Section H

Chassis

Contents

Section H — Overview

1. Description

This section of Vehicle Standards Bulletin 6 (VSB6) relates to modifications of heavy vehicle chassis and details requirements to modifying other vehicle parts that may be affected.

Common reasons for chassis modifications are:

- increased or decreased wheelbase
- increased front and rear overhang
- increased gross vehicle mass (GVM) (e.g., additional axles)
- special body requirements (e.g., low load height)
- increased localised loading due to special equipment such as hoists, cranes or large fuel tanks.

Not covered by this section of VSB6

Although this section applies to the modification of a motor vehicle or trailer, unless specifically mentioned, it does not apply to a trailer that has been modified to change the trailer's basic type, e.g., semitrailer to dog trailer, pig trailer to dog trailer, semitrailer to dolly, etc. When the modification of a trailer results in a change in trailer type, the trailer is regarded as being re-manufactured rather than modified and as such, a new RAV entry approval and new vehicle identification number (VIN) issued to identify correctly the trailer and the manufacturer.

Conversion of a semitrailer to a B-double lead trailer is not a change of basic trailer type and must be done in accordance with the applicable sections of VSB6 including sections G and P.

Modification codes

This section of VSB6 consists of the following modification codes:

H1	Wheelbase extension outside OEM* options • extension of existing chassis • re-location of axle or suspension assemblies • replacement of original chassis with one of greater length.
H2	**Wheelbase reduction outside OEM options** • reduction of existing chassis length • re-location of axle/suspension assemblies • replacement of original chassis with one of shorter length.
H3	**Wheelbase alterations within OEM options** • wheelbase extension or reduction within first manufacturer's options • re-location of axle/suspension assemblies • replacement of original chassis with one of greater length.
H4	**Chassis alteration** • chassis alteration • cross-member alteration.
H5	**Trailer chassis modifications** • chassis modifications where the registration category or configuration of the trailer to be modified is not changed • trailer chassis extension or reduction, including dimension between point of articulation and: – rear overhang line – rear end • chassis alterations for the fitting of suspension substitutions (including relocation of suspension systems) • installation or removal of cross-members • attachment of components to the chassis such as container twist locks.

OEM = original equipment manufacturer

2. Related Australian Design Rules

The Australian Design Rules (ADRs) relevant to this section of VSB6 include:

ADR no.	Title
Vehicle chassis	
7/..	Hydraulic Brake Hoses
13/..	Installation of Lighting and Light-signalling Devices on other than L-Group Vehicles
35/..	Commercial Vehicle Brake Systems
38/..	Trailer Brake Systems
42/..	General Safety Requirements
43/..	Vehicle Configuration and Dimensions
44/..	Specific Purpose Vehicle Requirements
62/..	Mechanical Connections Between Vehicles
64/..	Heavy Goods Vehicles Designed for Use in Road Trains and B-Doubles
84/..	Front Underrun Impact Protection
92/..	External Projections
Trailer chassis	
13/..	Installation of Lighting and Light-signalling Devices on other than L-Group Vehicles
43/..	Vehicle Configuration and Dimensions
44/..	Specific Purpose Vehicle Requirements
62/..	Mechanical Connections between Vehicles
63/..	Trailers Designed for Use in Road Trains

3. Record keeping

The person responsible for certifying the modification should:

- collate complete records, including drawings, calculations, test results and copies of the appropriate issue of Australian Standards and related Australian Design Rules
- retain the records for a minimum of seven years after commissioning of the modified vehicle
- make the records available upon request for inspection by officers of the relevant federal, state or territory authority or relevant heavy vehicle regulator.

Reports and checklists

The person certifying the modification must complete and record the following reports and checklists as applicable:

H Calculation sheet	Chassis modification
H1 Checklist	Wheelbase extension outside OEM options
H2 Checklist	Wheelbase reduction outside OEM options
H3 Checklist	Wheelbase alterations within OEM options
H4 Checklist	Chassis alteration
H5 Checklist	Trailer chassis modifications

4. Design requirements

General information

The chassis is the backbone of a heavy vehicle, and its main function is to carry the maximum load safely in all designed operating conditions. It absorbs engine and driveline torque, endures shock loading and accommodates twisting on uneven road surfaces. To ensure a modified heavy vehicle chassis remains safe under all operating conditions, any modification must be subject to careful design and rigorous testing.

Typically, heavy vehicle manufacturer's employ C-section chassis rails in their vehicle design. To ensure vehicle safety or performance will not be affected, modification of a C-section chassis should only be performed after consulting with the vehicle manufacturer, or a professional engineer registered with a professional registration body. Vehicle specifications should remain within the options offered by the original manufacturer. If they differ, then the chassis must meet at least the requirements outlined in this and other sections of VSB6. Heavy vehicle chassis design varies greatly but the focus of this section of VSB6 is on medium to heavy goods vehicles (NB and NC category vehicles) and the following guidelines apply primarily to vehicles of this type.

Manufacturers may also incorporate top hat or box section chassis into their vehicles. These vehicles can be modified under this VSB6 section, however, any modifications must be performed in accordance with the vehicle manufacturer's modification guidelines.

The following design requirements apply to most of the modification codes in this section of VSB6.

If the original manufacturer's instructions are unavailable, these requirements apply:

Required:

- Where chassis alterations result in modifications to the wiring harness, ensure, where possible, replacement harnesses are installed to avoid cutting/splicing. Seek guidance from the vehicle manufacturer about the preferred method for lengthening or shortening wires or cables.
- Ensure all fabricated sections of the chassis rail and components have bends of suitable radius and are free of cracks, notches and imperfections.
- As far as possible, keep all additional material used to modify the chassis rails to the same dimensions and material specifications.
- Fasten all attachments to the web of the chassis.
- Ensure all modified chassis rails are straight and square before assembly.
- Do not straighten bowed chassis rails by assembly of the frame (i.e., bolting everything together to straighten the chassis).

Recommended:

- Use the original manufacturer's chassis rail material if available.
- For additional or relocated cross-members, maintain the original manufacturer's design maximum spacing, strength and attachment strength.

Holes

Required:

- Ensure all new holes in the chassis are in line with the Drilling holes in chassis' sub-section in VSB6 Section H — Overview.

Bolts and fasteners

Required:

- Ensure all bolts for structural purpose are high tensile bolts in at least, ISO Grade 8.8 (or SAE Class 5).
- Use the vehicle manufacturer's recommendations to select bolt diameter.
- Ensure bolts used to secure suspension hangers and brackets to chassis are at least ISO grade 10.9 (or SAE class 8).
- Tighten all bolts in an acceptable manner to the correct torque.
- Avoid using countersunk bolts where possible, and where unavoidable, make allowance for the lower tensile capabilities of countersunk bolts.
- Observe the manufacturer's re-usability limitations on fasteners (bolts, nuts, locknuts, huck bolts etc.).

Recommended:

- Fasten attachments to the chassis rail by bolting and not by welding.
- Fitted bolts are preferable.
- Huck bolts may be used for fastening chassis components.
- Fit all structural bolts with suitable washers or doubling plates with self-locking nuts.
- Do not use spring type washers on structural members.
- Replace all fasteners (bolts, nuts, locknuts, huck bolts etc.) that have been removed with new fasteners of the correct size and grade. In the case of new vehicles — that is, modified before going into service — fastener replacement may be limited to only new locknuts.

Advanced braking systems

Advanced braking systems are an important safety feature fitted to many new vehicles.

Advanced braking systems are programmed by the vehicle manufacturer and are specific to the vehicle to which they are fitted. Changes made to the vehicle, such as engine, tyre size, steering control, suspension characteristics, vehicle mass and its distribution, may impact the performance of the advanced braking system.

Exercise extra caution when modifying vehicles fitted with advanced braking systems. Electric braking systems may be known as:

- electronic stability control (ESC)
- electronic stability program (ESP)
- vehicle stability control (VSC)
- dynamic stability control (DSC)
- vehicle stability assist (VSA)
- roll stability control (RSC)
- roll control system (RCS)
- electronic braking system (EBS)
- trailer electronic braking system (TEBS).

- Advanced braking systems and their components may be easily damaged by common modification, maintenance and servicing techniques, such as the use of rattle guns within one metre of the sensors. When undertaking any work on a vehicle fitted with an advanced braking system, ensure all modifiers are familiar with these systems and the precautions that must be taken.
- Ensure that before undertaking any modification on a vehicle that is fitted with an advanced braking system the modifier and approved vehicle examiner (AVE) consult with the vehicle manufacturer to determine the impact on the system.

Chassis reinforcing

Recommended:

The following requirements apply to chassis rail reinforcements:

- Do not terminate reinforcements within a distance 2H from the centre of a spring hanger (H = the chassis rail depth) unless in line with the vehicle manufacturer's specifications (see Figure 1).

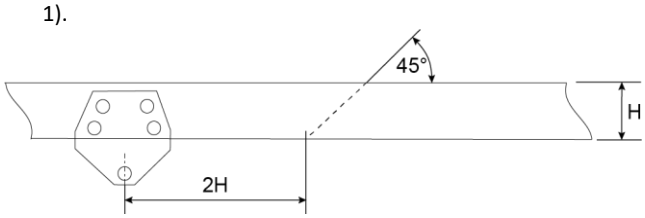


Figure 1: Reinforcement termination distance

- Extend the reinforcement section at least 2H past a chassis rail join.
- Extend additional reinforcement at least 2H forward of the rearmost front spring hanger bracket and rearward past the rearmost rear spring hanger bracket by a distance of 2H.
- Consider allowance for associated components that would be displaced by the reinforcement section.
- Taper each end of a reinforcement at 45 degrees, or alternatively, use a frog-mouth tapering (see Figure 2).

