AUSTRALIAN DEVELOPMENT OF THE LAND ROVER ONE TEN FOR THE CIVILIAN AND MILITARY MARKET

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The Land Rover 110 is one of only two four wheel drive vehicles (apart from trucks) which are assembled in Australia — continuing a 30 year tradition of local Land Rover assembly. The range includes a number of derivatives which have been locally designed and developed to meet particular market needs, including:

- Isuzu diesel engine installation
- Land Rover Tray Top
- Land Rover 6 x 6
- Specialised military 4 x 4 and 6 x 6 derivatives for Project Perentie

This paper traces the role of JRA Limited in the development of these vehicles, and examines some of their design features.

BACKGROUND

Despite Australia's standing as the world's second largest four wheel drive market, with total sales this year of over 70,000 units, all but some 1500 vehicles are fully imported.

JRA Limited through its Land Rover division currently assemble some 450 Land Rover 110 vehicles per year at our Moorebank (Sydney assembly plant — mainly diesel engined Station Wagons, together with a number of diesel engined chassis cab 4 x 4 and 6 x 6 vehicles. These supplement the V8 petrol engined station wagon and hard top vehicles which are imported assembled from the U.K.

Land Rovers have been assembled in Australia since the early 1950's with varying degrees of local content. Local manufacture of body panel pressings commenced in 1956 and continued through to 1980, with diminishing levels of local content — brought about by gradual elimination of local assembly incentives. The supply of Land Rovers to the Australian Army commenced in April 1960 with the delivery of the first Series II vehicle, followed by orders for Series IIa and Series III — a total of some 9000 vehicles.

The decision to locally assemble the new Land Rover 110 range was inspired by two factors — a continuing market need for a high performance diesel engined derivative of the Land Rover 110, and our need to maintain a specialised local assembly operation to support our bid to supply the Land Rover 110 to the Australian Army.

In general, local assembly is now confined to unique Australian derivatives, and civilian local content (apart from tyres and batteries) is strictly confined to the unique components which are required to produce those derivatives.

ISUZU DIESEL ENGINE

Land Rovers had for some time been criticised locally for their lack of highway performance — their relatively small and understressed 2.3 and 2.6 litre engines proving no real match on the highway for the Toyota Land Cruiser's 4 litre six cylinder petrol and diesel engines. Land Rover in U.K. planned to counter this by fitting their 3.5 litre aluminium V8 petrol engine in the Land Rover, but had no plans to provide a diesel engined vehicle of similar performance.

This, combined with a significant swing towards diesel engines for heavy four wheel drive vehicles (spurred by the fuel crisis of the late 1970's), and our understanding that the Army not only needed more power than that provided by their Series III 2.6 litre petrol engine, but also were moving to an all diesel fleet — led us to investigate the local fitment of a large capacity diesel engine in Land Rover.

An extensive survey of available diesel engines was undertaken, and the 3.9 litre four cylinder Isuzu 4BD1 diesel engine was selected as the most suitable for our application. In particular:

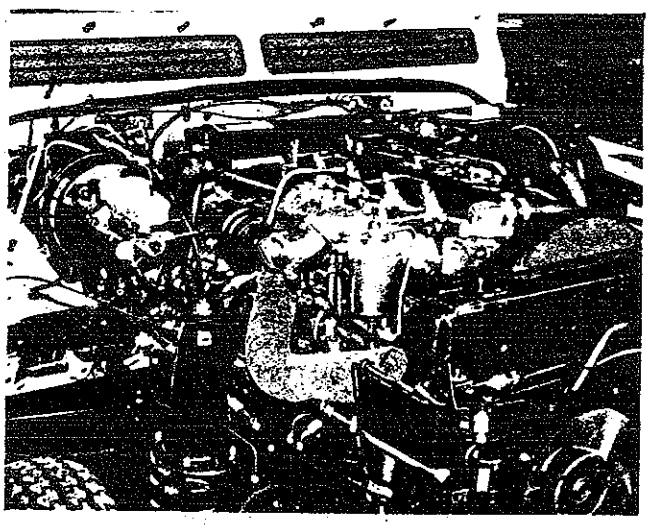
- The engine packaging and performance was similar to that of the 3.5 litre V8.

- The engine was a heavy duty truck derived unit with proven market acceptance, reliability, and durability.
- Its direct injection system combined excellent fuel consumption with high torque throughout the engine speed range.
- Future higher performance derivatives of the engine were likely to be available for future extensions of the Land Rover vehicle range.

Isuzu and their trading company, C. Itoh, proved most enthusiastic partners, assembling special 4BD1 engines for our Land Rover application, which has included the manufacture of a special flywheel housing and engine sump.

The Isuzu diesel engine installation in the original 109 Land Rover was carried across to the new model, with a number of modifications to improve its refinement for the Land Rover 110 application:

- Isuzu introduced a noise reduction package consisting of a double skinned rocker cover and front cover, a rubber mounted sump and revised pistons.
- The original Land Rover V8 derived body mounted air cleaner was replaced by a locally sourced engine mounted Donaldson unit — with safety element and filter replacement indicator. The first Donaldson filters featured circumferential air intake slots in the air cleaner body, which proved to be a significant source of induction system noise. This was finally cured after extensive comparative testing by a revised air cleaner linked by flexible ducting to a remote air intake under the right hand front wing.
- Additional engine compartment sound proofing was added to the bulkhead and under bonnet areas (12 mm thick metallised polyester insulating foam), supplementing the additional passenger compartment insulation material which was introduced for the Land Rover 110 range.
- The transfer box high range gearing was revised for the Land Rover 110 installation — utilising a 0.996:1 high range ratio, compared to 1.123:1 for the 109 vehicle. This significantly improved the vehicle's cruising noise levels, while the engine's good low speed torque still ensured most acceptable top gear flexibility.



