics (vomiting)	❒❒	*Bandages*	❒❒
Cortisone cream	❒❒	*Eye drops*	❒❒
Interflora	❒❒	*Plasters*	❒❒
Medical bag/box	❒❒	*Malaria prophylaxis*	❒❒
Mosquito repellent	❒❒	*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 books*	❒❒
Workshop manual	❒❒	.....	❒❒

CAMP

Shovel	❒❒	*Axe/panga*	❒❒
Water containers	❒❒	*Clothes pegs*	❒❒
Fire extinguisher	❒❒	*Chairs – adult*	❒❒
Table – catering	❒❒	*Chairs – children*	❒❒
Table – other	❒❒	*Table cloths*	❒❒
Shade cloth	❒❒	*Taupaulin*	❒❒
Catapult	❒❒	*Pen knife/Leatherman*	❒❒
Multitool	❒❒	*Bin bags (black)*	❒❒
Newspaper	❒❒	*Solar shower*	❒❒
Coolbag	❒❒	*Coolbox*	❒❒
Ice bricks	❒❒	*Freezer/Fridge*	❒❒
Wood saw	❒❒	.....	❒❒

CHILDREN

Games and toys	❒❒	*Stationery & 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.*	❒❒

Contraceptives/condoms	❒❒	*Moisturiser*	❒❒
Towels	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

DOCUMENTS & MAPS

Passports	❒❒	*ID book/drivers license*	❒❒
Visas and permits	❒❒	*Travellers cheques*	❒❒
Cash	❒❒	*Credit cards*	❒❒
Trailer registration	❒❒	*Triptique*	❒❒
Vehicle registration	❒❒	*Booking receipts*	❒❒
Cheque book	❒❒	*Trailer registration*	❒❒
InfoMaps	❒❒	*AA 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	❒❒	*Corn 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*	❒❒
Concentrate	❒❒	.....	❒❒

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	❒❒	.....	❒❒
.....	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

CLOTHES

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*	❒❒
Protractor and ruler	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

VEHICLE MAINTENANCE

Tool box	❒❒	*Funnel/syphon hose*	❒❒
Tyre pump/s	❒❒	*Tyre repair kit*	❒❒
Spare inner tube	❒❒	*Spark plugs*	❒❒
Workshop repair manual	❒❒	*Globes*	❒❒
Second spare wheel	❒❒	*Fan belt/s*	❒❒
Engine oil	❒❒	*Fuses*	❒❒
Q-20 or equivalent	❒❒	*Jerry-cans*	❒❒
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*	❒❒
Jump cables	❒❒	*Fuel filter*	❒❒
Engine oil	❒❒	*Warning triangles*	❒❒
Auto transmission fluid	❒❒	.....	❒❒
Abrasive paper	❒❒	.....	❒❒
Various electric connectors	❒❒	.....	❒❒
.....	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

Photographic safari list:

Camera body/s	❒❒	*Wide-angle lens*	❒❒
Film/Memory cards	❒❒	*Std./zoom/tele lenses*	❒❒
Telephoto lens	❒❒	*Lens brush*	❒❒
Plastic bags	❒❒	*Close-up attachments*	❒❒
Tripod/monopod	❒❒	*Flash gun*	❒❒
Compressed air	❒❒	*Flash batteries*	❒❒
Camera batteries	❒❒	*Lens tissue*	❒❒
Digital camera	❒❒	*Laptop*	❒❒
Blank CDs/media	❒❒	*USB camera connection*	❒❒
Camera battery charger	❒❒	*Lens brush*	❒❒
Bush bag/sand bag	❒❒	*Binoculars*	❒❒
Spotting scope	❒❒	*Video camera*	❒❒
Video tapes/DVDs	❒❒	*Video camera battery*	❒❒
Video camera charger	❒❒	.....	❒❒
.....	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