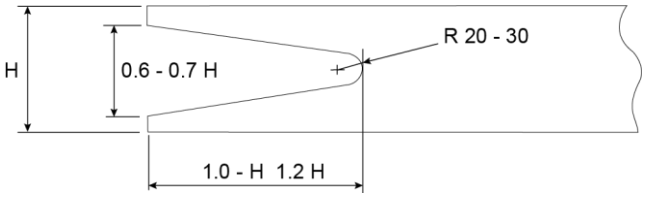


Figure 2: Typical frog-mouth tapering

- Reinforce chassis joins that are not in low stress areas to ensure adequate chassis strength.
- Ensure the thickness of each reinforcement does not exceed the thickness of the chassis at the point of reinforcement.
- Make reinforcement section either an angle or channel.
- Attach all reinforcements securely to the chassis. Fasten reinforcements by bolting, using existing bolt holes if possible.
- Taper the ends of any reinforcing section to reduce abrupt change in chassis stiffness as a result of reinforcement installation.
- Ensure the inside radius *Ro* of outer reinforcement curvature is smaller than outside radius *ri* of chassis curvature (see Figure 3).
- Ensure outside radius *ro* of inner reinforcement curvature is larger than inside radius *Ri* of chassis curvature (see Figure 3).

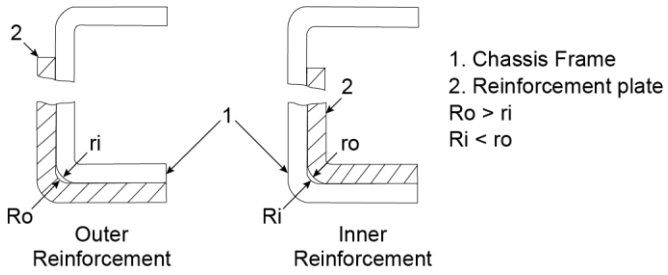


Figure 3: Reinforcing material corner radius

Multi-section chassis rail reinforcements:

A chassis that is upgraded over its entire length may not easily accommodate a full-length reinforcement section due to the installation of other chassis components. One acceptable way of overcoming this difficulty is to use multiple reinforcement sections.

Required:

- When this method of chassis reinforcement is utilised, attach reinforcements securely to each other, either by overlapping and bolting or by butt welding.

5. Installation requirements

Cutting of chassis rails

When a chassis modification involves cutting a frame, regardless of the reason (e.g., to drop, taper, lengthen or shorten the rails), consider restoring its structural integrity.

Required:

- Consider, in particular, these two situations:

Load distribution on chassis is unchanged or improved	This may occur in wheelbase shortening and chassis dropping modifications. If so: • restore the equivalent resistance to any bending moment in the modified chassis to produce satisfactory results • consider the location of any chassis joint in highly stressed areas, the method of joining and the reinforcement of the joint.
Wheelbase is increased by lengthening chassis between wheels or adding an axle behind the rear axle	The load distribution may increase the bending moment on the modified chassis beyond the acceptable values. If the load distribution changes: • compensate for additional loading by calculating the new bending moment for the vehicle and in conjunction with the nomogram, determine its required section modulus (see Overview, 6. Examples — calculations) • Calculate the weight distribution – Calculation of weight distribution for a vehicle requires determination of the centre of gravity (CoG) for the various elements involved. These are normally available from the vehicle and equipment manufacturer data sheets. Using an outline diagram, to approximate scale, will simplify the process and provide a useful aid to check body length and other critical dimensions. The example on the following page is for a typical vehicle mounted lifting system (VMLS) mounted behind cab on a two axle truck which has a wheel base of 4250 mm.

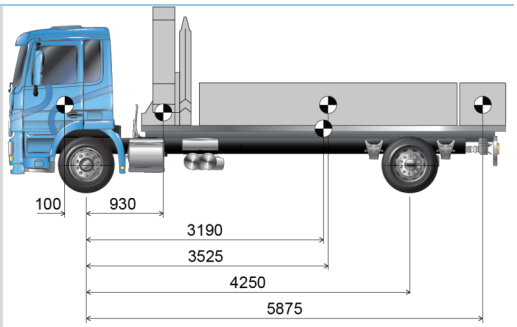


Figure 4: Weight distribution example (units in millimetres)

Weight imposed on:

- front axle = weight/wheelbase x distance rearwards of front axle
- rear axle = weight - weight imposed on front axle

Item	Total weight	CoG distance from front axle	Imposed mass (kg)	
			Front axle	Rear axle
Cab/chassis	3890 kg	2764 mm	2530	1360
Subframe	180k g	3190 mm	45	135
VMLS	1180 kg	930 mm	922	258
Driver	150 kg	-100 mm	154	-4
Body	1100 kg	3855 mm	102	998
Payload 1	4000 kg	3525 mm	682	3318
Payload 2	900 kg	5875 mm	-344	1244
Total	11400 (GVM)		4091	7309

Recommended:

- Cut and bevel chassis members with metal cutting wheels or by using plasma cutting. Heat from oxyacetylene cutting or excessive grinding will reduce the strength of a heat-treated rail.

Chassis cut-outs

If a different type of engine is being installed into a chassis, the cut-outs in the chassis may need to be altered to suit the new engine. Always keep chassis cut-outs for any such modification to a minimum to avoid excess stress in the chassis and as far as possible meet the following conditions:

Recommended:

- Provide the profile of all cut-outs with a smooth transition to the original chassis profile. To obtain a smooth transition:
  - do not allow the taper in the chassis flange to be greater than 1 in 5, i.e., make the flange width decrease progressively 10 mm's over a 50 mm length of chassis rail
  - provide a minimum radius of 100 mm on all internal and external corners of a chassis rail cut-out.
- Do not position chassis cut-outs behind the rearmost hanger bracket of the front suspension unless the chassis is adequately reinforced.
- Provide reinforcement on chassis cut-outs that remove more than 50% of the chassis rail flange.
- Dress all edges of a cut-out smoothly by fine grinding or finishing in the longitudinal direction of the rail. Do not allow nicks, blow holes, punch marks or any other imperfection that could initiate cracking of the chassis rail.
- Do not make unnecessary holes in the chassis rail adjacent to cut-outs.
- Do not position cut-outs in the upper and lower flanges on the same chassis in close proximity unless it is appropriately reinforced.

Welding of chassis

Required:

- Where heat–treated chassis rails are fitted, ensure advice from the chassis manufacturer is obtained about the suitability of welding these rails.
- Before performing any welding on a vehicle chassis, obtain the material specifications of the chassis so that the correct welding consumables and welding procedure are used.
- Follow the vehicle manufacturer's recommendations for welding and preparation (i.e., pre-heating).
- Always attach the earth welding cable terminal as closely as possible to the region in which welding is being carried out.
- Never attach the earth terminal to components such as axles, springs, engine, driveline, etc. Arcing on these components may cause serious damage to bearings, springs, or other stressed components etc. and parabolic leaf springs are particularly sensitive to surface damage.
- Ensure the electrode or the earth clamp does not come into contact with electrical component casings (e.g., ECU's).
- On vehicles fitted with SRS airbags, consult with the manufacturer before working on the vehicle or consider disconnecting them.
- Before welding any part of the cab consult the manufacturer as some use a stressed shell to provide cab strength and integrity; welding can affect the strength of such cabs.
- Take care to protect suspension parabolic leaf springs, air suspension springs as well as brake and air and electrical system hoses, wires and conduits against:
  - cutting and welding sparks and spatter
  - temperatures exceeding 80 degrees Celsius.

↘ Leaf spring fracture can be caused even by momentary exposure to welding spatter.

- Remove fuel tanks and pipes from the vicinity of welding.
- Before welding, disconnect the alternator, batteries, regulator and, if fitted, electronic components for the anti-lock braking system (ABS) and engine management systems.
- Remove all paint, dirt and grease from the areas to be welded.
- Choose welding consumables and heat treatment and surface preparations in accordance either with recommendations of the vehicle manufacturer, or a professional engineer registered with a professional registration body.
- Perform all welding in accordance with the original manufacturer's recommendations, and Australian Standard *AS 1554 Structural Steel Welding* Category SP.
- Ensure this is done by a qualified tradesperson.
- Position surfaces to the correct gap prior to welding.
- Apply full edge preparation to joins in chassis rails on the top and bottom flanges. Weld these continuously all around.
- Do not cool welds with water.
- Avoid welds transverse to the rail flanges where possible and do **not permit these in areas** of high stress.
- Do not perform transverse welding on chassis flanges other than as part of a repair or join in the chassis.
- Perform chassis welding from both sides, where feasible, to ensure full penetration.
- Grind flush all welds (up to 10% increase in chassis thickness is permissible but not recommended) (See Figure 5).

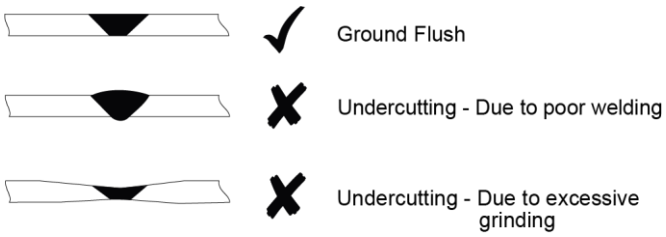


Figure 5: Weld finishing

- Do not allow welds to exhibit excessive undercutting.
- Do not weld within 15 mm of the edge or bend radius of a chassis flange, unless otherwise stated by the manufacturer or when joining chassis rails. (See *Figure 6*).

