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

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

BODY-MOUNTED ACCESSORIES

BULL BARS

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

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

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

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

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

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

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

SIDE-STEPS/RUNNING BOARDS

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

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

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

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

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

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

BUMPERS AND TOWING EQUIPMENT

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

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

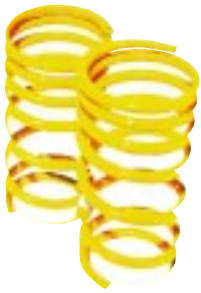
Front tow-bars

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

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

SUSPENSION MODIFICATIONS

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



Specialist suspension modification manufacturers

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

Heavy-duty springs

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

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

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

Spring assisters

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

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

Possible problems caused by suspension modifications

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

Gas shock absorbers

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

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

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

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

Why gas?

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

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

Polyester Bushes

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

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

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

AUXILIARY TANKS

Fuel tanks

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

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

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

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

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

Carrying fuel

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

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

Water tanks

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

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

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

A few considerations when piping from water tanks:

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

AUXILIARY LIGHTING

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

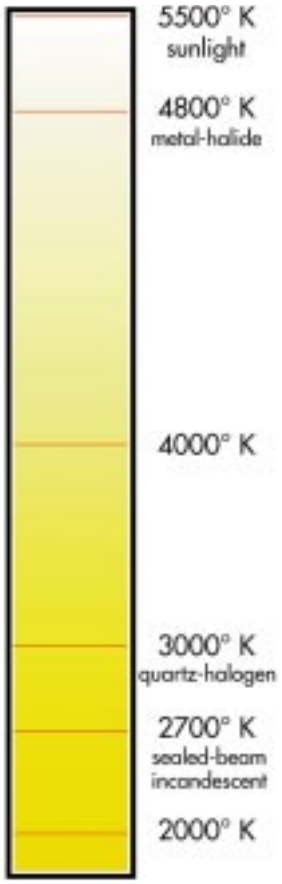
If you intend to travel at night in Third World Africa, where dogs, chickens, cattle and goats are a constant danger, fit good quality auxiliary lighting to your vehicle.

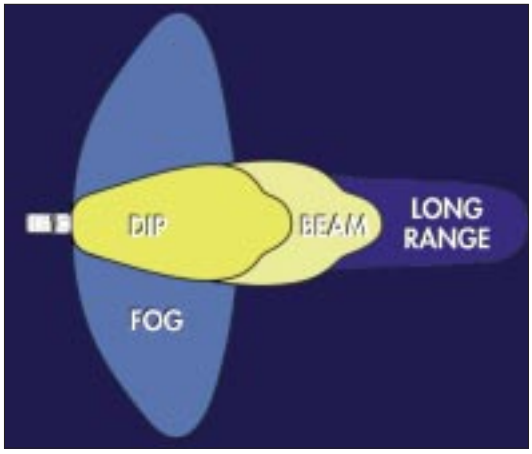
Driving lights

Driving lights supplement the vehicle's own lighting, giving a modvisibility broad spread illumination to the side of the road and providing penetration ahead.

Fog lamps

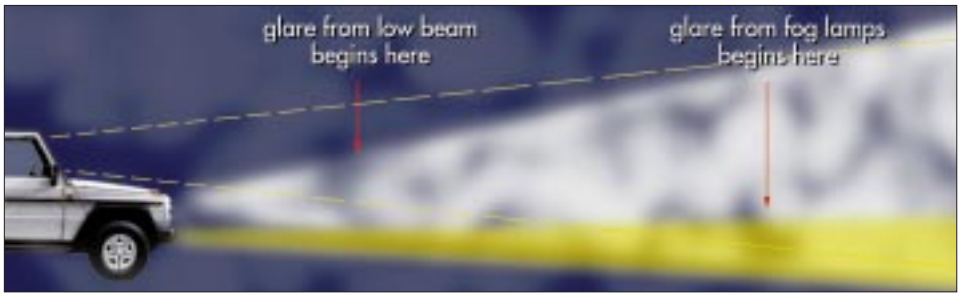
Fog lamps are not simply driving lights with an amber filter. What is crucial about a fog light is its spread, not its colour. Genuine fog lamps throw a very broad flat beam that stays low. This prevents glare as the light bounces off the airborne particles and is thrown back into the face of the driver.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





Long range

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



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

THE COLOUR OF LIGHT

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

Metal halide

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

Quartz halogen

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

Sealed beam

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

FITTING AUXILIARY LIGHTS

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

Light guards

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

Rear lighting

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

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

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

GAUGES

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

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

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

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

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

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

Oil pressure gauge

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

Oil temperature gauge

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

Voltage meter

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

Ammeter

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

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

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

Inclinometer

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

ELECTRICS

BATTERIES

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

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

than the amount of cur-

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

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

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

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

DEEP-CYCLE BATTERIES - MODELS AVAILABLE

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

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

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

Willard 774 heavy duty deep cycle battery.

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

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

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

Delco Voyager Deep-Cycle Batteries

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

Features

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

Hydrometer indicator

Green: Above 70% charge. Ready for use.

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

Red: Below 50%. Recharge immediately.

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

Storage

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

Normal charging requirements

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

Charging Deep-Cycle Batteries

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

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

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

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

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

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

Charging requirements with a very flat battery

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

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

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

TIME REQUIRED FOR FLAT BATTERY
TO ACCEPT A MEASURABLE CHARGE

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

HOURS OF USABLE POWER

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

Care of batteries:

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

Storing batteries

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

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

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

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

220-VOLTS

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

Unipower mobile welding kit

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

Inverters

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

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

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

Portable generators

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

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

ROOF-RACKS

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

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

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

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

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

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

Alloy and wood roof-rack.

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

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

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

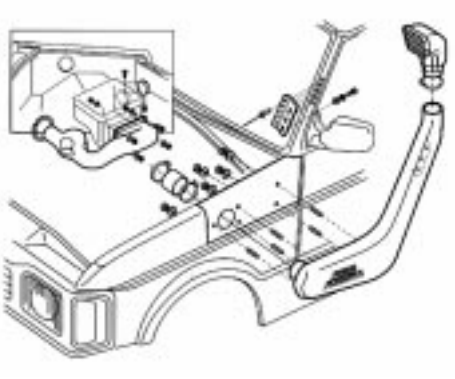
Roof-racks which extend to beyond the windscreen are very useful to set up a roof-top tent, or to carry awkward loads. Some designs have the roof-rack extension supported by the front bumper. However, it is not advisable to drive with loads too far forward as overloading the roof pillars and the front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

MISCELLANEOUS

AIR-INTAKE EXTENSIONS/SNORKELS

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

COURTESY SAFARI SNORKEL



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

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

PROTECTION PLATES

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

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

GRILLE NETS

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

FIRE EXTINGUISHERS

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

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

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

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

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

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

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

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

OIL COOLERS

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

SEAT COVERS AND INTERIOR VEHICLE PROTECTION

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

SOUND SYSTEMS

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

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

WINDSCREEN CLEANING MODIFICATION

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

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

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

TWO-WAY RADIOS

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

SECURITY

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

INSURANCE

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

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

MORE INFORMATION AND ADVICE

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

AUXILIARY EQUIPMENT PRODUCERS AND SUPPLIERS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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