Isuzu diesel engine installation in Land Rover 110

Higher rate front springs and revised front suspension dampers are used with the Isuzu diesel engine. These maintain the basic vehicle's suspension periodicity, and in conjuction with deeper bump rubbers, raise the vehicle's trim height by 25 mm, but retain the original bump and rebound travel.

The springs are of constant rate with the ends wound flat — compared to the dual rate, ground flat springs in the base vehicle.

CHASSIS CAB/TRAY TOP

The fitment of a flat floor rear tray to Land Rovers is a uniquely Australian requirement — other markets specify a pickup body with fixed sides and a fold down tailgate. In order to more satisfactorily accommodate a flat tray body of adequate dimensions, all Australian chassis cab Land Rovers are built with their wheelbase extended by 246 mm to 3040 mm, and are uprated by 150 kg (using revised springs and dampers) to 3200 kg gross vehicle mass.

A 1.8 m x 2.5 m Hockney Alcan extruded aluminium tray is factory fitted.

Land Rover 110 Tray Top

LAND ROVER 6 x 6

History

The development of the Land Rover 6 x 6 was spurred on by two factors:

- The success of the lightweight four wheel drive pickup — and the need to expand the Land Rover chassis cab vehicle range away from these much less expensive vehicles.
- The known Australian Army requirement for an off road vehicle with a 2 tonne cross country payload, and a 3.2 m x 2.1 m flat floor tray.

A detailed market survey identified a small but definite requirement for a specialised cross country vehicle with a payload of around 3 tonnes, and a tray area of around 7 m^2. A number of methods of meeting this need were examined:

- Resurrecting the Land Rover 101 military forward control vehicle.

- Using the Spanish Land Rover Santana forward control vehicle.
- Adopting one of the available 6 x 6 conversions of the Land Rover 109 from U.K.
- Marketing one of the specialised 4 x 4 vehicles which were available from Stonefield and Renolds Boughton.
- Locally developing a forward control version of the new Land Rover 110.
- Locally developing a 6 x 6 version of the new Land Rover 110.

These were evaluated in relation to:

- Maximising value for money, compliance with the Australian Army and civilian market requirements, compatability with the basic Land Rover 110 vehicle.
- Minimising project risk, local development time and costs.

The results of this evaluation clearly favoured locally developing a 6 x 6 version of the Land Rover 110.

The detailed specification which was selected for the vehicle was largely dictated by our understanding of the Army's requirements (certainly our largest potential customer), but with care to accommodate as many civilian market requirements as practicable. This produced the following arrangement:

Dimensions

The Army's 3.2 m x 2.1 m rear tray requirements, together with considerations of vehicle operation, axle loadings, departure angle and registration legislation led to adoption of a 3040 mm intermediate wheelbase (up 246 mm), a 900 mm rear axle spacing, and a 1660 mm rear track (up 174 mm). The standard Land Rover 110 front track of 1486 mm was retained to maintain the use of standard Land Rover 110 cab, axle and suspension components. Although such a disparity in front and rear tracks appears undesirable, both our own testing and later Australian Army tests have not highlighted any problems with this layout.

Mass

A gross vehicle mass of 5.50 tonnes was selected — providing a mass of just over 3 tonnes for body and payload. This met the civilian vehicle requirements, and also tied in well with the Army's 2 tonne payload for a fully equipped vehicle including the driver and his personal kit, with maximum axle loads of 1.50 tonnes for the front axle and 2.00 tonnes for each rear axle.

Engine

The 6 x 6 vehicle's engine compartment is identical to that of the basic Land Rover 110 4 x 4 vehicle, and hence could accommodate the Isuzu 4BD1 diesel engine and Land Rover's 3.5 litre aluminium V8 petrol engine. We were aware, however, that Isuzu were developing a turbocharged version of their 4BD1 diesel, and took this into account in the detail design of the vehicle.

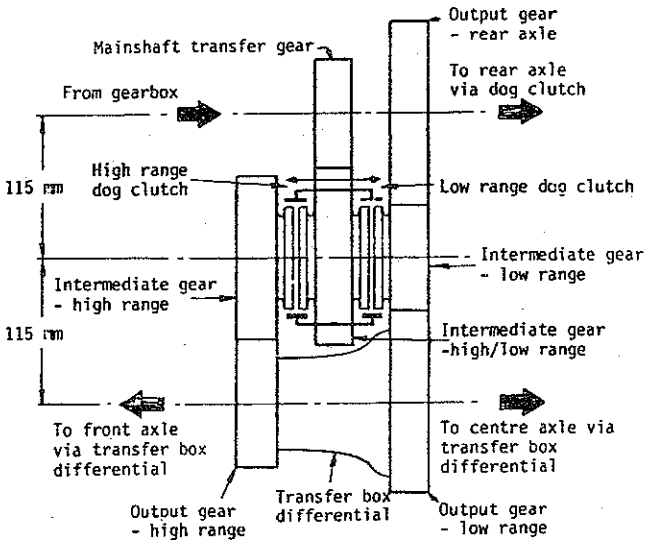
The turbocharged Isuzu 4BD1T diesel engine is now our standard engine for the Land Rover 6 x 6 vehicle, Land Rover Australia being Isuzu's first overseas customers for the engine. The 4BD1T engine maintains the high reliability and durability of the naturally aspirated engine, but features lower noise levels and a 30% improvement in maximum power and torque.

Transmission

The heavy duty LT95 four speed gearbox and integral two speed transfer box which was fitted to the Land Rover 110 4 x 4 has always had provision for fitting a second rear axle drive. This transmission was fitted to the original Land Rover 101 military forward control vehicle, and was used to drive its optional power drive trailer. It was, therefore, only logical to utilise separate prop shafts from the transfer box to drive the front, centre, and rear axles.