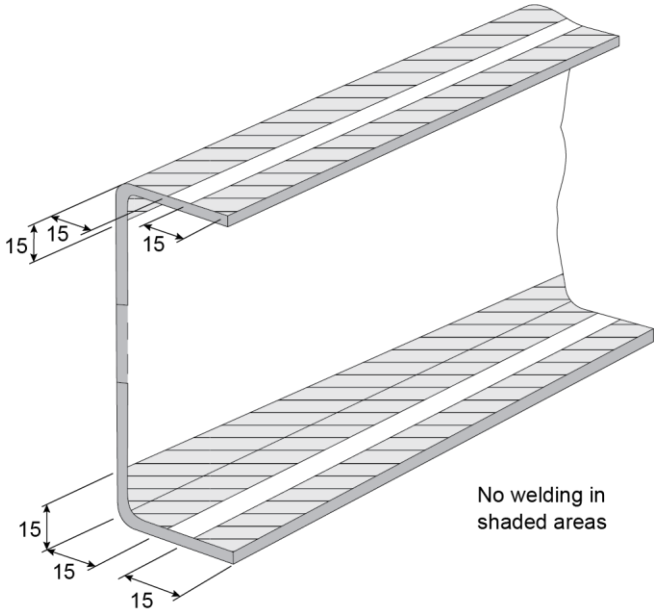


Figure 6: Chassis rail allowable welding areas

Recommended:

- Ensure minimum length of any weld is 30 mm and that stitch welds are 30–50 mm long and spaced 30–50 mm apart.
- Grind in the direction of chassis rail length, (see Figure 7) (i.e., so any grinding marks are along the chassis).

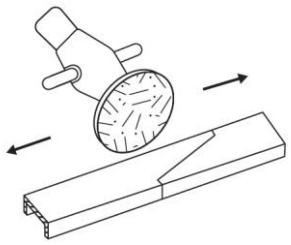


Figure 7: Direction of grinding

- Fill unused holes in critical areas with fitted filler bolts.
- Plug weld holes on non-heat treated chassis rails but limit this technique if you need to re-drill close to the original hole.
- Weld holes from both sides of the chassis rail. If only one side of the chassis rail is accessible, proceed as suggested in Figure 8.

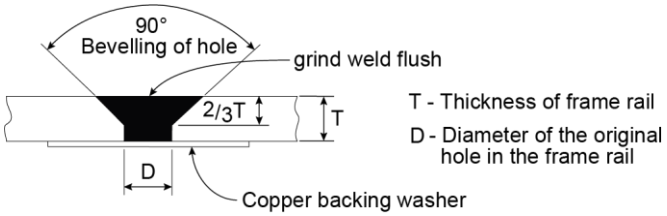


Figure 8: Example of preferred method for weld filling holes from one side

- If holes with a diameter (D) greater than 20 mm are to be weld filled, then weld a disc into the hole to eliminate excessive use of weld. Complete the weld from each side of the chassis rail and then finish it (see *Figure 7*).
- Except when joining the chassis flange or fitting longitudinal strapping, do not place welds within 25 mm of flanges. Welds may be ground flush with the chassis rail, but avoid grinding back the weld and chassis rail material excessively and thereby reducing section thickness.
- Use low-hydrogen consumables to weld suspension brackets.
- Remove all paint, dirt and grease in the area of the weld before welding.
- In low ambient temperatures or if there is dew or other moisture present, slightly warm the area to be welded i.e., with an oxy-fuel torch.
- Remove auxiliary air and oil tanks in the vicinity of welding

Welding heat treated chassis rails

The following applies to modifications involving the welding of heat treated chassis rails.

Required:

- Do not weld heat-treated chassis rails in areas of peak stress; these are usually the upper and lower flanges together with 40 mm of the web adjacent to the flange (See *Figure 9*).

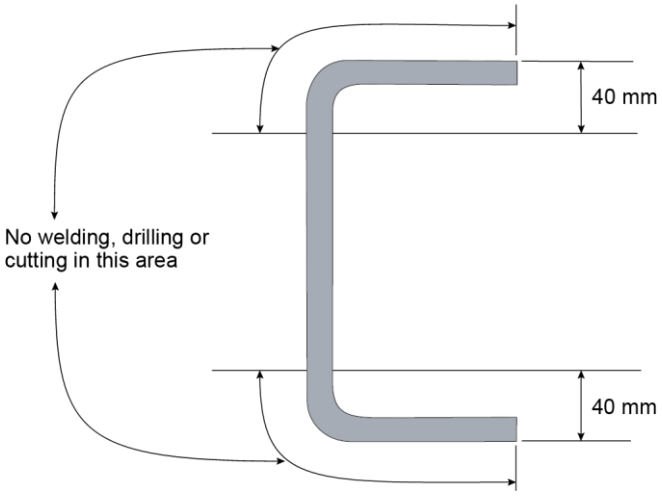


Figure 9: Diagram of welding, drilling, and cutting prohibited area

- Where the vehicle manufacturer does not endorse or recommend welding of heat-treated rails, you cannot override that requirement.

Recommended:

- Source the vehicle manufacturer's recommendations before performing modifications on a heat-treated chassis rail.
- Identify heat-treated metals using the Rockwell test or other hardness test.
- If you cannot avoid having to weld this type of chassis rail, choose proper welding consumables, preparation and make allowance for reduction in the allowable tensile yield strength.

➘The typically tensile yield strength of a chassis may vary significantly depending on the origin of the vehicle.
Typical tensile yield strengths are:

Vehicle origin	Typical tensile yield strength
America	750–800 MPa
Europe	450–500 MPa
Japan	300–350 MPa

➘ When welding these chassis, follow the vehicle manufacturer's requirements. Where the manufacturer's requirements are not available or where preheat treatment of the chassis before welding cannot be accomplished, the tensile yield strength of the chassis is likely to reduce to 250 MPa. Improper choice of welding filler (i.e., rods) may further reduce the yield strength of the chassis.

- Do not plug holes in a heat-treated chassis rail to fit chassis components unless absolutely necessary. Reduction in strength due to loss of heat treatment greatly exceeds any advantage that may be gained by plugging the holes.

Types of cross-members

There are four types of cross-member that can be fitted to a vehicle:

1. Rear suspension cross-members
2. Intermediate cross-members
3. End of frame cross-members
4. Special cross-members

1. Rear suspension cross-members

Recommended:

- To achieve satisfactory service life for rear suspension cross-members, you need to support the rear suspension correctly.
- Attach each rear suspension hanger bracket to a cross-member (see *Figure 10*) to prevent excessive flexing of the chassis rail at these highly stressed areas.

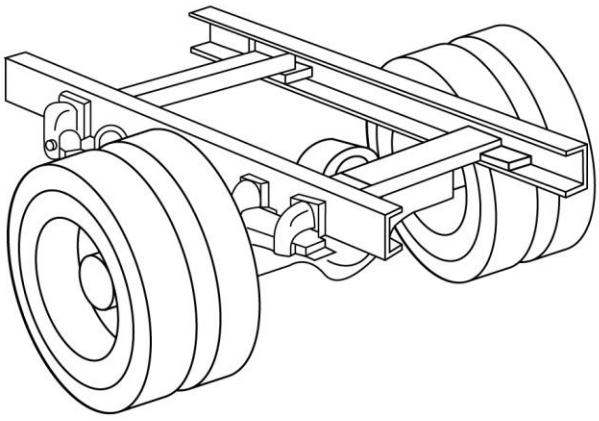


Figure 10: Example of rear suspension cross-members

- Design the gussets on suspension cross-members so that the attachment bolt holes align with those for the spring hanger.
- For a two-spring type tandem rear suspension, install a butterfly type cross-member, notably for suspension types such as single point and walking beam (see *Figure 11*).

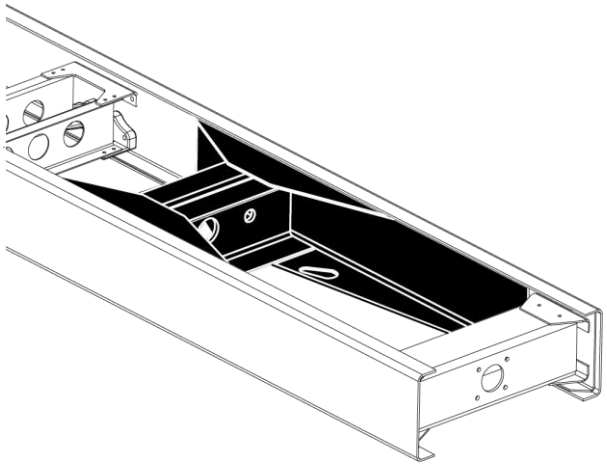


Figure 11: Example of a butterfly type cross-member

- For a four-spring type tandem rear suspension, mount individual cross-members between each pair of spring hangers (see Figure 12).

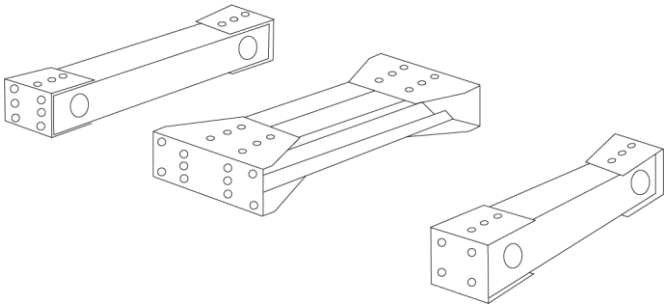


Figure 12: Typical four-spring suspension cross-member arrangement

2. Intermediate cross-members

Examples of typical intermediate cross-member designs are shown in Figures 13, 14 and 15.

