

National Code
of Practice

**STEERING
CONVERSIONS
FOR LEFT HAND
DRIVEVEHICLES**

INFORMATION FOR THOSE
ASSOCIATED WITH THE
DESIGN, MANUFACTURE,
SALE, MODIFICATION,
MAINTENANCE OR REPAIR OF
MOTORVEHICLES
AND TRAILERS



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Other Vehicle Standards Bulletins issued as at March 2002

- VSB 1National Code of Practice – Building Small Trailers
- VSB 2Maximum Road Speed Limiting for Heavy Trucks and Buses
- VSB 3Vehicle Safety Recalls Update
- VSB 4National Code of Practice – Steering Conversions for Left Hand Drive Vehicles
- VSB 5ANational Code of Practice – Commercial Manufacture and Installation of Additional Seats
- VSB 5B.....National Guidelines – Construction and Installation of Additional Seats by Individuals
- VSB 6National Code of Practice – Heavy Vehicle Modifications
- VSB 7ANational Code of Practice – Design Parameters Necessary for Compliance with ADR 59/00 – Omnibus Rollover Strength
- VSB 7B.....National Code of Practice – Design Parameters Necessary for Compliance with ADR 59/00 – Omnibus Rollover Strength
- VSB 8Discontinued
- VSB 9Installation of Lights on Road Vehicles
- VSB 10Importing Vehicles to Australia
- VSB 11.....Certification of Road Friendly Suspension

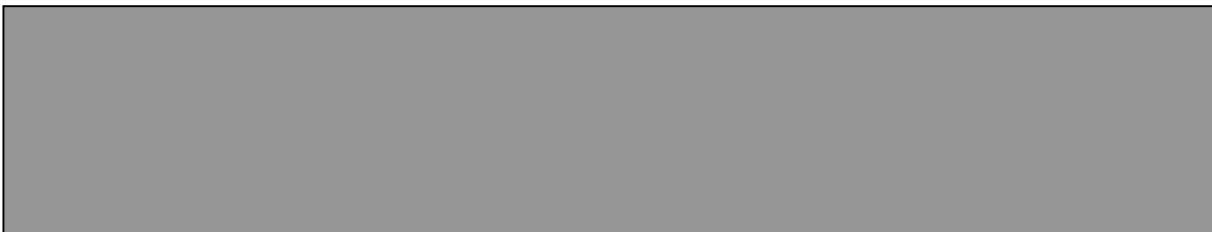
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Administrator of Vehicle Standards
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Australian Motor Vehicle Certification Board
comprising Commonwealth, State and Territory representatives



NATIONAL CODE OF PRACTICE

STEERING CONVERSIONS FOR LEFT HAND DRIVE VEHICLES

This Code does not cover administrative requirements, which are imposed by State, Territory and Federal jurisdictions



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SCOPE

This Code of Practice applies to cars, car derivatives and other light vehicles which need to be converted to right hand drive for registration in Australia. While it is generally applicable to trucks and other heavy vehicles, there is a separate Code of Practice for steering modifications to these vehicles. Conversion from left to right hand drive steering would also need to be accompanied by corresponding modifications to other features of the vehicle to make it suitable for use on public roads. This Code of practice also addresses these aspects.

CAUTION

Conversion of a vehicle from left hand to right hand drive configuration involves modification of the vehicle's brake and steering systems.

This has the potential to seriously affect the safe operation of the vehicle in the following ways:

Reduced Component Strength

Loads applied in an emergency situation, e.g. panic stop or loss of power assist to steering, can be very high.

A component which is modified and does not retain the strength of the original design may operate satisfactorily under everyday driving loads. However, under high loads it may fail catastrophically.

Susceptibility to Fatigue Failure

Poor design can lead to fatigue failure.

Vehicle manufacturers invest a great deal of time and money in producing components which will not be affected by fatigue failures. They do this through design, material selection, manufacturing controls and endurance testing using manufacturing techniques not readily adaptable to low volume modification procedures.

Fatigue can lead to the catastrophic failure of a component which performed satisfactorily for many years after modification.

Reduced Primary Safety

Modifications to steering can radically alter a vehicle's handling by introducing undesirable traits such as increased bump steer and poor self centering.