The gearbox follows a conventional two shaft layout, with a shaft spacing of 95 mm, and has more than adequate capacity to accommodate the full range of engines — including the turbocharged diesel engine — and the 5.50 tonnes gross vehicle mass/7.50 tonnes gross combination mass.

The integral transfer box utilises a three shaft layout, each 115 mm apart, with the change speed dog clutch on the intermediate shaft gears. This arrangement is illustrated diagramatically below.



The transfer box output shaft incorporates a bevel gear into axle differential, which is activated by a vacuum operated dog clutch. The same vacuum operated components are utilised on the rear axle output shaft, and are linked to a common vacuum control switch on the vehicle fascia. The vehicle is designed to operate in four wheel drive (to the front and centre axles) with the inter-axle differential unlocked for on-road operation, and in six wheel drive with the inter-axle differential locked for off-road operation.

Axles

The 6 x 6 vehicle's front axle is similar to that used on the basic 4 x 4 vehicle, but features:

- Reinforced axle housing (using tubes pushed into each side of the housing and welded in position).
- Heavy duty four pinion differential (in lieu of the two pinion differential on the basic 4 x 4 vehicle).
- Locally sourced (Repco) high strength induction hard-

ened axle shafts with involute inboard splines (in place of the square sided splines on the basic axle).
- High strength 'Oerlicon' generated spiral bevel crown wheel and pinion with 4.70:1 ratio (in place of the Gleeson 3.54 ratio standard gears).

Standard front hubs, brakes, bearings, seals, etc. are fitted.

The use of separate drive shafts from the transfer box to drive the centre and rear axles permits the use of conventional rear axle assemblies — rather than a special through drive unit. Also, the close coupling of the centre and rear axles, and degree of suspension articulation required for effective cross country operation effectively ruled out the use of a through drive axle, due to the inter axle drive shaft's operating angles.

After an abortive attempt to mount the centre bearing for the rear axle prop shaft on the centre axle, a satisfactory solution was achieved by chassis mounting the centre bearing and using a double Hooke's jointed shaft running over the centre axle, and tilting the rear axle pinion upwards by 14°.

Two Salisbury hypoid bevel rear axles are employed, differing from the basic 4 x 4 vehicle's rear axle only in:

- Rear track (increased from 1486 mm to 1660 mm).
- Axle tubing thickness (increased from 8 mm to 12 mm).
- Axle ratio (4.70:1 in lieu 3.54:1).

Common short and long axle half shafts are employed in the centre and rear axles, the differential on the centre axle being offset to the right, and offset to the left on the rear axle. The rear axle also utilises two additional oil seals — one on each side of the differential — to accommodate the higher axle oil level which is required due to its increased pinion inclination.

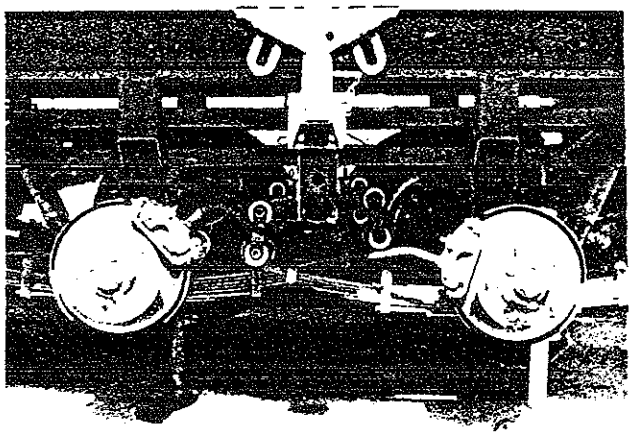
Suspension

The 6 x 6 vehicle's front suspension is similar to that used on the Isuzu engined 4 x 4 vehicle, but uses higher rate front springs.

The use of a coil sprung rear suspension was investigated — virtually two independent 4 x 4 vehicle rear suspensions — and a 6 x 6 conversion was imported from England with this suspension arrangement.

An alternative load sharing leaf spring rear suspension was also investigated — using two simple semi-elliptic leaf springs per axle linked by a rubber bushed load sharing rocker beam. A diesel engined 109 Land Rover was locally converted to this suspension arrangement, to evaluate the concept.

Comparative trials between the non-load sharing coil spring rear suspension and the load sharing leaf spring installation favoured the leaf spring approach — principally because the high coil spring rates which were required to provide acceptable load stability severely restricted inter-axle suspension articulation, particularly when lightly laden, with consequent deterioration in vehicle ride and potential cross country mobility. The load sharing rocker beam on the leaf sprung vehicle provided some 75 mm of relative axle articulation with zero spring deflection, permitting the use of relatively high rate springs without imparing ride or mobility.



Land Rover 6 x 6 Rear Suspension

In order to accommodate the close coupled rear axles with relatively long leaf springs, the centre axle springs are mounted inboard of those for the rear axle. The centre and rear axle springs are anchored to the chassis at their forward and aft ends respectively, and linked by shackles to the load sharing rocker beam at the other ends. High durability flexible polyurethane bushes are used in the spring eyes and shackles, with a large Silentbloc rubber bush in the rocker beam.

Two locally sourced heavy duty telescopic rear dampers are employed on each rear axle.