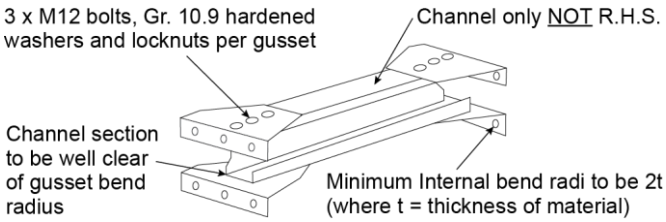


Figure 13: C-section

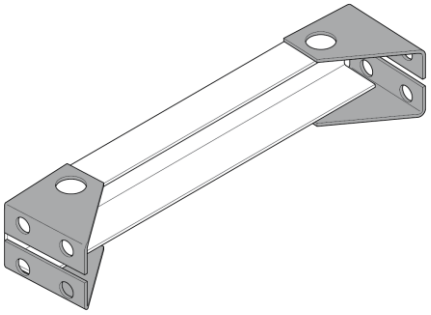


Figure 14: Example of typical intermediate cross-member design

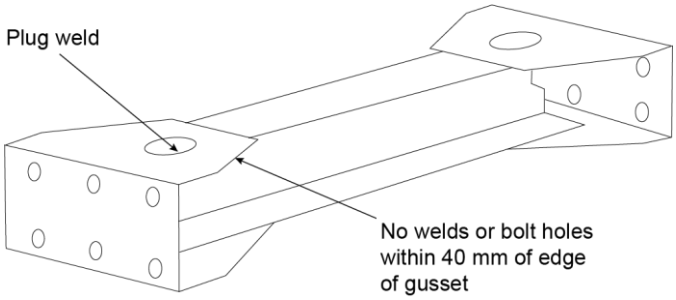


Figure 15: Example of typical intermediate cross-member design

Recommended:

- Ensure all intermediate cross-members are of similar type to avoid stress concentration in the region of the cross-member with greater torsional stiffness.

3. End of frame cross-members

As cross-members in the rear chassis overhang are of similar design to the other intermediate cross-members, *end of frame* (EOF) cross-members also need to be similar. The key difference between an EOF and an intermediate cross-member is that it is frequently used to mount a tow coupling or that it may be a low profile design to suit a tapered chassis rail.

Two typical EOF cross-members intended for use to attach a tow coupling tow members are shown in Figures 16 and 17. For details on tow couplings see VSB6 Section P — Tow couplings.

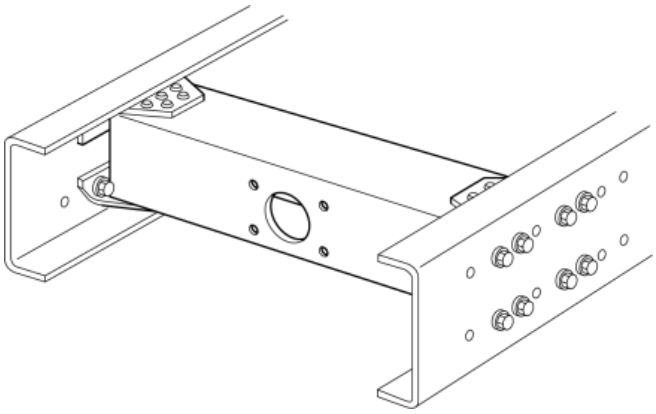


Figure 16: Recessed end of frame cross-member

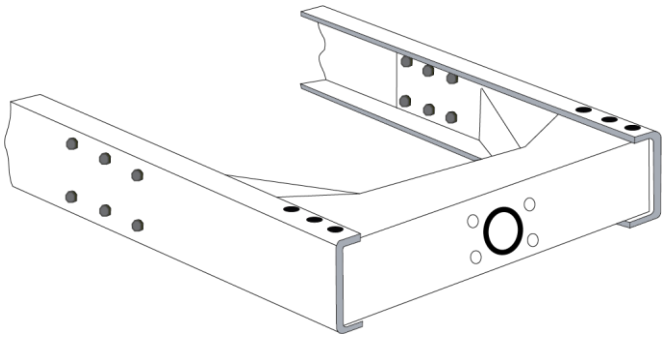


Figure 17: Cross-braced end of frame cross-member

Required:

- If the end of frame cross-member is to be used for mounting a tow coupling, then design, manufacture and mark the cross-member in line with the requirements of ADR 62/... Cross-members used to mount tow couplings with high D-values require substantial reinforcement and bracing.

4. Special cross-members

Many other types of cross-members, commonly used in vehicle chassis construction, are designed for specific applications but are often a variation of a standard intermediate cross-member.

A typical special cross-member is the cross-member supporting the tail shaft centre bearing, which may be a standard intermediate cross-member positioned at the correct location on the chassis, and has a suitable centre bearing mounting bracket attached. An additional non-frame stiffening cross-member may be installed instead. Other applications such as engine or cabin support may require a specific design to achieve desired strength and torsional stiffness while maintaining satisfactory clearance from other components.

Recommended:

- For specialised cross-members, use only original manufacturer components because of the complicated nature of their design.

Cross-members requirements

The chassis of a heavy vehicle must have a satisfactory vertical load carrying capacity while still being torsionally flexible to accommodate uneven road surfaces.

Required:

- Ensure all additional cross-members are designed to be compatible with the vehicle chassis, most effectively by utilising original manufacturer components.
- Install these in accordance with the manufacturer's specifications and recommendations.

Caution

It is not always possible to install the original manufacturer's cross-member without disassembling the cross-member or vehicle.

- Ensure that all cross-members are not of less strength in vertical load capacity and transverse strength compared to that of an original manufacturer for the same application.
- Do not weld within 40 mm of the edge of a cross-member gusset.
- Ensure all new holes in the cross-member gussets are in line with the 'Drilling holes in chassis' requirements in this section of VSB6.
- Ensure all nuts are self-locking.

Recommended:

- If original cross-members are not available, fit alternatives provided that all the replacement cross-members are either channel or hat section construction.
- Avoid using cross-members constructed from large section rectangular hollow section (RHS) or pipe cross-members (see Figure 18) due to their inherent torsional rigidity. Unless supported by the vehicle manufacturer's recommendations, these cross-members are not preferred as they may lead to cracking in the chassis or the cross-member.

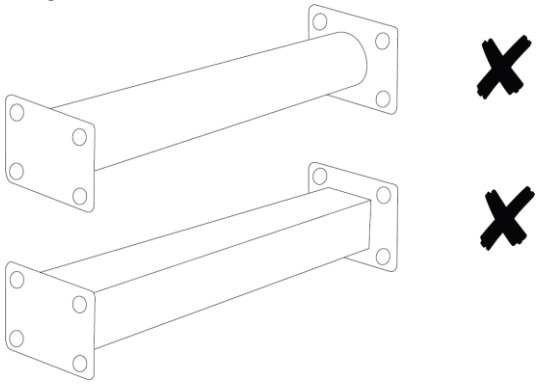


Figure 18: Example of large section pipe and RHS cross-members

- Fit cross-members provided that:
  - the torsional stiffness of an additional or replacement cross-member is similar to that specified by the vehicle manufacturer
  - the thickness of material used in cross-member construction is no greater than the web thickness of the chassis rail to which it is mounted
  - the minimum attachment requirement for a cross-member is equivalent to other original equipment cross-members
  - flat washers or load distribution plates are utilised under all nuts or bolts
  - cross-members are attached only to the web of the chassis rail
  - end of chassis cross-members which may be flange mounted
  - the length of the cross-member is the same as the internal chassis width, i.e., the distance from the outside edge of each gusset equals the internal distance between the mounting faces of the chassis rail.

➘ Manufacturers often fit spacer shims between the cross-member gussets and the chassis rail to adjust the length of a cross-member to give the correct chassis width when optional reinforcements are not fitted.

Drilling holes in chassis

Required:

- Drill or punch holes only. Do not flame cut holes.
- Do not drill holes in the flanges of the chassis rail unless it is recommended by the vehicle manufacturer.
- Do not allow the hole diameter to exceed the bolt diameter by more than 1.0 mm.
- Ensure bolts have sufficient unthreaded under headed length to prevent thread being in contact with the inside of the hole.
- Use a hardened washer between the chassis and the nut so that the nut has enough thread on the bolt to be fastened tightly.
- Do not drill holes in chassis flanges unless:
  - the practice is recommended by the original equipment manufacturer; and
  - an attachment method of the original equipment manufacturer is being directly replicated.
- Do not elongate existing holes.

Recommended:

- Use existing bolt holes wherever possible.
- Fill unused bolt holes with filler bolts in areas such as suspension mounting and where other components are attached.
- Ensure the shank of the filler bolt is a tight fit within the chassis hole and extends throughout the depth of the hole.
- If the original equipment manufacturer permits, plug weld existing holes in non-heat treated chassis rails to prepare for re-drilling of new holes in close proximity to pre-existing ones.
- Plug weld holes in line with the 'Welding of chassis' requirements in this section of VSB6.

Positioning hole centres

Required:

- If a hole is added, ensure that its centre is at the following distances from the centre of other holes:

If all holes are less than 17 mm diameter	50 mm
If one of the holes is 17 mm diameter or greater	3 times D away (mm), where D is the diameter of larger hole.

- Do not allow holes within 50 mm of a chassis rail join.

Examples:

The centre of any new hole (green) cannot be located in the grey region unless the existing hole at the centre is filled (see Figures 19 to 23).