Even minor alterations to braking components can reduce the system's effectiveness.

Completed Vehicle Check for ADR Compliance

The completed vehicle must be checked for compliance with all applicable ADRs as original components retained may no longer meet ADR requirements eg. field of view through the internal rear vision mirror and an ALALR seatbelt in the driver's seating position.

Documentation

To provide assurance that all the aspects of the conversion have been addressed adequately, a list of the modifications must be retained.

The list must identify the components changed in the vehicle with sufficient information to confirm the adequacy of the replacement. This requires a comparison of the differences in the characteristics and functioning of the original and replacement components and systems and an assessment to indicate that the level of safety offered is not degraded by the modification. This comparison typically includes dimensions, strength, location, orientation, fit and function, the need for fail-safe provisions (if the level of seriousness in the case of failure is increased by the design changes made).

If the replacement component is new and to the original manufacturer's left hand drive specification no further information is needed in regard to that replaced component.

If the replacement component is new and to the original manufacturer's optional right hand drive specification then, where applicable, information is needed to confirm that it has been used in conjunction with all other related components used by the original manufacturer.

MODIFICATION REQUIREMENTS

Steering conversions for left hand drive vehicles can produce safe, driveable vehicles with no degradation of handling or braking performance if appropriate principles are observed.

The following guidelines apply:

- unmodified original manufacturers' components should be used wherever possible;
- original manufacturers' specifications should be replicated, e.g. steering geometry; relative locations of the driver's seat, steering column, steering wheel and foot controls.
- components which must be manufactured, or modifications to original components, should be designed conservatively;
- satisfactory provision must be made for lubrication and adjustment of play at all wear points;
- energy absorbing features of the original steering wheel and column system and front body must not be downgraded;
- no system or component may be used if it causes a reduction relative to the strength of the original system;
- welding, heating, bending, or deforming of components should be avoided if at all possible. Non-destructive testing is required if these processes are used;
- the overall finish should be compatible with the original vehicle, i.e. the conversion must not introduce potential injury-causing projections such as protruding bolts, sharp edges, etc.

Wherever the term Steering Box is used it also applies to Rack and Pinion assemblies.

GENERAL

Heating or Welding of Steering Components

While heating or welding of steering components such as steering connecting link, tie rods, pitman or idler arms, etc is not recommended it may be acceptable subject to an engineering report being submitted which includes comment on the following:

- material specifications of the component to be modified;
- specifications on weld material and compatibility with the parent material;
- description and/or diagrams of the preparation of the component if welding is involved;
- details of preheating if required prior to modification;
- details of heat treatment procedure after modifications;
- hardness testing before and after modification of the modified zone;
- results of non destructive testing supported by a certificate issued by a NATA approved materials testing laboratory to verify that the structural integrity of the component is maintained.

All welding must be in accordance with Australian Standard AS 1554 Part 1 1985 "*Welding of Steel Structures*" SP (Structural Purpose) category unless a higher standard is specified.

Fasteners

All fasteners on safety related systems (brakes, steering, etc) or in highly stressed locations must be at least of similar strength and number to those in the original installation. Self-locking nuts (nyloc) should be used in preference to spring washers.

SPECIFIC AREAS OF CONVERSION

In the following sections, recommended procedures are outlined for specific areas of the conversion.

CONVERSIONS USING STANDARD RIGHT HAND DRIVE COMPONENTS

If a vehicle is produced in a right hand drive model, the steering conversion should make use of the right hand drive components installed to the manufacturer's specifications. Caution should be exercised to ensure that the right hand drive configuration is replicated as certain components may have subtle differences.

All components must be mounted in accordance with the manufacturer's specifications in terms of positioning, number, grade and size of fixings, etc.

Steering Geometry

The vehicle's original steering geometry should be replicated as any variation may produce undesirable handling characteristics.

If the geometry is altered or the tie rod pick-up point locations are changed, a check on the vehicle's bump steer characteristics must be made.

This should be compared with the unmodified vehicle to verify that the modified vehicle's bump steer characteristics are of equivalent standard to that of the original vehicle.