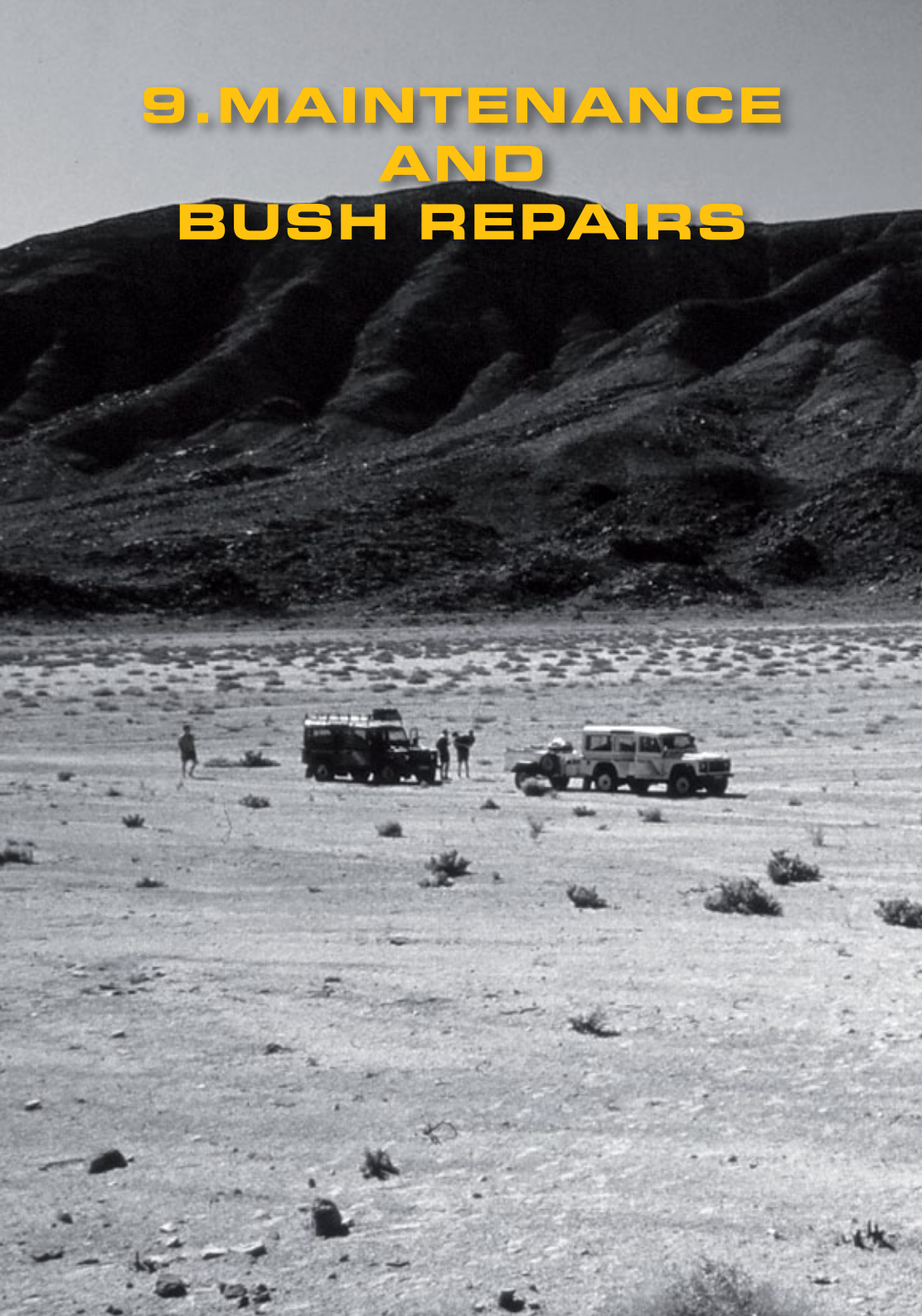
BEFORE GOING AWAY

Cancel deliveries	❒	*Disengage immobiliser*	❒
Turn off geyser/s	❒	*Inform next of kin*	❒
Fish, plants and animals	❒	*Domestic workers*	❒
Engage night time-switches	❒	*Inform security*	❒
.....	❒❒	.....	❒❒
.....	❒❒	.....	❒❒

Camera and valuables – serial nos.

VEHICLE REG. no. .....
Chassis no. .....
Engine no .....
TRAILER .....
REG. no. .....
.....
.....

9. MAINTENANCE AND BUSH REPAIRS



MAINTENANCE

BREAKDOWNS

FUEL

4XOVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

FOLLOWING YOUR VEHICLE manufacturer's service handbook recommendations when doing maintenance will get you going in the right direction. Get yourself a good workshop repair manual and carry it in the vehicle particularly when on an outback trail. This chapter gives advice on proper maintenance guidelines and how to avoid common mistakes as well as remedies for common vehicle breakdowns far from home.

MAINTENANCE

VEHICLE LUBRICANTS

Engine oils

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.

Transmission oils

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 synchronizers in main gearboxes and should not be used as the additive is so effective that it negates the friction required for synchronizers to synchronize 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 kilometers . 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 kilometers 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 engine. Buy the best.