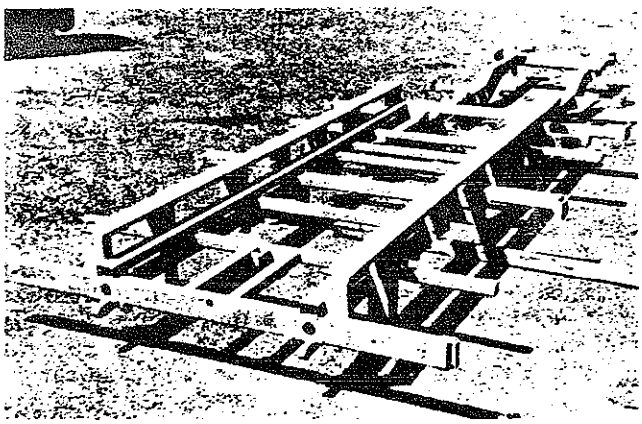
Chassis

Although some attempt was made during the vehicle development phase to rework a 4 x 4 chassis for the 6 x 6 application, it quickly became evident that such a procedure was totally impractical for production.

The chassis design requirements were:
- A relatively rigid chassis was essential (to accommodate the standard Land Rover cab) — and also desirable to accommodate the proposed Army shelters.
- The front end had to be shaped to match the 4 x 4 vehicle's chassis frame (to clear the body and to utilise common suspension pickups).
- An increase in section modulus of at least 50% at the chassis centre was required (to accommodate the increased wheelbase and axle loadings, to allow for occasions when the rear axle supported the entire rear suspension load, and to accommodate the Army's rear suspended tow and helicopter slinging requirements).
- The spare wheel was required to be accommodated away from the load area (an Army requirement) and preferably under the rear of the chassis.
- A hot dip galvanised finish was desirable (both for Army and civilian use).
- The chassis should permit the easy mounting of specialised rear bodies (preferably bolted directly to the chassis).
- Chassis tooling costs needed to be commensurate with the relatively low build volume.

- The chassis design should permit the easy production of alternative wheelbases, rear overhangs, chassis widths and body mountings.

These requirements led to the development of a chassis frame manufactured from welded square and rectangular steel tubing, 102 x 76 x 3.6 mm tubing being used for the front portion of the chassis, twin 76 x 76 x 3.2 mm tubes spaced 51 mm apart for the centre section, with twin 51 x 76 x 3.2 mm tubes spaced 51 mm apart for the rear portion of the chassis. The spacing between the twin tubes of each chassis rail is structurally efficient, and enables crossmembers to pass between the chassis rails without a break. The majority of the chassis welding is also confined to the lower stressed central area.



Land Rover 6 x 6 Chassis

An inverted 110 × 25 × 3.2 mm channel section rear body mounting member is fitted over the rear chassis rails, with jig drilled body mounting holes. Body mounting brackets are also welded to the ends of the rear chassis front, centre, and rear crossmembers.

The chassis is finished by hot dip galvanising — the process adding some 40 kg to the chassis mass.

Steering, Brakes, Wheels, Tyres, Fuel System

The standard Land Rover 110 4 x 4 vehicle's power assisted steering system is fitted — assisted by the provision of the Isuzu engine's integral gear driven Power steering pump.

Standard Land Rover 110 axle mounted brake equipment is utilised, linked to a locally sourced Repco tendem brake booster and a Bendix U.S. source 30 mm diameter master cylinder. A simple fore/aft split circuit is utilised — after early experiments with a front/centre axle and front/rear axle split circuit.

Locally courced heavy duty 5.50 B x 16 pressed steel road wheels are utilised for the 6 x 6 vehicle. These utilise HSLA centres and a revised centre pressing, but are otherwise interchangeable with the wheels on the 4 x 4 vehicle.

Locally sourced 7.50 R16 LT tyres are fitted — either the 8 ply Goodyear Wrangler or 10 ply Olympic Steeltrek 105 pattern.

The fuel system is similar to the basic 4 x 4 vehicle's installation, except that underseat tanks are fitted in lieu of the 4 x 4 vehicle's rear mounted tank (which would interfere with the rear mounted spare wheel). Twin tanks are fitted to the majority of 6 x 6 vehicles — with an electric change over switch controlling the fuel feed and return, as well as the fuel gauge reading. A unique double skinned fuel filler pipe and a screw on cap with low melting point plugs are fitted — to meet the requirements of ADR17 — Fuel Systems for Goods Vehicles.

Cab

The standard Land Rover truck cab from the 4 x 4 vehicle is used for the 6 x 6. This features a steel scuttle with aluminium alloy wings, bonnet, roof panel, floor and back panel. The doors utilise steel frames with clinched on aluminium alloy outer skins. The major assemblies are painted individually then bolted together.

The Land Rover 110 now features a larger, single piece windscreen, wind down door windows and full interior trim — all of which are carried across to the 6 x 6 vehicle.

PROJECT PERENTIE

Background

Perentie is the Army's code name for their programme to procure new light cross country support vehicles in one tonne and two tonnes payload categories.

The Army's detail requirements were first released at their Briefing to Industry in July 1982, and tenders were released to manufacturers for the supply of three vehicles for evaluation by the Army in each category. Of the seven one tonne and seven two tonne payload vehicles tendered, the Army chose the Land Rover 110 4 x 4, the Mercedes-Benz 300GD and the Jeep M10 for evaluation in the 1 tonne payload category, and the Land Rover 110 6 x 6 and Mercedes-Benz Unimog U1300 for evaluation in the 2 tonne category.

The evaluation vehicles were handed over to the Army in September 1983. One of each vehicle was subjected to accelerated durability trials at the Army's Trials and Proving Wing at Monegeetta near Melbourne, while the other two vehicles were involved in a very comprehensive series of user studies. This included hot dry trials at Woomera in South Australia, hot wet trials at Tully in North Queensland, and cold weather trials at Khancoban in the Snowy Mountains, as well as trials by various Army units around Australia.