STEERING BOX

A common type of conversion utilises a replacement steering box sourced for a right hand drive vehicle. If this is impractical, the use of left hand drive steering boxes or racks, retained in their original left hand location and operated through gearboxes, may be used.

Left hand drive steering boxes transferred to the right hand side and inserted in the chassis rail may only be used if the structural integrity of the chassis rail is shown to be maintained. This method of modification is generally inferior to other methods and is not recommended.

STEERING - RIGHT HAND DRIVE STEERING BOX

This is the preferred method of conversion. A suitable right hand drive steering box is mounted on the right hand chassis rail and the idler is transferred to the left hand side. In effect, a mirror image of the original steering installation is created.

Steering Box Selection

When selecting a substitute steering box, the following guidelines should be observed:

- the box should be sourced from a vehicle of approximate mass and specification to the vehicle being converted. Pitman arm length and arc of travel should be similar;
- taper for attachment of the drag link ball joint must match.

Steering Box Mounting

The steering box must be correctly located to replicate the original orientation of the steering box input shaft to the steering column and the pitman arm to the drag link.

The chassis rail may require modification to provide a suitable mounting face. Any reinforcing of the chassis rail on the left hand mounting area must be replicated on the right hand rail.

Suitable reinforcing tubes must be fitted through the chassis rail at each mounting point to prevent the retaining bolts crushing the box section.

Any modifications to the rail must not reduce its strength or cause stress concentrations. Allowance should be made in the design for the high torques from the steering box during operation.

Steering Box Coupling

As the input shaft on replacement right hand drive steering boxes is often different from that of the original installation, it may be necessary to modify or replace the coupling.

It is acceptable for the lower half of "Rag" type couplings to be removed and replaced with a machined component which mates with the steering box and coupling. Modified couplings must be of similar design and must have a torque capacity not less than that of the original. This can best be demonstrated by torque testing the original and fabricated couplings.

The use of "Rag" type couplings is limited to where the relative angle of the shafts to be coupled is minimal. If a "Rag" type joint is used, a mechanical fail-safe device (eg. pins engaged in the steel safety plate) must be fitted.

Welding of replacement couplings to steering columns is not recommended and may only be done if the structural integrity of the steering column is shown to be maintained.

Steering Idler

The preferred method of mounting the steering idler is to fabricate a mounting bracket which is attached to the original left hand steering box mountings.

This bracket must be designed to provide the correct location and angle of the idler in relation to the drag link.

The bolts attaching the idler arm to the fabricated bracket must be replaceable. This can be done by simply providing access holes in the backing plate.

Suitable reinforcing tubes must be fitted through the chassis at any additional mounting points.

Drag Links

Original right hand drive drag links should be used in preference to substitute or modified links.

Where drag links are asymmetrical, replacement or modification may be required to replicate the original geometry.

Substitute Drag Links

Substitute drag links obtained from standard production vehicles must not alter the original steering geometry. Any variation in steering geometry may result in inferior handling of the vehicle.

Replacement drag links which have been forged and machined to similar specifications to those of the original component are available. These should be used in preference to modified drag links.

Modified Drag Links

Modified drag links may be used providing the structural integrity of the drag link is shown to be maintained.

STEERING - CROSS SHAFT

With this method of conversion, the steering box and all steering linkages remain unaltered. The upper section of the steering column is transferred to the right hand side and is connected to the lower section of the column by means of two right angle gearboxes and an interconnecting cross shaft.

This method of conversion is not recommended for vehicles required to comply with ADR 69/.. – Full Frontal Impact Occupant protection and/or ADR 73/.. – Offset Frontal Impact Occupant protection.

ADR 69/.., applies to vehicles of;

- a) MA category for new models from 1 July 1995 and to all vehicles from 1 January 1998
- b) MB and MC category for new models from 1 January 1998 and to all vehicles from 1 January 2000 and
- c) NA1 category for new models built from 1 July 1998 and to all vehicles from 1 July 2000

ADR 73/.. applies to new models of MA category vehicles with a GVM of less than 2.5 tonnes built from 1 January 2000 and to all MA category vehicles with a GVM of less than 2.5 tonnes from 1 January 2004.

For these vehicles, an analysis must be conducted to show continuing compliance with these ADRs addressing at least the following items.