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 South Africa than elsewhere because of the very poor quality of most diesel fuel sold here. Atmospheric dust is also a contributor. If you operate 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, even if the manufacturers recommend less frequent changes.

BREAKDOWNS

Most breakdowns in the bush can be handled with a good tool set and spares such as fan belts, 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 carburetor is the first component to be accused as the villain and stripped only to find that it is not at fault. Once the carburetor 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*
- *Galvanized wire*
- *Radiator cap*
- *Quick set epoxy glue*
- *Five liters 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/Blue Tack*
- *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*
- *Set of sockets*
- *Power bar for sockets*
- *Tyre pressure gauge*
- *Hacksaw*
- *Sharp nose pliers*
- *Wire cutters*
- *Feeler gauge*
- *Impact wrench*

I recommend a toolkit that is versatile, containing a combination of sockets, spanners and vice-grips, hacksaws and pliers.

- *Watchmaker screwdrivers.*
- *Valve spanner.*
- *Jump-cables.*
- *Two hammers – 1/2 &2kgs.*
- *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.*

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 make it ooze from pipe connectors leaving green stains over parts of the cooling system).*

Drowning an 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:

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 that can even cost lives.

Recovery of a drowned engine:

- *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 con rod 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 dish-washing

Being able to venture into the remote and unspoiled wilderness is the part of off-roading that gives me the most pleasure. I began with a vehicle (below) which was over twenty years old at the time. I carried a wide range of spares, a good selection of tools and a repair manual. It gave me peace of mind during my travels and on a few occasions was needed. Today, with a newer and considerably more reliable vehicle; while I do not carry the range of spares I once carried, I always carry a good set of tools and a box of odds and ends to enable me to effect a repair far from home. Bottom: Or, take a bunch of friends and not worry. This was an expedition in 2012 to conquer the roughest public road in Southern Africa with a stock Land Rover Discovery-4. We succeeded.

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 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 down 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.*

In 1987 I had a head-on collision with a Toyota Land Cruiser on a narrow bush track. It took all my resources to repair my vehicle, which was a day's drive from the closest town. I carried with me all kind of odds and ends, such as wire, radiator putty, electric cable, hose clamps and more. It took me three days to rebuild my vehicle, then named, the Strange Rover.

- *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 it 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/VIN 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 complex sentences and 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.

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.

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 raiser air intake 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 carburetors 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.

FUEL

Not all fuels are created equal

A commonly held theory is that all fuels come from one huge bowser and the fuel tankers, whether they be Shell, BP or Total, all fill up together and then go out to their branded pumps where they off-load their cargo. This is untrue. I know this because with the various vehicles I have owned, some fuels caused the engine to clatter a lot and others made it go better while others gave me better consumption. Call me fussy, but I don't just go anywhere to fill up, if I have a choice. In my own experience, I found that my turbo-diesel G-Wagen ran poorly when using Engen diesel. It ran much better with BP and Shell. Sasol diesel had the effect of lowering the running temperature of this engine and it made it run quieter while consumption was unchanged. I don't know why, but at the time thought it might be peculiar to that engine. After further experiments with two normally-aspirated 4.2 Land Cruisers, I recorded that they both consumed an extra liter every per 100 kms

on Engen diesel when compared to running with BP diesel. I have concluded that Shell and BP are the best performing diesels now available. While my experiments are hardly scientific, I mention this to encourage you to experiment with the fuels that you use, and that they are not all created equal.

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 JERRY CAN LIDS by touching the Jerry-can against any bare metal part of the vehicle.*
- *Open Jerry cans 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 and if it's on your clothes, you'll smell for the rest of the day.*
- *Empty Jerry cans with a spoonful of petrol at the bottom are more dangerous than full ones as they contain an explosive air-fuel mixture.*

Funnels & Spouts

A small green spout designed to clamp onto the spout of a Jerry-can is the best method I have found of pouring into a fuel tank without spillage but if you use unleaded fuel, make sure the spout fits your filler They are, however, only suitable for use with steel Jerry cans. Unlike the Jerry-can 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.

Refuelling in the bush or purchasing fuel in remote villages introduces the possibility of vehicle trouble caused by contaminated fuel. Avoid buying fuel taken from drums that are labelled with any non petroleum chemical. Keep funnels and hoses clean.