Tenders for production quantities of these vehicles to the Army closed in October this year for some 2500 1 tonne and 400 2 tonne vehicles to be produced over a three to four year period commencing in May 1986 for the supply of limited quantities of Initial Production Vehicles, with volume production scheduled for May 1987. Six basic types of 1 tonne vehicles are required and three basic 2 tonne vehicles:

1 Tonne	
Cargo/Personnel Cargo/Personnel FFR (fitted for Radio)	Soft Top
Survey Vehicle Command Post	Hard Top

Formation Commander's Vehicle Personnel Carrier	Station Wagon

2 Tonne

Cargo Truck Artillery Vehicle Ambulance	Chassis Cab

Although these vehicles are based on the civilian specification, the Army vehicles do differ significantly in regard to:

- The provision of Army fittings and equipment.
- The level of Australian content.
- The severity of vehicle operation.

Land Rover Australia have been totally responsible for the design and development of the Perentie derivatives from the basic civilian vehicles. This has included all the required durability testing, A.D.R. homologation testing, and specific Army testing of such areas as slinging and tie down points, and radio interference suppression. In addition this has also included the development of design solutions to all Perentie trials problems — either independently or in conjunction with local and overseas component suppliers.

Army Fittings and Equipment

Locally developed fittings and equipment which are required for the Perentie vehicles includes the following:

- Helicopter slinging, shipping tie down and vehicle recovery points are required to be incorporated in the chassis of all vehicles.
- The Perentie tender required that the spare wheel be located outside the load area and in an area which did not interfere with the driver's field of view. This ruled out the two usual military spare wheel locations — in the rare of the vehicle and on the bonnet. Fitting the spare wheel on a fold out gate at the rear of the vehicle was considered most unsatisfactory — due to interference with the towing pintle, and the added complications when loading and unloading the vehicle.
  Accordingly the rear end of the 4 x 4 vehicle's chassis was extensively redesigned to accommodate the spare wheel on a winch carrier under the vehicle's rear floor between the chassis longitudinals. This involved lengthening the chassis, increasing the longitudinal spacing, and providing a side mounted fuel tank in lieu of the standard rear tank. The 6 x 6 vehicle's chassis was designed from the outset to accommodate a chassis mounted spare wheel and side mounted fuel tanks.
- All vehicles were required to have provision for fitting a winch. Although an electrically driven winch appeared attractive with regard to cost and the avoidance of installation complications, this was ruled out following discussions with Army engineering personnel who favoured a mechanical winch for reasons of reliability, durability, and compliance with the Army's operating requirements.
  The locally sourced Thomas T8000 mechanical drum winch was selected for the 4 x 4 vehicle. The larger Thomas T10000 winch was of adequate capacity for the 6 x 6 vehicle, but was just too big and heavy. Winch Industries (the Thomas winch manufacturers) therefore developed a mid sized winch for the 6 x 6 vehicle — the Thomas T9000 — with the aim of combining the capacity of the T10000 winch with the mass of the T8000 unit.
  Refinements to both winches which have been added as a result of the Army test programme have included the fitment of large diameter (50 mm) polyurethane cable guide rollers, and the provision of a grooved drum to provide improved cable feed.
- A new power take off was required to drive the drum winch on the 6 x 6 vehicles — as the rear axle drive unit occupied the space in which the winch power take off was normally fitted. A special winch power take off was locally developed, fitted to the lower face of the transfer box and chain driven from a sprocket which was electron beam welded to the transfer box input gear. This also incorporated an automatic torque limiter (an Army requirement) which restricted the winch cable load to half the nominal cable capacity. The winch torque limiter consists essentially of sixteen spring loaded steel balls which sit in countersunk holes on a hardened steel drive plate. The cutout torque can be pre-set by utilising a range of springs and selected shims between the driving plates. The torque limiter assembly is submerged in the transfer box oil, and is therefore well protected and capable of maintaining the pre-set torque for long periods.
  The same bottom power take off with torque limiter is fitted to the Army 4 x 4 vehicles — with a lower cutout torque.
- All the Army vehicles are required to be suppressed for radio interference — to MIL STD 461, RE05 for basic vehicles, and MIL STD 461 CE07, RE05 for vehicles which are required to be fitted for radio (FFR).
  The FFR vehicles also require the fitment of a fully screened military alternator, preferably the locally manufactured EDE 28 volt/100 amp unit, either driving both the vehicle and radio electrics, or, as in our case, driving just the radio electrics with separate 12 volt alternator/vacuum pump for the vehicle electrics. Large radio battery trays are required to be fitted to the FFR vehicles — mounted on each side of the chassis, with an access hatch in the body side just forward of the rear wheels.
- Roll over protection was originally required by the Army for both the 1 tonne and 2 tonne vehicles. On the Land Rover 4 x 4 vehicle this as accomplished by fitting tubular steel roll over bars through the body side cappings and fixing the ends to the pannier boxes at the front and rear of the cargo area. The roll over bars also double as hood bows.
  The 6 x 6 vehicle was designed from the outset to accommodate rear tray roll over protection with three tubular steel roll over bars/hood bows tied to the tray coaming and to the ends of the chassis cross-members — although this requirement for rear roll over protection is now no longer applicable to the 2 tonne vehicle.