1. Details of the mounting of the cross shaft or chain drive assembly and an assessment of how the steering wheel may move (compared to the original configuration) in a crash test.
2. Details of the location of the cross shaft or chain drive unit and brake crossover shaft in relation to possible knee contact and femur load, giving due consideration to the possible forward movement of occupants during a collision.
3. Details of the steering wheel/column mounting compared to the original configuration and an assessment of the strength/movement of the mounting giving consideration to the fact that the lower section of the steering column has been disconnected from the upper portion. Consideration should be given to possible implications for the support/location of the driver's air bag.
4. Details of any energy absorbing elements in the steering wheel and column and an assessment of their performance compared to the original configuration.
5. Details of construction and an assessment of the new passenger's side dash in relation to its' energy absorbing characteristics compared to the original dash, giving consideration to the extreme head movements often observed in crash testing (eg head/knee strikes).

Right Angle Gearboxes

Only gearboxes specifically designed for motor vehicle steering applications may be used. These gearboxes are designed to withstand high torques at very low or zero rotational speed. They are also designed to eliminate backlash which would produce free play in a steering application. Industrial or aeronautical gearboxes are not suitable as they are normally designed to transmit lower torque at medium to high rotational speeds.

Input and output shafts of gearboxes must have a spline and cotter bolt recess.

Couplings

All connections to the gearboxes must be by means of correctly mating splines with clamping cotter bolts.

Cross Shafts

Cross shafts must be articulated at both ends by means of universal joints or fail-safe flexible couplings.

Design Loadings

All components, i.e. gearboxes, couplings, cross shafts and steering column connections, must be designed to withstand a torque of 200Nm.

Gearbox Mounting

The cross shaft gearboxes must be securely mounted to substantial mounting brackets to correctly align with steering column and cross shafts.

STEERING - FULLY ENCLOSED CHAIN DRIVE UNIT

With this method of conversion, the steering box and all steering linkages remain unaltered. The upper section of the steering column is transferred to the right hand side and is connected to the lower section of the column by a chain drive unit.

This method of conversion is not recommended for vehicles required to comply with ADR 69/.. – Full Frontal Impact Occupant protection and/or ADR 73/.. – Offset Frontal Impact Occupant protection.

For these vehicles, an analysis must be conducted to show continuing compliance with these ADRs addressing at least the items identified under the section headed "STEERING – CROSS SHAFT".

Enclosure

The chain drive and sprockets must be fully enclosed.

Drive Chain

The drive chain shall be at least a duplex chain. Some method of adjustment to eliminate freeplay must be provided.

Design Loadings

All components i.e. the chain, input and output shafts, bearings and steering column connections, must be designed to withstand a minimum torque of 200 Nm.

Input and Output Shafts

Input and output shafts of the unit are to be provided with a suitable means of connection to the respective shafts.

STEERING COLUMN

The steering column must be transposed to the right hand side and correctly aligned with the steering box and driver's position.

Mounting

The original upper column mounting is normally removed from the left hand side and remounted to the right hand side of the firewall. The mounting of this bracket must provide similar strength and rigidity to that of the original installation as it must resist the steering column load in a frontal collision.

Attachments must replicate those of the original installation. The column's mounting to the firewall must also replicate the original installation. (See section on brakes for details on firewall modifications.)

Collapse Operation

The features designed into most steering columns which allow a controlled collapse if the vehicle is involved in a frontal collision must not be affected. It is therefore necessary to ensure that mounting strength and geometry are replicated. Telescopic sections must not be extended or contracted from their manufactured specification.

BRAKES-GENERAL

The preferred method is for the master cylinder and all associated equipment and connections to be transferred from the left hand to right hand side of the vehicle.

Operation of the braking system may be transferred to the right hand side by installing a cross shaft to transmit the movement of the brake pedal which is mounted on the right hand side to the brake booster/master cylinder which is kept in its original position on the left hand side. This method is to be used only if it is impractical to reposition the brake cylinder on the right hand side.

All components must be securely mounted and correct operation must be maintained.