Above: On this particular occasion, we purchased all the fuel available in the small town in the Kalahari. It had to be decanted into a measuring container, before it went into our Land Rovers. The container, when full, contained 38 liters. We filled all our tanks and Jerry cans, measuring , adding, and calculating as we went. Lucky we had a calculator!

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 continue turning after the fuel stops 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. The entire affair can turn into a very unpleasant incident.

Dirty or contaminated fuel is a common cause of vehicle breakdowns in all remote areas. When buying fuel from old drums, check the labels on the drums and if it appears that the drum once contained another liquid, beware of contaminants or residues that may have dissolved in the fuel, e.g. resin.

DIESEL FUEL CONTAMINATION CHART

Contaminant	*Consequences*	*Test method*
Water	*Damage to pump and injectors. Rapid rusting.*	*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)	*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.*	*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*
Oxidations	*Only heavily oxidized fuel is a risk.*	*Colour darkens. Acrid smell. (Source - Land Rover's Manual For Africa - Land Rover LTD.)*

PHYSICAL PROPERTIES OF FUEL	
Petrol	*Volatile, highly flammable vapour. Light straw or pinkish colour. Distinctive smell.*
Paraffin	*Some models are very noisy*
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.*

Fuel sampling and taking a sample

Testing can be done with the use of a length of PVC tubing, your nose, your eyes, a liter-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.

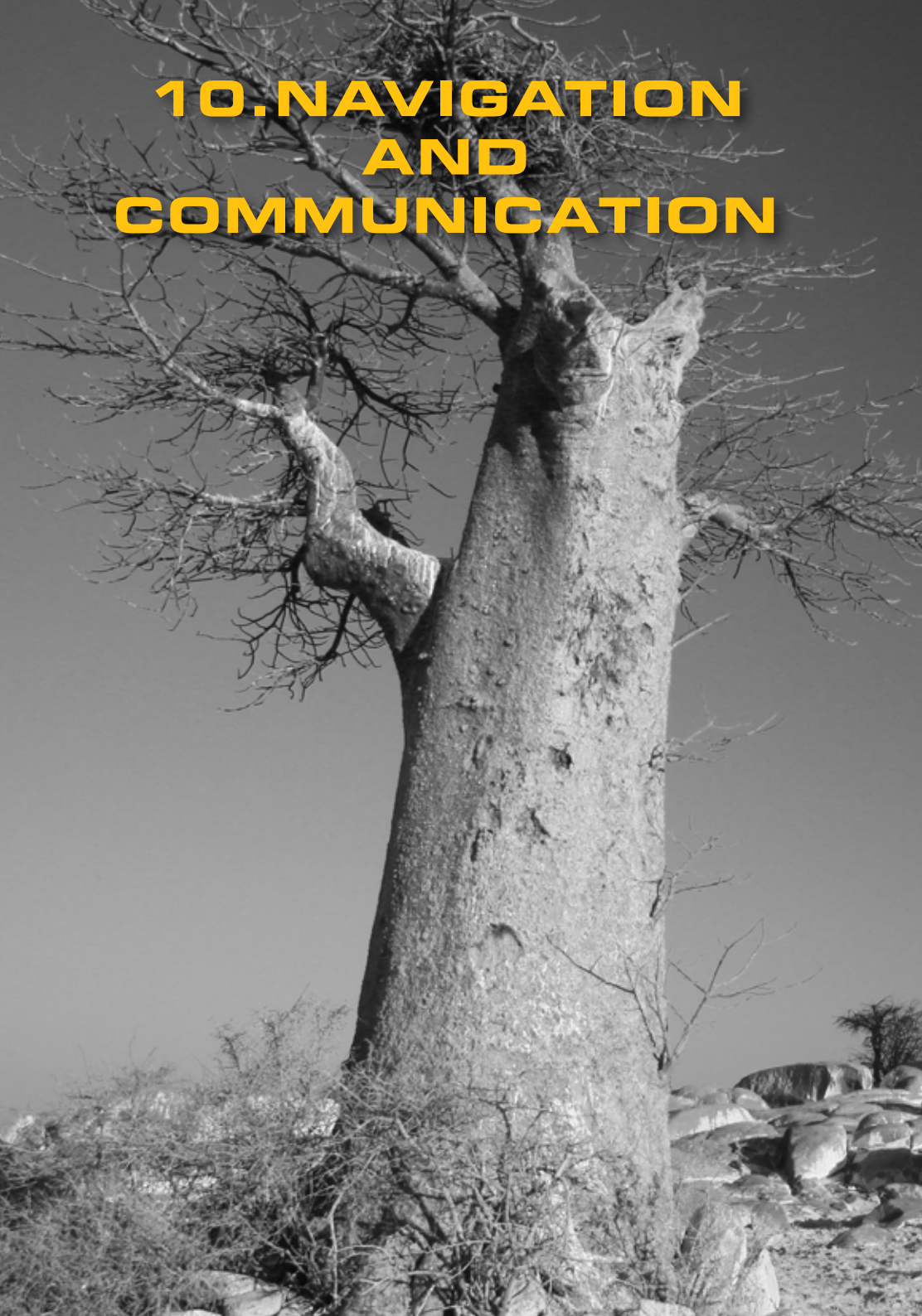
The density of the contaminant will have a different density to the fuel itself, causing the heavier liquid to sink and the lighter liquid to float. This is why tipping the barrel to take a sample will effect accuracy.