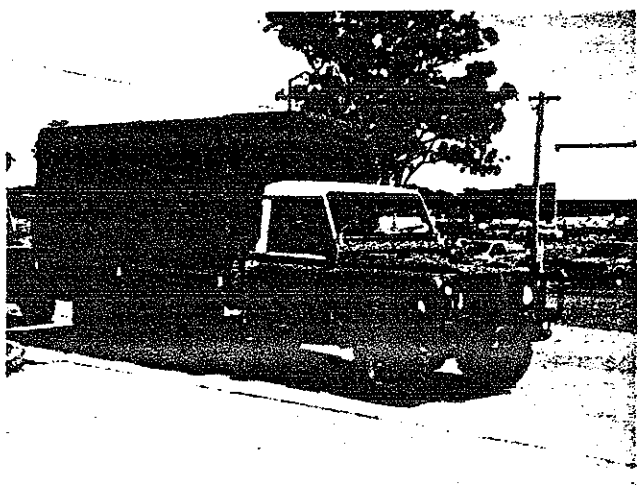
- A specialised extruded aluminium rear tray has been locally developed by Hockney Alcan for the two tonne vehicle. This features:
  - — Heavy duty extruded aluminium floor planking.
  - — Four identical double skinned removable side boards, two per side, and a heavy duty removable tail board.
  - — A fixed head board with extruded aluminium lower section and steel tube framed steel mesh upper portion.
  - — Two steel framed seats with folding cushion frame and extruded aluminium slats on the cushion and squab. Two sets of seat mountings are provided in the tray, enabling the seats to be fitted in the centre facing outwards, or along the sides facing inwards.

  The tray is bolted to the inverted channel sections along the rear chassis, and tied to the ends of the chassis crossmembers by tubular steel posts which also incorporate shackles for load tie downs.
- The Land Rover 6 x 6 vehicle also incorporates a slide out stowage drawer which fits between the chassis and the underside of the tray, and which holds the sideboards, tailboard, seats and hood ties when the vehicle is being used in flat top configuration — with the hood bows stowed in pockets at the front of the tray over the cab.

  Although this feature is not a specific Army requirement, it does enable the 2 tonne vehicle to be used in a variety of roles without having to discard any of its basic equipment.
- The one tonne vehicles — particularly the FFR soft top, the survey vehicle and the command post — have required the development of a large variety of special locally sourced body fittings:
  - — Special rear body mounted tool boxes with external access lids are required on all vehicles.
  - — Access covers for the heavy duty radio batteries and radio aerial support sockets are built into the FFR and hardtop vehicle body sides.
  - — A special low height fixed tailboard is fitted to the FFR vehicle.
  - — The FFR and hard top vehicles are fitted with special lighting, radio trays, and electrical distribution boxes.
  - — Folding longitudinal rear seats and inertia reel lap set belts are provided in all but the survey vehicle.
  - — The hard top vehicles are fitted with a high capacity forced draught ventilation system — to dissipate the heat from the specialised radio and electrical equipment.
  - — Hard top and station wagon vehicles are specified with reinforced fibreglass tropical roofs.
  - — A folding table and whiteboard, and a security locker are provided in the rear compartment of FFR and Command Post vehicles.
- All vehicles are required to be fitted with front and rear blackout lights, reduced headlamps and convoy lights.
- The vehicle's deditching tools are bonnet mounted for both the Land Rover vehicles, while chassis mounted stowage for one water and one fuel jerry can are also provided.
- A common locally sourced front brush guard is fitted to the one tonne and two tonne vehicles — incorporating the front recovery points, slinging points and shipping tie down fittings.
- The problem of providing front seat accommodation for three persons — if only occasionally — in the Land Rover cab, as well as providing accessible stowage for three rifles has proved to be one of our most difficult to solve satisfactorily.

  Our initial solution was to develop a single driver's seat and a dual passenger's seat, with three rifles mounted on a shadow board behind the seats. Access to the rifles was gained by tilting the seat squabs. This proved unsatisfactory during the trials, mainly due to unacceptable rifle access. Our production solution has been to develop a combined rifle stowage frame/centre seat, which will accommodate the occasional carriage of a centre passenger with three rifles stowed in recesses in the seat squab and cushion.
- Rotatable rear jaw type towing pintles are required on both vehicles. On the two tonne vehicle, which requires a high mounted pintle, its mounting bracket is designed to hinge down to provide access to the under-tray stowage area.

Land Rover 4 x 4 Military Soft Top



Land Rover 6 x 6 Military Vehicle

Australian Industry Involvement

The selection of military equipment is based largely on concurrent consideration of:

- equipment performances
- product support arrangements, i.e. supply and engineering support
- price and delivery arrangements
- the proposed level of Australian Industry Involvement (A.I.I.)

The weight given to each of these factors will vary with the operational significance of the equipment. However, given satisfactory performance, support and pricing, the final selection can be based on comparative levels of A.I.I.

In the context of the Perentie vehicles, Australian Industry Involvement comprises:

- the direct local content in the vehicles being supplied to the Army
- Offset

Every attempt has been made to maximise the practical level of local content in the vehicles being offered to the Australian Army.

To do this satisfactorily, given the relatively small numbers of vehicles involved, it has been necessary to adapt the vehicle to the available locally sourced components, rather than producing straight copies of the basic U.K. sourced hardware. For instance, we are offering a locally sourced PBR brake master cylinder and booster on the one tonne vehicle. This is basically common to the Ford Falcon assembly, and is fitted to the vehicle via a modified pedal mounting bracket and revised brake lines.

In the majority of cases, the locally sourced hardware has already been proved on the Army trials vehicles, being supplied on the vehicles initially, or fitted during the trials evaluation period.

Further higher levels of Australian content have been offered to the Army for consideration as "alternative tenders". This has included the offer of locally sourced Borg Warner Model 90 rear axles, and locally sourced rear disc brakes for the 4 x 4 and 6 x 6 vehicles.

The Borg Warner Model 90 axle has been designed as a heavy duty axle to supplement their current range of passenger car and light commercial axles. It is of similar size and torque capacity to our current Salisbury rear axle, but has the additional advantage of the availability of a cross axle differential locking mechanism.

Offsets are defined as work directed to Australia by an overseas supplier as a result of receiving a major order for equipment or services in which the Commonwealth Government is involved. The required minimum level of offsets is 30% of the imported value of the order.