BRAKES - MASTER CYLINDER TRANSFERRED TO THE RIGHT HAND SIDE OF THE VEHICLE

Firewall

The section of the firewall on the right hand side of the vehicle onto which the brake master cylinder is to be mounted often has large openings originally used for airconditioning ducting. It is also commonly a different profile to the left hand side where the master cylinder was originally mounted. The firewall must therefore be modified to replicate the left hand side mounting profile. This may be done by inserting a suitable section removed from the left hand firewall of a similar vehicle or by fabricating a suitable section.

All fabricated sections should be of at least the same gauge material and incorporate similar reinforcing to that used in the original installation. They must be fully welded to the original firewall with an overlap of at least 10 mm.

All openings in the firewall must be permanently sealed to prevent entry of engine fumes into the vehicle cabin.

Mountings

The master cylinder and support brackets and the brake pedal support brackets must be remounted on the right hand side in a similar manner to the original installation, utilising similar fixing methods, i.e. number, grade and size of attachment bolts to be replicated.

The brake pedal support bracket may be modified to give the opposite offset for right hand drive provided it retains or exceeds its original strength.

Brake Pedal

The original left hand drive brake pedal is to be used if possible. Alternatively, a new pedal may be fabricated having similar cross-section and dimensions to those of the original pedal.

While a one piece pedal is preferred, if the pedal must be cut and welded, non-destructive testing must be performed to verify that the structural integrity of the component is maintained.

Brake Pipes

Brake pipes are not to be extended. New steel bundy tube brake lines of the correct bore must be fitted as necessary. All flares, tapers and threads must correctly mate with the original equipment. All brakepipe work must be adequately supported throughout its length and protected from abrasion.

Electrical Connections

Electrical circuits to brake fluid level sensors and circuit failure switches may be extended but the systems must operate correctly.

Operation

Correct operation of the pedal, operating linkages, booster and master cylinder must be maintained. The full stroke of the master cylinder must be available and the pedal ratio must not be altered.

BRAKES - CROSS SHAFT OPERATION

Loadings

The cross shaft and all associated mountings, levers, pivots, bearings, push rods, etc must be designed to withstand loads imposed under an emergency situation, i.e. an application force at the pedal pad of not less than 1800 N.

Deflection of the shaft at maximum loading must not be of such magnitude that it prevents the full stroke of the master cylinder being used.

Cross Shaft Bearings

The cross shaft must be mounted on suitable selfaligning and selflubricating bearings and bushes. Retaining collars or spacers must be fitted as necessary to locate the shaft longitudinally. Location by means of grub screws or similar is acceptable provided collars and/or spacers prevent axial movement should these screws fail.

Brake Pedals and Operating Levers

Brake pedals and operating levers must be drilled to allow the full diameter of the cross shaft to pass through. Full circumferential fillet welds should then be used to attach the pedal or lever to the cross shaft.

Mountings

The mountings for the cross shaft bearings must be securely attached to the vehicle's structure and must be sufficiently rigid to prevent binding of the shaft in its bearings at the maximum design loads.

Pivots

The pivot pins in the linkages must be manufactured from hardened material unless selflubricating bushes are fitted. The pins must be retained by means of suitable clips or split pins and washers.

Bolts as pins, with self-locking nuts as retainers, are not acceptable.

Operation

The design of the cross shaft and linkages must provide similar mechanical advantage between pedal and master cylinder to that provided by the vehicle manufacturer.

Full travel of the master cylinder stroke must be provided.

AIR-CONDITIONING AND VENTILATION

Effective windscreen demisting must be maintained for the modified vehicle.

Repositioning of the ventilation/air-conditioning system to the left hand side of the vehicle and any other necessary modifications must not lead to a reduction in effectiveness.

DASH PANEL AND CONTROLS

The original or an equally effective crash pad must be used. All instruments and controls must be repositioned on the right hand side in a similar location with respect to the driver as in the original vehicle.

Joints in any panels must not result in any weak points.

WINDSCREEN WIPERS

All LEP, MA, MB, MC and MD1 category vehicles must show proof that Area C is 99% wiped when measured by a method that meets the intent of SAE J903c "*Passenger Car Windshield Wiper Systems*" (Refer Figure 1).

As an alternative, it is acceptable practice to mirror image the pivots and wiper arms of a left hand drive wiper sweep pattern when converting a vehicle to right hand drive.