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. Next, smell the sample. Shake the contents and then smell it again and note any difference. If possible, weigh one liter of the sample.

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 15:1.

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)	*0.76-0.98*		



10. NAVIGATION AND COMMUNICATION

THE GPS

MAP READING

FEATURES OF MAPS

RADIO COMMUNICATIONS

4XOVERLAND
THE EXPLORER'S INFO-TAINMENT CHANNEL

THIS CHAPTER IS in two parts, GPS navigation followed by traditional map, protractor and compass navigation. Despite the cleverness and accuracy of a GPS, much of what is required in traditional map work still applies when using a GPS.

THE GPS

Global Positioning System (GPS) receivers receive signals from a constellation of 24 GPS satellites and tapping into this $14 billion resource is free of charge. This system is owned by the United States. Russia owns a similar system, but it is used for military purposes and civilians do not have access to it.

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.

Not all GPS receivers are the same because not all users require the same thing out of them. Decide in what sphere you need the GPS to work. Is it needed in the city, in the country or in the remote wilderness? Answer this before you shop, not the other way round. Bottom: In a vehicle a large screen is a real advantage. This is the one of the best value big screen units available but unfortunately today, a Garmin 176C.

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.

Once coded to reduce accuracy with a system called Selective Availability, a GPS with ten satellites can today read with an accuracy of between 15 and five metres, anywhere inside our atmosphere.

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. Not all modern GPSs are alike and a four-wheel driver will demand different things from a GPS than say a pilot or urban GPS user. For a 4x4 adventurer, there are things that are essential, so when selecting a GPS, consider the following:

Important features to look for:

- *Ease of use and instructions that are easy to follow*
- *External power supply*
- *The ability to drop bread crumbs and record and save a track log*
- *Connectability (mapping on a PC)*
- *Software availability and internet support*

Where the only landmarks are few and man-made, a GPS can be a real advantage. But, while a GPS can almost magically give your position, this is not much use without something to reference it to, like a map for example. Because of this, basic map reading and compass skills are still essential.

- *Auto-routing is recommended but not essential.*
- *A map-enabled GPS is highly recommended.*

Tracks 4 Africa

T4A, as they are better known, was started by Wouter Brand early this century. His idea was to collect GPS track-logs from GPS users from all over the country and combine them in a downloadable file, compatible with any map-enabled GPS. This has been a great success, and his philosophy of accepting only technically near-perfect data as well as their verification techniques have resulted in a very trustworthy source for overland data. Nothing beats combining their paper and digital GPS maps. The paper maps are huge, so much so that they are very awkward, but despite this, having a paper map and a matching map loaded in a GPS is the most accurate and sure way of navigating I have ever used. Tracks 4 Africa's digital maps are available as downloads from their web site (www.tracks4africa.com) and their paper maps from all outdoor stores.

Unfortunately for us in South Africa, Garmin is the most used make of GPS receiver. I say unfortunately because using a Garmin means using Garmin software, and that means using the supremely mediocre software called MapSource, even though their receivers are mostly excellent.

GPS mounts supplied with a GPS leave much to be desired if you want to use the GPS in a land vehicle. Neither Garmin nor Magellan make decent dashboard mounts sturdy enough for use in a vehicle moving off-road or over corrugations. But Tom Tom does.Pictured above is a RAM windscreen suction clamp. It is brilliant and highly versatile. Bottom: Tom Tom's clever and sturdy windscreen mount is invisible from the front.