- In figure 19, the diameter of the new hole and the diameter of the existing holes are less than 17mm. Ensure that the centre of the new hole is at least 50mm away from the centre of any existing holes

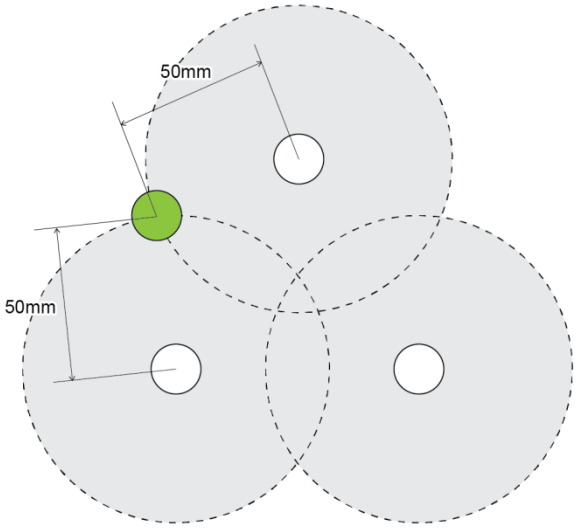


Figure 19: Hole diameters less than or equal to 16 mm only

- In Figure 20, the existing holes all have the same diameter D, which is greater than 17 mm and greater than the diameter of the new hole. Ensure that the new hole is at least 3 x D away from the existing holes.

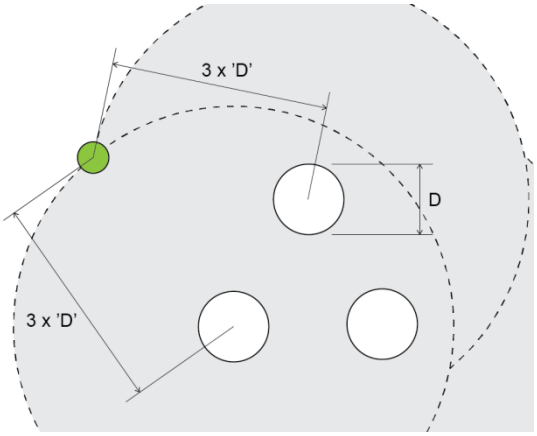


Figure 20: Smaller hole near hole diameters greater than 17 mm

- In Figure 21, the new hole has diameter D, which is greater than 17mm and that of the existing holes. Ensure that the new hole is at least 3 x D away from the existing holes.

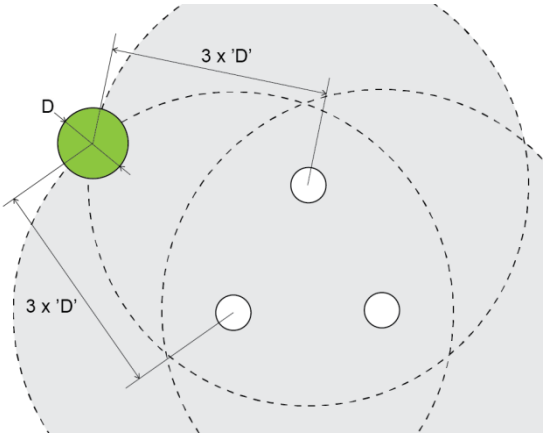


Figure 21: Hole diameter greater than 17 mm near smaller holes

- In Figure 22 the top existing hole is the largest ('D') and the new hole also has a diameter greater than 17mm ('d'). Ensure the new hole is located at least 3 x D away, but also located at least three times its own diameter ('d') away from the smaller existing hole.

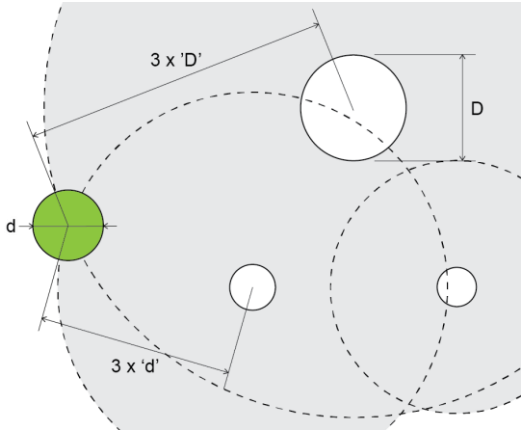


Figure 22: Holes of varying diameter, which are 17 mm, or greater

- Once a new hole has been added, it becomes an existing hole and the same hole spacing rules apply (see *Figure 23*).

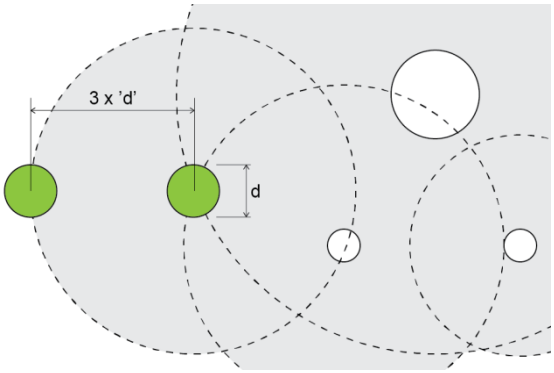


Figure 23: Drilled holes are considered existing holes

6. Examples — calculations

Calculation of weight distribution

Calculation of weight distribution for a vehicle requires determination of the centre of gravity (CoG) for the various elements involved. These are normally available from the vehicle and equipment manufacturer data sheets. Using an outline diagram, to approximate scale, will simplify the process and provide a useful aid to check body length and other critical dimensions.

The example below is for a typical vehicle mounted lifting system (VMLS) mounted behind cab on a two axle truck which has a wheel base of 4250 mm.

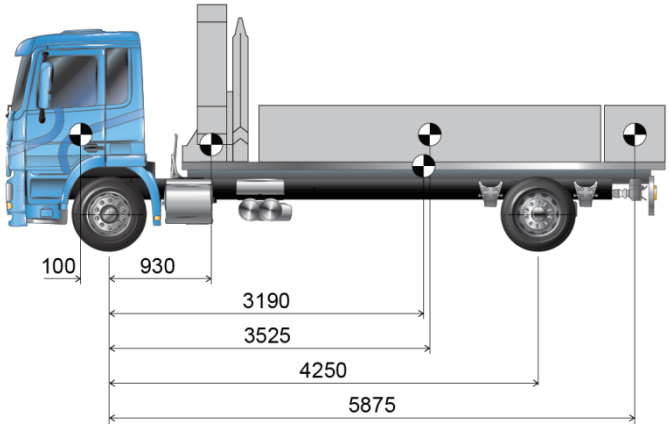


Figure 24: Weight distribution example (units in millimetres)

Weight imposed on:

front axle = weight/wheelbase x distance rearwards of front axle
rear axle = weight - weight imposed on front axle

Table – Calculation of weight distribution

Item	Total weight	CoG distance from front axle	Imposed mass (kg)	
			Front axle	Rear axle
Cab/chassis	3890 kg	2764 mm	2530	1360
Subframe	180k g	3190 mm	45	135
VMLS	1180 kg	930 mm	922	258
Driver	150 kg	-100 mm	154	-4
Body	1100 kg	3855 mm	102	998
Payload 1	4000 kg	3525 mm	682	3318
Payload 2	900 kg	5875 mm	-344	1244
Total	11400 (GVM)		4091	7309

Calculation of chassis strength

This example demonstrates a method to calculate stress in a chassis rail and the reinforcement needed to give it an adequate factor of safety, based on maximum GVM of the vehicle. The below calculations only cover fixed tray/body applications. Whilst a tipper body follows a similar process, the shear force and bending moments will be significantly different.

Unless otherwise stated by the vehicle manufacturer, the minimum factor of safety for chassis rails of vehicles intended primarily for normal road use, (i.e., not for extended use on unsealed roads or other special applications) is three, i.e., the maximum stress in the chassis rail, when under maximum static load conditions, must be less than one-third of the yield stress of the chassis rail material.

Perform an engineering evaluation to establish the required increase in the factor of safety to maintain satisfactory levels of performance for vehicles intended primarily for other than normal road use, (i.e., extended use on unsealed roads), tippers and special application vehicles. Typically, the minimum factor of safety for chassis rails of off-highway vehicles and tippers is five.

Calculations require the value of these parameters to be known:

Wheelbase of vehicle, measured from centre of the front axle / axle group to the centre of the rear axle / axle group	WB (m)
Rear overhang, measured from centre line of the rear axle or axle group to the rear end of frame	ROH (m)
Distance from the forward end of the load (i.e., back of the cab) to the rear axle or centre line of rear axle	CA (m)
Tare mass over front axles	TF (kg)
Tare mass over rear axles	TR (kg)
Maximum manufacturer's allowable mass over front axles	MF (kg)
Maximum manufacturer's allowable mass over rear axles	MR (kg)
Payload allowable mass over front axles	PF (kg)
Payload allowable mass over rear axles	PR (kg)
Gross vehicle mass	GVM (kg)
Allowable yield stress of the chassis rail material	YS (MPa)
Section modulus of the material	Z (mm^3)

The suffix *O* is used to denote original and *F* to denote final.