ELECTRICAL WIRING

Wiring must be at least equivalent to the original vehicle in terms of connections, wire size, insulation, support and protection from abrasion, etc.

HEADLAMPS - MAIN AND DIPPED BEAMS

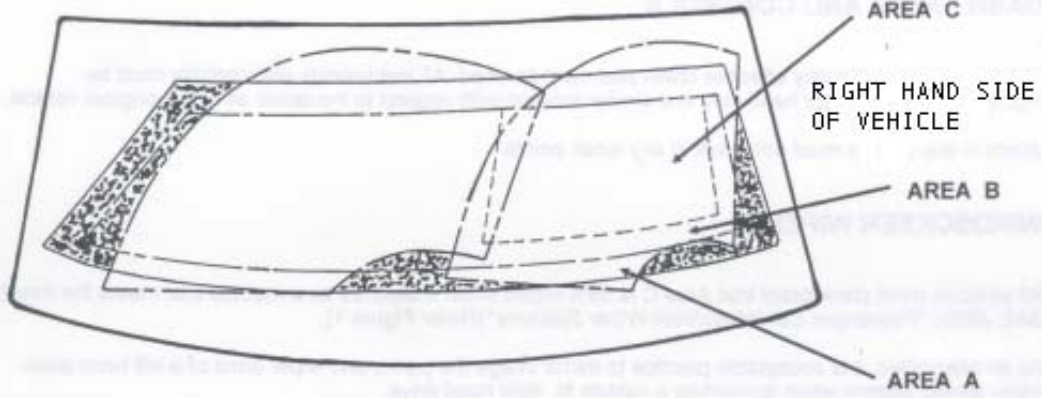
Main (driving) and dipped (passing) beams must be directed to meet the requirements of driving on the left hand side of the road.

EXTERNAL MIRRORS

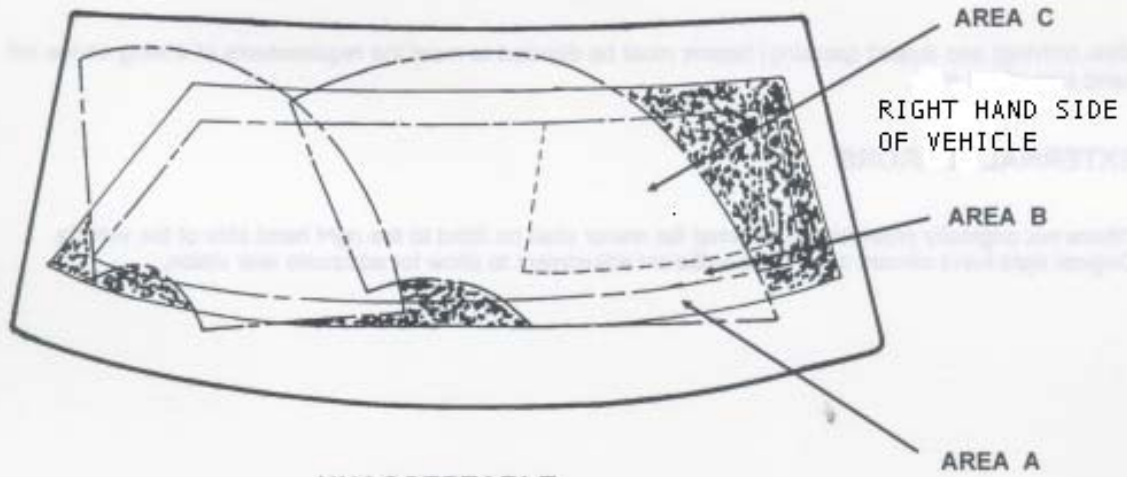
Where not originally provided, an external flat mirror shall be fitted to the right hand side of the vehicle to provide the field of view required by ADR 14/..Rear Vision Mirrors. Original right hand mirrors must have sufficient adjustment to allow for adequate rear vision. Otherwise the right hand side flat mirror must be re-positioned or replaced by a flat mirror to provide the required field of view.

FIGURE 1

VIEW FROM DRIVERS SEAT LOOKING FORWARD



ACCEPTABLE



UNACCEPTABLE