In the case of our Perentie Vehicles, offsets can be generated by:

- Increasing the level of locally sourced parts in locally assembled civilian Land Rovers.
- Exporting locally sourced Perentie parts for use in U.K. Land Rover production.
- Exporting our Perentie Land Rovers for sale by Land Rover Limited.
- Exporting Australian manufactured components which are unrelated to the Perentie project for use by Land Rover U.K.

Specifically, we plan to generate offsets for the Perentie project by export of the Land Rover 6 x 6 vehicle to Land Rover Limited, who will market the vehicle through their world wide Sales network. A left hand drive V8 engined 6 x 6 vehicle is currently undergoing evaluation trials overseas, and a further export vehicle has since been produced.

Severity of Army Operation

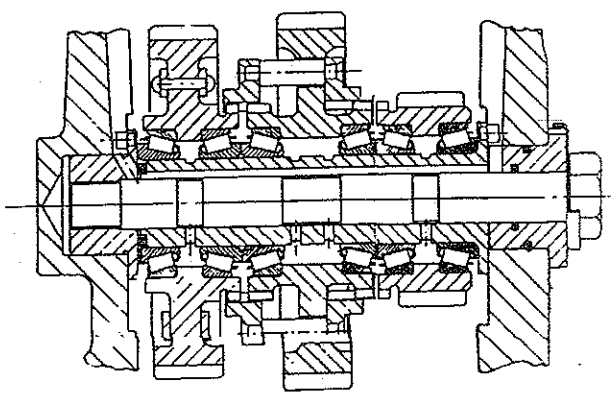
In addition to the provision of special Army fittings, and the incoporation of higher levels of local content, the Army vehicles need to be designed to accommodate higher loadings and more severe operation than their civilian counterparts of similar nominal payload. This is due to a combination of:

- The additional mass of the special Army equipment.
- The Army's definition of payload which is based on the difference between the gross vehicle mass and the mass of a vehicle fully equipped with driver and his kit and full fuel, oil and water — including full jerry cans.
- A greater percentage of off-road operation — at least during the evaluation trials.
- A significantly higher percentage of towing.
- A greater diversity of climatic conditions and vehicle operations.

Accordingly our Army vehicles have been uprated in a number of areas, amongst these being:

- The 4 x 4 vehicle's GVM has been increased to accommodate the Army's one tonne cross country payload.
- The 4 x 4 vehicle's chassis has been reinforced to counter the more severe operation — by incorporating the Land Rover armoured car chassis reworks.
- The LT95 transfer box intermediate gear mountings have been modified to accommodate the higher vehicle loading — using taper roller bearings to support the intermediate gears in lieu of the previous needle roller bearings and thrust washers.

This modification was locally developed for the Perentie vehicles, and is now being incorporated into production in U.K.



Modified Transfer Box Intermediate Gear Mountings

- The transfer box inter axle differential has been uprated for the Army vehicles to improve its durability. This has involved the provision of:
  - — Brass thrust washers and bushes to support the differential side gears.
  - — Scrolled oil grooves in the differential cross pins with a 'Niflor' (non electrous nickel plating with PTFE infusion) treated surface finish.
  - — A high performance friction modified engine oil (Castrol FMX) in the transfer box.

In addition, the differential lock vacuum switch has been relocated from its former heelboard location to a more accessible position in the centre of the fascia.

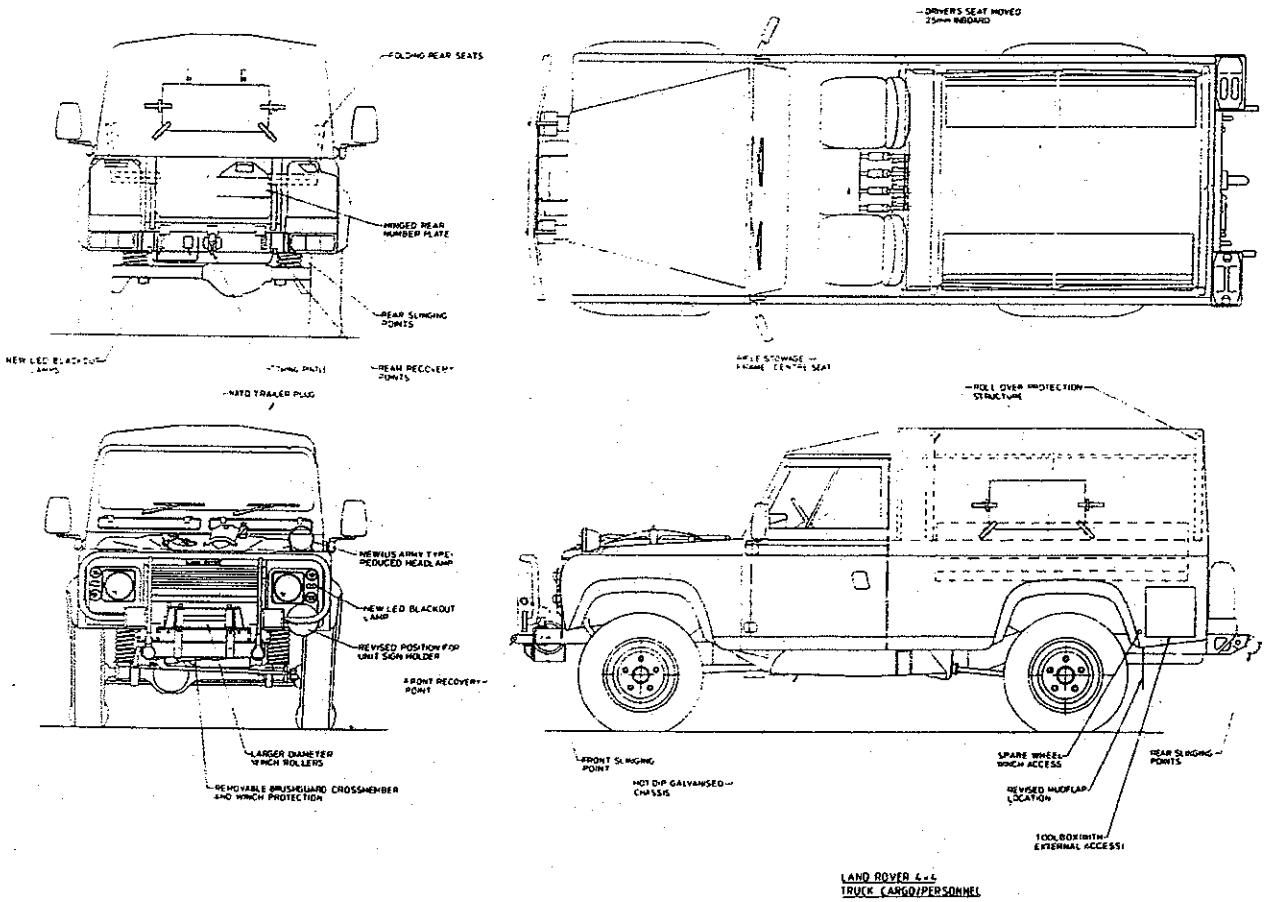
- The local road wheels have been uprated — firstly using HSLA wheel centres, and then by specifying thicker rim material.
- The locally sourced (Wylie) suspension dampers have been significantly uprated for Army operation, by incorporating a number of features from their suspension strut production:
  - — larger diameter piston rod (18 mm vs 16 mm)
  - — improved piston rod finish
  - — new 'Glacier' rod guide bush
  - — new 'garter' type seal
  - — improved mechanical rebound stop