1. Standard vehicle — calculate bending stress in chassis rail

Original body (Figure 25)

Cab-over 4 x 2 body truck or tray back (GVM):	15,000 kg
Maximum allowable mass over front axle (MF):	6,000 kg
Maximum allowable mass over rear axle (MR):	10,500 kg
Wheelbase (WB):	4.2 m
Chassis rail material:	
Single channel – Dimensions =	250 x 75 x 7.9 mm
Yield strength (YS) =	250 MPa
Section modulus (Z) =	213.03 x 10- 6 m^3
Tare mass over front axle (TF):	2,650 kg
Tare mass over rear axle (TR):	1,870 kg

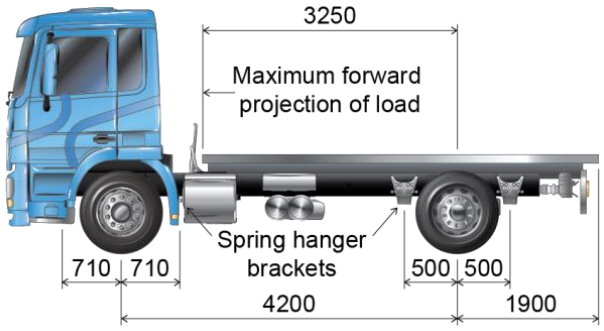


Figure 25: Calculation example — original configuration

Modified body (Figure 26)

For ease of calculation, the mass of the tray body is considered as part of the payload.

- Existing rear axle and suspension assemblies are removed.
- Chassis is cut at 5.200 m behind centre line of the front axle.
- Section of chassis cut-off is replaced with a 3.810 m section.
- Tandem rear axle and suspension assembly installed with wheelbase at 6.200 m.
- Ground rating of rear axle and suspension assembly is 16,500 kg.
- Rear overhang of rear axle and suspension assembly is 2.810 m.

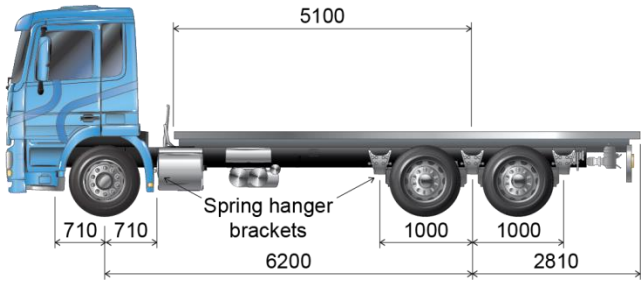


Figure 26: Calculation example — final configuration

- A tray is fitted extending from 5.1 m ahead of the centre line of the rear axle group to the end of the chassis.
- Payload masses are evenly distributed between spring hangers of respective suspension assemblies. This payload mass is distributed uniformly over the length of the tray.
- In this example, remaining components, i.e., engine, brakes, tyres, etc. will accommodate GVM increase.

Tray-body length:	7.91 m
Tray-body mass:	1,500 kg
GVM will be increased to:	22,500 kg
Tare mass over front axle (TF):	2,950 kg
Tare mass over rear axle (TR):	3,000 kg
Vehicle will be loaded to the maximum allowable: over the front axle: over the rear axle group:	 6,000 kg 16,500 kg

Maximum payload over axle	=	Maximum allowable mass over axle	–	Tare mass over axle

Front axle: PF = MF – TF =6,000–2,950 =	3,050 kg
Rear axle: PR = MR – TR =16,500 – 3,000 =	13,500 kg

Total payload mass $P = PF + PR$	$= 3050 + 13500$ $= 16550\ kg$
From *Figure 27*, maximum bending moment Bmax situated 2.169 m behind the front axle centreline.	Bmax = 5579.4kg.m
Another large bending moment also occurs at the rear suspension centre spring hanger bracket.	= 4908.4kg.m
Stress	$= \frac{Bending\ moment\ (BM)}{Section\ modulous\ (Z)}$
Maximum bending moment Bmax	= 5579.4 kg.m = 5579.4 x 9.81 Nm = 54734 Nm

Assuming equal bending moment for each chassis rail

Bending moment per rail	$\frac{54734}{2} = 27367\text{Nm2}$
Therefore, maximum stress, Smax	$= \frac{27367Nm}{213.03 \times 10^{-6}m^3}$ $= 128.5 \times 10^6 N/m^2$ $= 128.5\ MPa$
For chassis rail material with a *yield* stress of 250 MPa and using a factor of safety of three, the maximum allowable stress is:	$\frac{250}{3} = 83.3\ \text{MPa}$

Therefore, without reinforcement, the maximum allowable stress would be exceeded. To achieve a maximum level of stress less than the maximum allowable stress, increase the chassis rail section modulus (Z).

The minimum value of section modulus is:	$Z = \frac{27367\ Nm}{83.3 \times 10^6\ N/m^2}$ $= 328.5 \times 10^{-6}m^3$

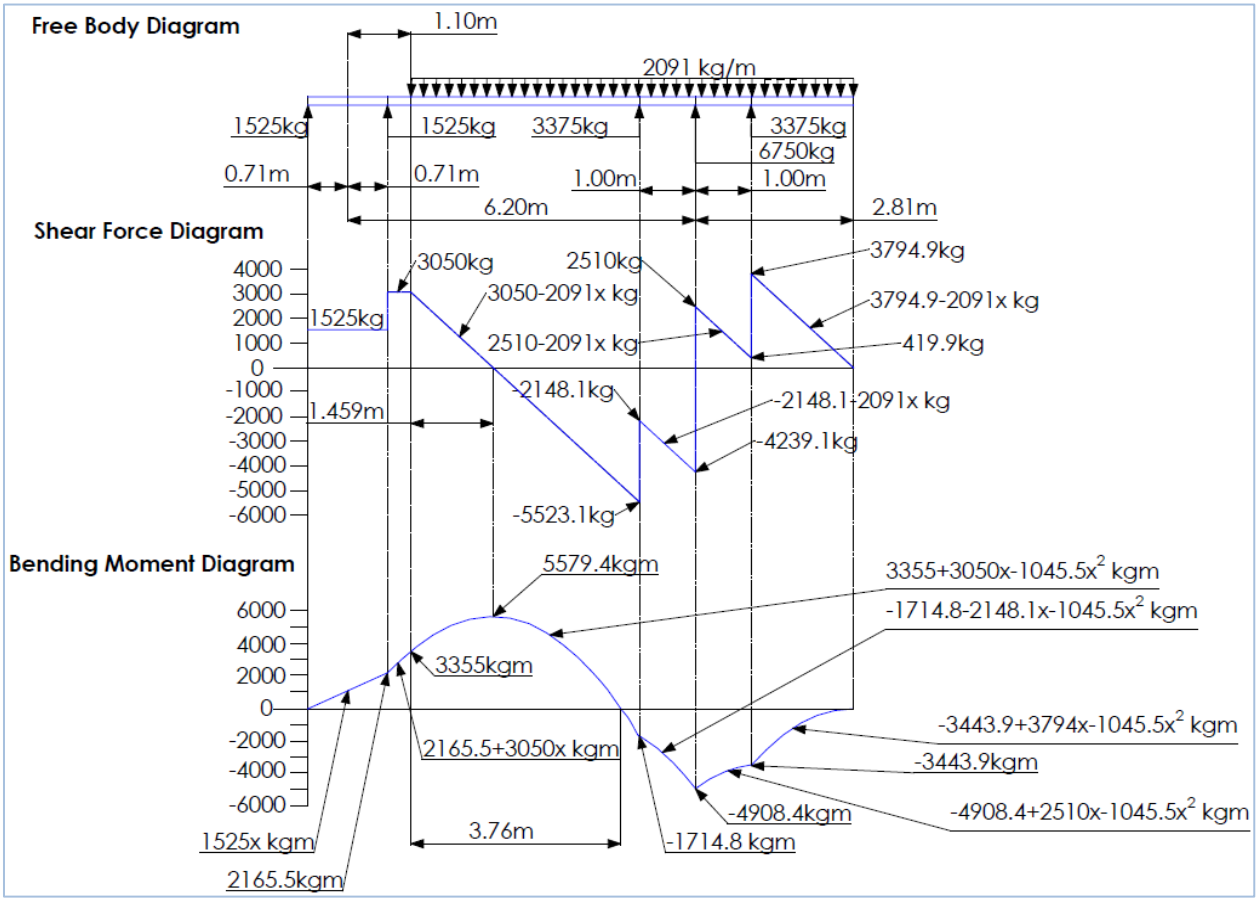


Figure 27: Shear force and bending moment diagrams

Using pre-calculated section moduli of typical chassis rail reinforcement (see Figure 29), achieve the section modulus by reinforcement via:

- internal channel reinforcement, Figure 29 Sub-Figure 4 (433.44 x 10-^{6}m^{3}),
- outer channel reinforcement, Figure 29 Sub-Figure 5 (421.97 x 10-^{6}m^{3}); or
- internal angle reinforcement, *Figure 29 Sub-Figure 6* (379.36 x 10-^{6}m^{3}).

By calculation, a full internal channel reinforcement of 234 x 66 x 7 mm will give total section modulus of:	$= 213.03 \times 10^{-6} + 154.86 \times 10^{-6}$ $= 367.86 \times 10^{-6} m^3$

Therefore, a full internal channel reinforcement section of these dimensions will provide the chassis with sufficient resistance to the bending moment. From the distribution on the bending moment diagram, it can be seen that the reinforcement should extend from ahead of the rear front spring hanger bracket through the end of the frame.

2. Example — chassis rail reinforcement with wheelbase alteration

This example shows how to find the required channel rail section modulus and hence, reinforcement, for a vehicle that has had a wheelbase alteration.