USING A GPS RECEIVER

Many GPS users make the mistake of switching off their brains when they turn on their GPS. A GPS is not a magical piece of gear that will prevent you getting lost. It is a navigation aid. It assists the brain, not replaces it. I say this because as a map publisher I have been accused of being responsible for someone driving, "600 miles in the wrong direction". Unbelievably, this person blamed an inaccurate coordinate (out by 30 kms) on a map for his day-long drive to who knows where. GPS receivers are not infallible and nor are maps, be they electronic or paper. Be aware of your position all of the time, or a GPS will get the better of you. However, armed with a GPS, good maps and the willingness to learn, there is nothing quite like the certainty that a GPS can provide during challenging adventures in the bush.

A GPS receiver (depending on features) can accomplish the following:

- *Pinpoint your position.*
- *Give you direction from your position to a given way point.*
- *Tell you which way to travel to get to a way point. 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 corrects the course.*
- *Calculate a speed over the ground.*
- *Calculate an average speed between two way points.*
- *Estimate the time it will take to reach a given way point/s.*
- *Calculate the distance to a given way point/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 way points for instant retrieval, such as favourite fishing spots and secret campsites.*
- *Record a journey in the finest detail to be played back in real time on a computer screen.*
- *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.*
- *Auto-routing means that given a destination a GPS will follow the recorded roads and tell you where to turn etc. Many, but not all GPS maps have the auto-routing feature.*

Converting GPS coordinates onto a map

Let's say for example, the coordinate (in this case Sylvia Shoal, Mozambique) is your position fix. Your GPS reads: 23° 13′ 15S, 35° 29′ 15E. Translated into English this means: 23 degrees, 13 minutes and 15 seconds south of the equator, line of latitude by 35 degrees, 29 minutes, 15 seconds east of the zero meridian, line of longitude. To pin-point this onto a map do the following:

Make sure the GPS datum is the same as the map that is being used. This is very important. Secondly, the notation must be set to degrees, minutes & seconds (hddd°mm'ss,s) or degrees, minutes & decimals, (hddd°mm.mmm) If in doubt how to set these to begin with, set the datum on WGS84 and the notation on the most commonly used format: hddd°mm'ss,s.

The ideal maps for pin-point navigation are topographical as they are small scale with an accurate grid. Doing this with large scale (e.g. 1: 1000 000) road maps is likely to result in major inaccuracies.

At the extreme top and bottom of the grid there are rulers displaying longitude and along the sides, rulers displaying latitude. Read off and measure the latitude (flat lines) first. Run along this line and locate your coordinate and make a mark. In this example 23° 13′ 15S. Then do the same for the latitude – in this example 35° 29′ 15E. 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.

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 you have 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 it that runs parallel to the hair line. Below the lid is another window which is marked

Prismatic Compass

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 card, marked off in degrees 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 reverse so they can be viewed through the prism the correct way up. On the inner ring of the compass 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 kilometers. This totals 625 square kilometers. 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.

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, two centimetres represents 1 kilometer. This is obvious if one considers the calculation; 2 cms = 20mm. 20 X 50 000 = 100 000 or 1000 metres = 1 kilometer. Don't let this confuse you – just remember that two centimetres represents one kilometer on a 1:50 000 map.

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

The scale of a map is of great importance to the navigator. If you are working in a small area of ten kilometers, 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 kilometers, 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

Taking a bearing:

- *Bearing: the angle measured clockwise from True North, Magnetic North or Grid North.*
- *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, although true north can be selected in the GPS set-up menu.

True north

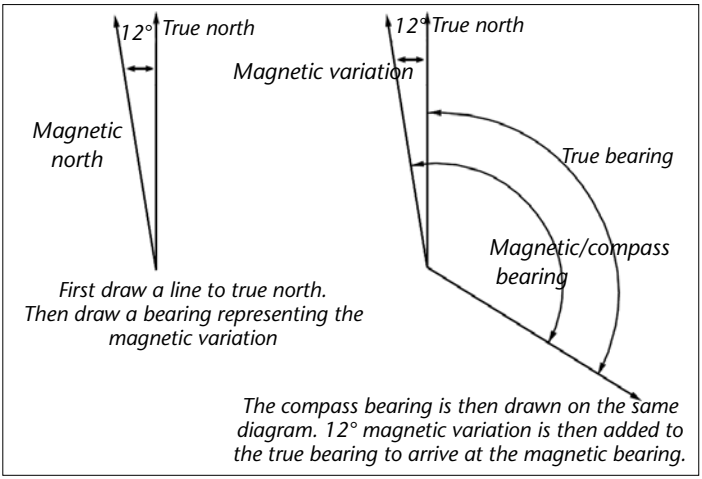
True north never changes. The North Pole is the most northerly point and is situated at 0˚ true north.