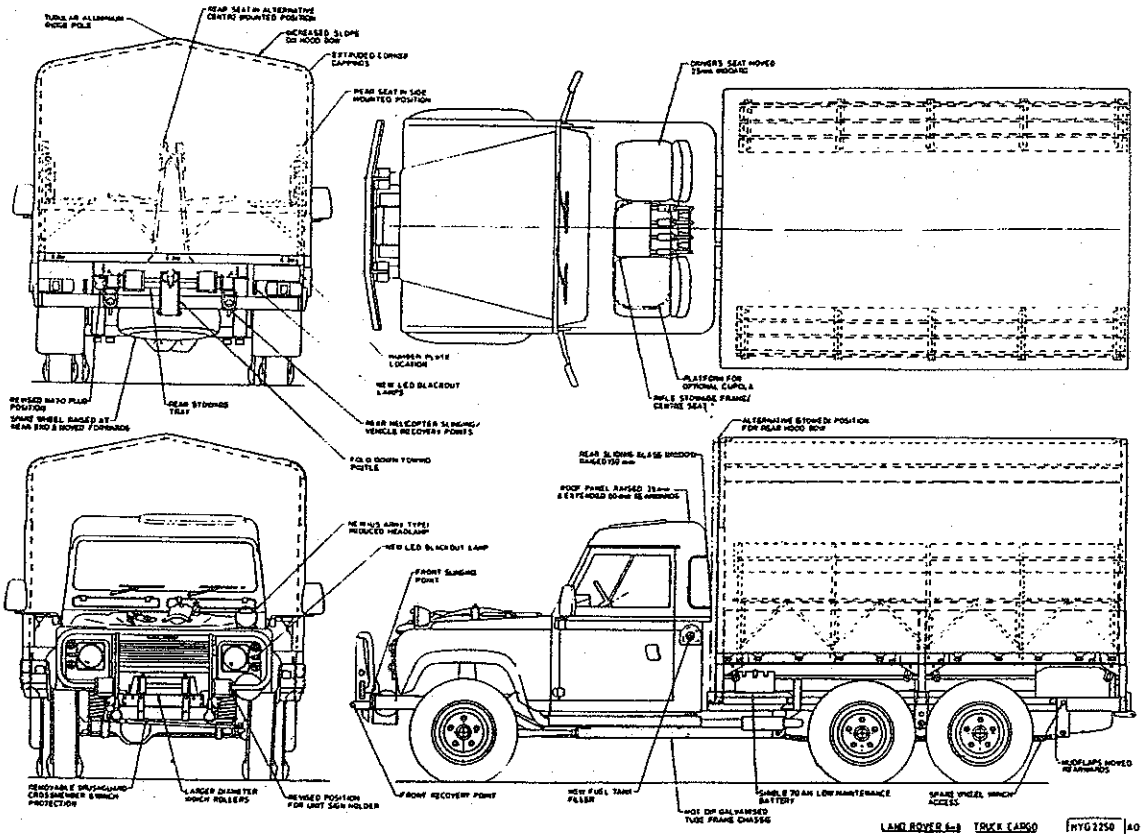
A welded on stone shield is also incorporated in rear suspension versions of the damper.

- A fully submersible starter motor is being specified for Army production — to accommodate the Army's stringent water wading requirements.
- The Army vehicle chassis are both finished by hot dip galvanising — to meet the Army's corrosion protection and operational requirements.
- The vehicle's paint finish complies with the government's Product Specification GPC-E-22/1 and Process Specification GPC22, the most stringent requirement of which is 1000 hours salt spray corrosion resistance. This is approximately twice the current industry standard for passenger cars, and has been met using a high durability urethane compatible epoxy primer, and a full polyurethane top coat.

The development of the vehicle specification to accommodate the Army's operating requirements, has again been a local responsibility — in conjunction with our local and overseas suppliers. Our ability to accomplish this task will be made public when the results of Project Perentie are announced in the not too distant future.

Drawings of the basic 1 tonne and 2 tonne payload cargo vehicles are shown on the following pages.





LAND ROVER 6x6 TRUCK CARGO FMYG 2250 A0