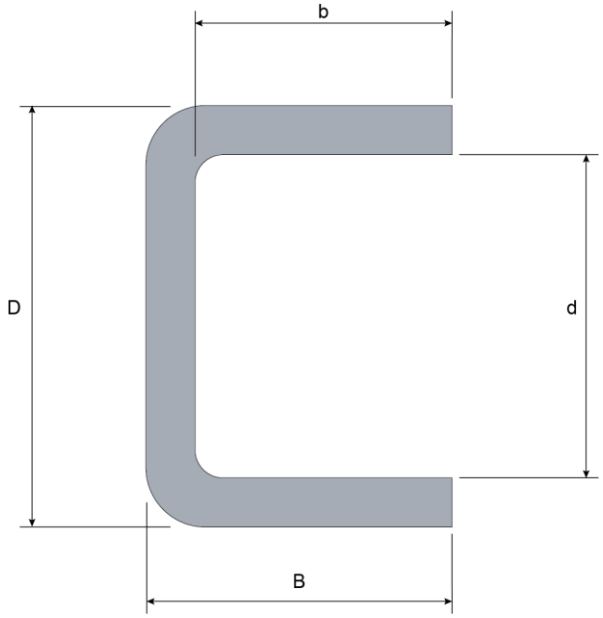
Example assumptions

- There is no change in the vehicle's original GVM.
- The yield strength of the chassis rail material after alteration is 250 MPa.
- The section modulus x frame yield strength, known as the *resisting bending moment* (RBM), of the modified chassis is equal to the RBM of the original chassis.

Formula employed

$$ZF = \frac{WBF}{WBO} \times \frac{ZO \times YSO}{YSF}$$

➘ Where a high tensile chassis is modified, determine the final yield strength (YSF) based on the welding technique and consumables used, calculations or testing. If the YSF cannot be obtained in this manner, a typical YSF of 250 MPa may be used.



$$Z = 2 \times \left[\frac{B \times D^3}{12} - \frac{b \times d^3}{12}\right] \div D$$

Figure 28: Formula for calculation of section modulus, Z

Calculation

Find the required final section modulus for a vehicle that has had a wheelbase extension from 4.500 m to 5.500 m. The original chassis rail section modulus is 154.6 x $10^{-6}m^3$ for each rail, and the chassis material yield strength is 750 MPa.

$$ZF = \frac{WBF}{WBO} \times \frac{ZO \times YSO}{YSF}$$

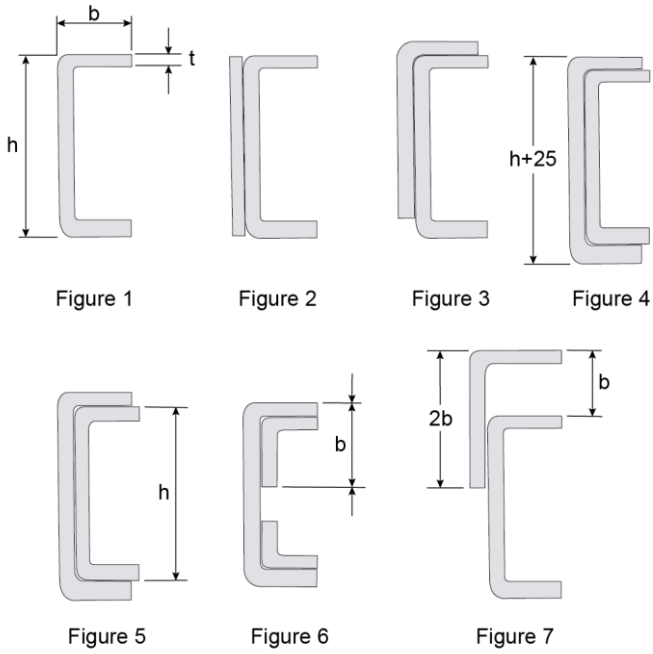
$$ZF = \frac{5.500}{4.500} \times \frac{151.6 \times 10^{-6} \times 750}{250}$$

$$ZF = 555.9 \times 10^{-6} m^3$$

Alternative to using this formula, use the attached nomogram. Using the nomogram, the section modulus needed after a change in wheelbase may be found by following these steps.

1. Locate the point on line A representing the original wheelbase.
2. Locate the point on line B representing the wheelbase after modification.
3. Draw a straight line from the point on line A through point on line B and mark intersection of this line and line C on line C.
4. Locate the point on line D representing the original chassis rail RBM as calculated from the manufacturer's data.
5. Draw a straight line from point on line C through point on line D and mark the intersection of this line and line E on line E.
6. Read the section modulus from the scale on line E at the point described by **5** above. This is the section modulus required for the modified chassis.

After determining the required section modulus, determine the reinforcement needed by the modified chassis by calculating the section modulus of various reinforcement sections or from the table at Figure 28, 30 and 31.



Note: Calculations for section moduli have been based on thickness of reinforcement equals chassis rail thickness, t

Figure 29: Typical chassis rail reinforcement

Section depth	Material thickness	Section modulus (x $10^{-6}m^3$) (z)						
h (mm)	t (mm)	Figure 1	Figure 2	Figure 3	Figure 4	Figure 5	Figure 6	Figure 7
200	6.4	128.31	173.05	186.81	260.55	253.02	230.89	191.73
225	6.4	151.58	206.97	223.68	273.66	298.08	273.17	228.11
250	6.4	175.34	243.68	263.83	353.96	345.77	317.25	253.51
300	6.4	228.60	326.92	350.68	460.48	449.50	410.17	317.25
200	7.9	155.35	209.92	228.60	317.91	307.91	274.16	242.69
225	7.9	183.54	252.69	272.84	373.62	363.14	325.61	276.12
250	7.9	213.03	298.41	320.37	433.44	421.97	379.36	314.30
300	7.9	277.76	400.66	427.70	563.72	549.79	492.92	391.98

Note: Flange width, b = 75 mm

Figure 30: Pre-calculated section moduli of typical chassis rail reinforcement

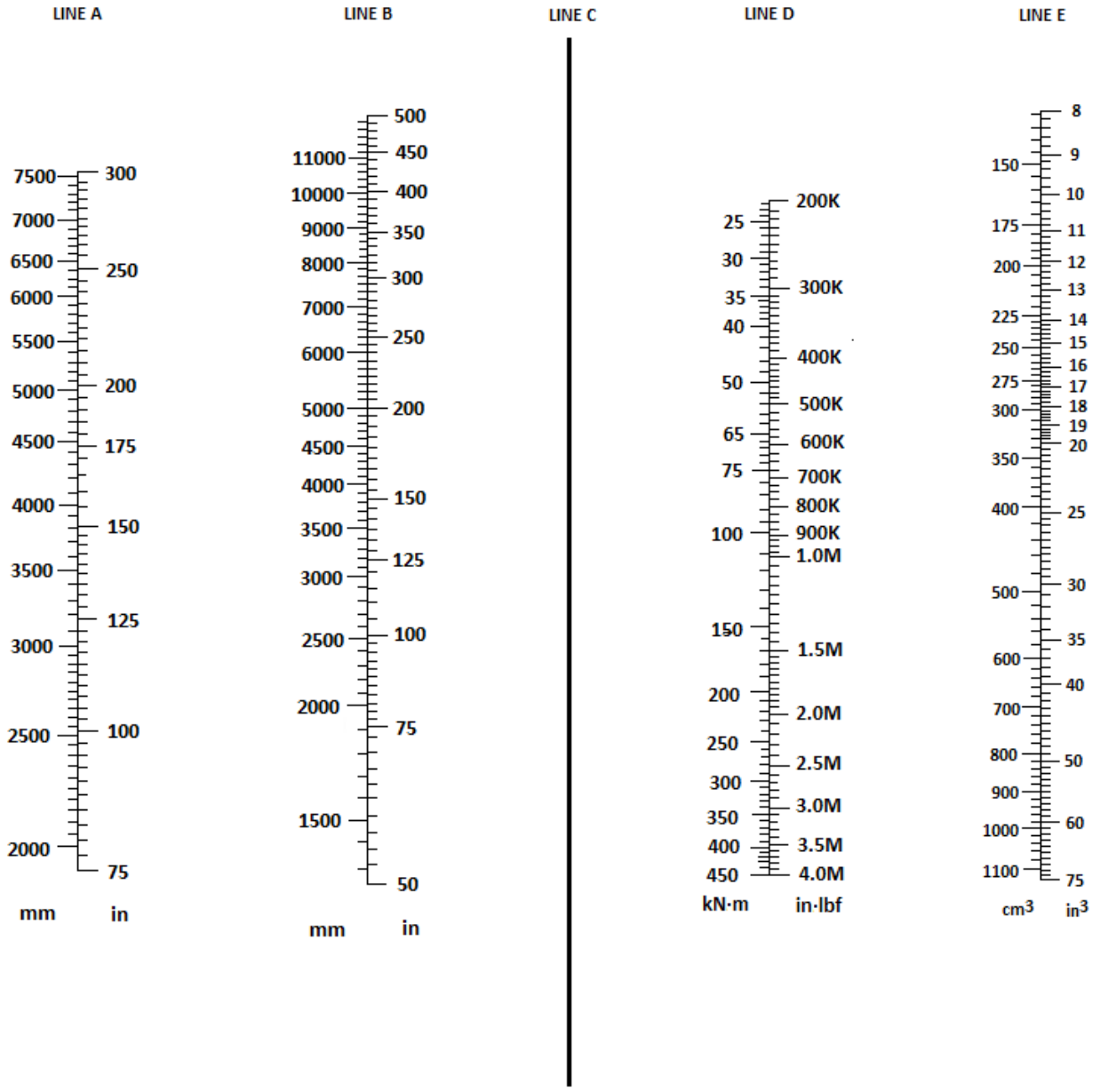


Figure 31: Section modulus nomogram

Section H Calculation sheet — Chassis modification

H Calculation sheet — Chassis modification

This report is for use by approved vehicle examiners (AVEs) when calculating data relating to chassis modification.