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.

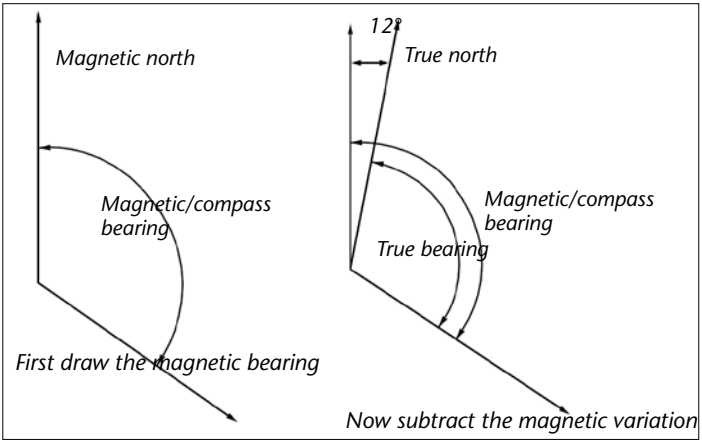
Converting a grid bearing to a magnetic bearing

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.



THE THREE BEARINGS

Because of the three norths, there are three types of bearing:

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.

Magnetic variation

The magnetic variation is the difference between the north measured by a magnetic compass and true or grid north plotted on maps. This difference is written as the magnetic variation on all maps with a workable grid. For the exercises on the left it is 12˚ west. This means that whatever grid/true bearing you have measured on your map, will be 12˚ more or less than the magnetic bearing.

Plotting bearings on a map

The conversion of bearings is necessary if you wish to use your map, compass and GPS together. Another important tool to the navigator, the protractor, a link between the compass and the map, will be used. It enables a bearing taken in the field to be plotted on a map, or a bearing taken on a map to be measured 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 where 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.*

CONVERTING DEGREE TO GRADIENTS	
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	

- *Read off the degrees from the degrees scale on the protractor. This is the grid bearing from one point to the other.*

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.

FEATURES OF MAPS

Contour lines

Heights on a map are represented by contour lines, continuous lines drawn on a map that join all the areas of equal height above sea level thereby indicating the shape of the landscape and 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, 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 kilometer 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 kilometers).*

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

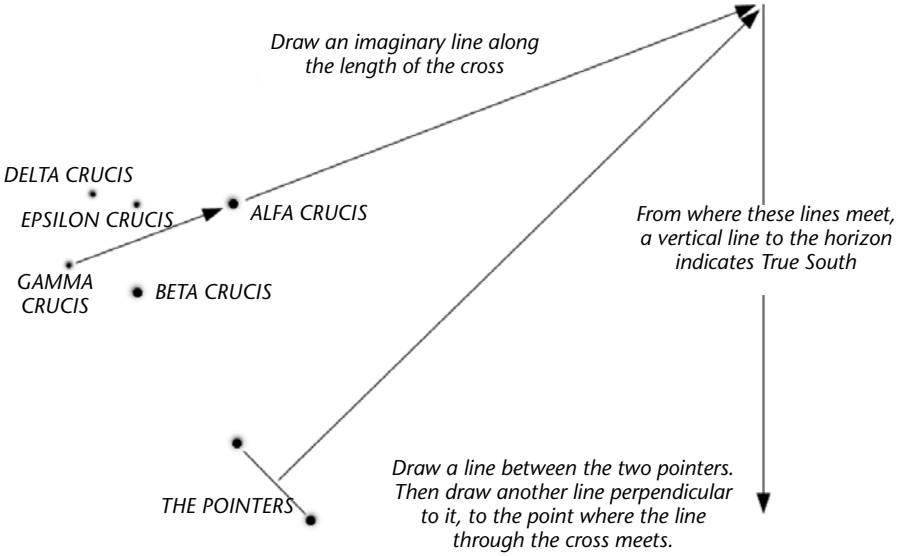
Areas of height can also be coloured to assist in quick recognition of landmarks. Greater heights are normally shaded darker. You will notice that the edge of each shaded area runs along a contour line.

FINDING YOUR WAY WITHOUT A COMPASS

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 kilometers).



The other star, Beta Centauri, is 330 light years from earth. The Cross itself is made up of five stars with 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 disoriented. 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 and stand on your vehicle's roof or climb a tree. Scan the horizon. 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.

MAPS

Using a map designed for an application unsuited can lead to frustration.

Topographic maps

Normally 1:50 000 or 1:250 000, they are highly detailed with topographic features such as contours, rivers, roads and railways. They are used by anyone needing high detail and accuracy and are suitable for reading off the grid lines and inputting into a GPS. InfoMap Leisure-Traveller maps feature the accuracy of a topo map with road and tourist information with stunning digital 3D computer imagery.

Road maps

Scales range from 1:50 000 to over 1:1 500 000. Their primary task is to illustrate roads and tracks for the motorist. They are not suitable for accurate navigation using latitude and longitude grids.

GPS maps

Those published by InfoMap are often referred to as GPS maps. They can be regarded as a combination topo and road map. While the scales of over 1:500 000 does not permit the reading of grid lines and inputting into a GPS, they contain actual GPS coordinates. The coordinates are simply inputted into the GPS as way points. These maps are available in paper and electronic formats.

RADIO COMMUNICATION

Travelling in a convoy with radio communication between the vehicles is not only practical, it is fun as well.

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 the 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 kilometer.*
- *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 dependant 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.*

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*
- *Sound quality*
- *Low power consumption*

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.

Top: Glass mount VHF. Middle: Body mounted HF with built-in single-frequency coil. Bottom: Body mount VHF.

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.

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.

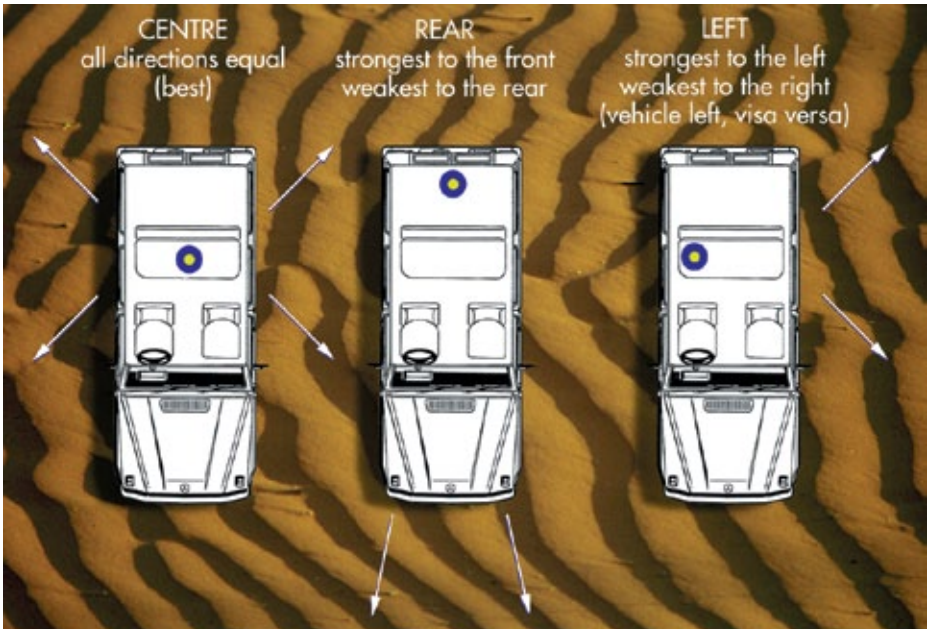
Body mount antennae are therefore the best way to go. If installed properly the vehicle will not rust around the antenna and the antenna's earthing system will be sound. The antenna cable is mounted permanently and is therefore less susceptible to damage by friction or passengers. In general the higher 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. Consideration should be given to keeping the unit out of reach of rising water should you venture into deep water. The perception that radio communication systems can be installed by anyone is generally incorrect all antennae have to be adjusted to resonate at the correct frequency and if this is done incorrectly a transceiver can malfunction and can require repair. Sometimes, only when a home installation is compared with a professional's can the difference be appreciated. The reasons for this are simple; 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

Operators licenses are required for both 27Mhz, 29MHz and VHF radios and are issued by ICASA, the national regulatory body. All equipment must be type approved and licensed before it can be used. Special precautions should be made when travelling in the Third World because often special permissions and licences are often required. When travelling in the Third World, do without radios if possible - it could save a lot of unwanted aggravation with police and officials.

Maintenance

Prevent water from entering your antenna cables by sealing them with silicone prior to installation. Once water has got into the cable, corrosion will occur and the cables must be replaced. Check the power 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 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.

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