Vehicle details

		Report no.:
Vehicle make:	**Vehicle model:**	**Month and year of manufacture:**
VIN (if applicable):	**Vehicle chassis no. (if applicable):**	**Vehicle modifier (company name):**
Chassis material:	**Chassis material yield stress:**	**Weld material:**
Reinforcing material:	**Reinforcing material yield stress:**	**Weld process:**

Data details

Data item	Total	Front axles / point of articulation	Rear axles
Tare weight			
Body and payload			
Axle(s) capacity			
Tyres capacity			
Current regulatory limit			

Calculations

Data item	Total	Front axles / point of articulation	Rear axles
Load reactions			
Section modulus-distribution			
Bending moment (max)			
Critical stresses			
Factor of safety on yield			
Location of welded joints			
Stress at welded joints			

Authorisation

Comments:			
Examined by:	**Company (if applicable):**		**AVE no.:**
Signed:	**Modification certificate no.:**	**Modification plate no.:**	**Date:**

Vehicle chassis no./VIN:	**Date:**	**Signed:**

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Modification Code H1 — Wheelbase extension outside OEM options

1. Scope

Modifications covered under this code:

Covered

- extension of existing chassis
- re-location of axle or suspension assemblies
- replacement of original chassis with one of longer length, but only in accordance with manufacturer's modification requirements.

Not covered

- fitting of components that are not compatible with original vehicle components
- chassis modifications that do not meet the requirements of VSB6
- replacement of original chassis with one of longer length where the modification is not permitted by the manufacturer's modification requirements.

2. Related standards

Modified vehicles must comply with all related Australian Design Rules, Australian Standards, acts and regulations. Below are some, but not all of the areas that may be affected by the modifications in this code and require certification testing or evidence to demonstrate compliance.

The certifier must ensure that the modified vehicle continues to comply with all related Australian Design Rules.

This…	Must comply with…
Design	Manufacturer's recommendations and VSB6 Section H — Chassis
Chassis	VSB6 Modification Code H4
Cross-members	Manufacturer's recommendations and VSB6 Section H — Chassis
Body mounting	VSB6 Modification Code J1
Tail shaft modification	VSB6 Modification Code C1
Extension of brake lines	VSB6 Modification Code G1
Extension of ABS data wiring	VSB6 Modification Code G1
Relocation of axles	VSB6 modification codes D1 and F1
Exhaust	VSB6 Modification Code A4
Turning circle	ADR 43/..

3. Certification procedure

The certification procedure for this modification code is as follows:

1.	Modifier	Determine if the modification is within manufacturer specifications. • If **yes**, refer to Modification Code H3. • If **no**, the modification will need to be done in accordance with this modification code.
2.	Modifier	Consult with an accredited H1 AVE for guidance on how to perform the modification.
3.	Modifier	Perform modification in accordance with AVE advice and this code.
4.	Modifier	Organise approval inspection by an accredited H1 AVE.
5.	H1 AVE	Perform inspection, complete H1 checklist and determine if compliance has been achieved: • If **yes**, proceed to step 6. • If **no**, do not proceed, advise modifier rework is required to ensure compliance. Return to step 2.
6.	H1 AVE	Issue modification certificate, affix modification plate, and submit paperwork as required by the relevant AVE registration scheme.

AVEs must be satisfied that vehicle modification requirements are being met. It is advised that before modifications are carried out they are discussed with the certifying AVE.

4. Compliance requirements

If modifications result in the removal of the original VIN/chassis number, check with the relevant regulator regarding vehicle identification policy before removing any part of the chassis containing VIN or chassis number stampings.

Required:

- Ensure the brake response timing meets the requirements set out in VSB6 Section G — Brakes.

5. Design requirements

It is better to shorten a longer wheelbase chassis than to extend a shorter one as it reduces the need for joins in the chassis rails.

A longer wheelbase vehicle is also likely to have the reinforcements required by the manufacturer and where feasible, the wheelbase should be a standard manufacturer's option.

Required:

- Do not allow extended chassis rails to exceed overall length or rear overhang dimensional limits as outlined in the ADR 43/.., the relevant in-service heavy vehicle regulations or exemption as applicable.
- As increasing the wheelbase will increase the turning circle of the vehicle, ensure that the requirements of ADR 43/.. or the relevant in-service heavy vehicle regulations as applicable are met.
- Ensure where steering alterations are required, including changes to steering arms/linkages, to maintain acceptable turning circle these alterations are performed and certified in accordance with VSB6 Section E — Front axle steering wheels and tyres.
- Ensure tail shaft alterations are performed and certified in accordance with VSB6 Section C — Tail shafts.
- When altering air and hydraulic lines, use piping of the same internal bore as that of the manufacturer's original.
- Do not introduce restrictions in air or hydraulic lines at joins or fittings.
- Ensure brake system alterations are performed and certified in accordance with VSB6 Section G — Brakes.
- When extending electrical wiring harnesses, keep all electrical joints waterproof and electrically sound.

6. Installation requirements

In addition to the following guidelines, see guidelines provided in VSB6 Section H — Overview.

Increasing wheelbase or chassis length

Apply the following when increasing wheelbase or chassis length:

Required:

- If possible, achieve an increase in wheelbase by moving the complete rear axle assembly along the frame.
- Only cut the chassis and insert extensions when relocation of the rear axle assembly is not feasible, e.g.:
  - if the rear overhang has a tapered chassis rail section
  - if the vehicle manufacturer requires the chassis to be cut rather than the suspension group moved rearwards.
- If the rear axle is relocated, then also relocate the associated cross-members and reinforcements to give the correct suspension arrangement.
- If additional chassis rail length is required, achieve this by extending the rear overhang rather than inserting any extension between the front and rear axle groups.
- Check the maximum stress levels in an extended chassis to ensure that the allowable limits are not exceeded (see Overview, 6. Examples — calculations
- Calculation of weight distribution
  - *Calculation* of weight distribution for a vehicle requires determination of the centre of gravity (CoG) for the various elements involved. These are normally available from the vehicle and equipment manufacturer data sheets. Using an outline diagram, to approximate scale, will simplify the process and provide a useful aid to check body length and other critical dimensions.

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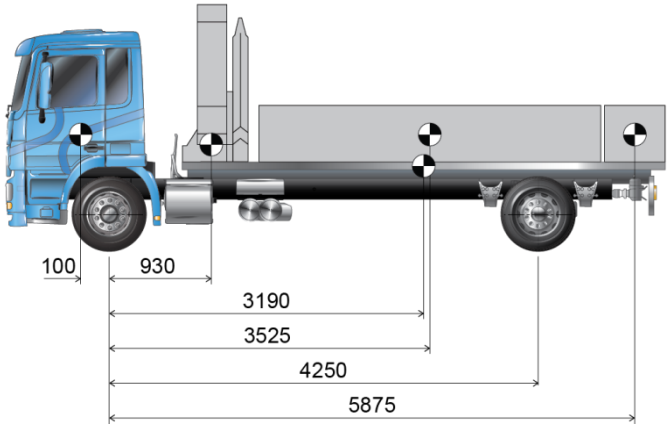

Figure 24: Weight distribution example (units in millimetres)

Weight imposed on:
front axle = weight/wheelbase x distance rearwards of front axle
rear axle = weight - weight imposed on front axle

Table – Calculation of weight distribution

Item	Total weight	CoG distance from front axle	Imposed mass (kg)	
			Front axle	Rear axle
Cab/chassis	3890 kg	2764 mm	2530	1360
Subframe	180k g	3190 mm	45	135
VMLS	1180 kg	930 mm	922	258
Driver	150 kg	-100 mm	154	-4
Body	1100 kg	3855 mm	102	998
Payload 1	4000 kg	3525 mm	682	3318
Payload 2	900 kg	5875 mm	-344	1244
Total	11400 (GVM)		4091	7309

- *Calculation* of chassis strength

If the wheelbase exceeds that available from the manufacturer, the chassis may require reinforcement.

- Apply all chassis reinforcements in line with the manufacturer's recommendations, or if not available this section of VSB6.
- Observe the original cross-member spacing and apply this when adding new cross-members.

Joins

Required:

- For multi-section chassis rails, ensure inner and outer rail joins have a minimum spacing of 300 mm (see Figure 36).
- Ensure the additional section of chassis rail has a continuous weld over the entire junction with the original chassis rail, using welding techniques described in Section H - Overview.
- Only allow non-reinforced butt joins in chassis rails if the join is within 200 mm from the end of the chassis and if the additional section does not support a cross-member or tow coupling.

Recommended:

- Ensure all joins in the chassis rail are well clear of highly stressed regions of the frame.
- Consult with the vehicle manufacturer on the location of the cut, where this information is not available:
  - for heat treated rails, use a cut angle of 45 degrees +/- 15 degrees if possible
  - for cold rolled rails, perpendicular cuts may be used.
- Position all joins at least twice the chassis rail depth (H) from a cross-member or spring hanger bracket and do not allow holes within 50 mm of a chassis rail join (see Figure 33).

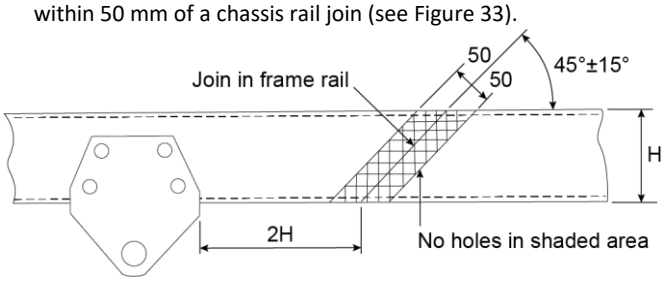

Figure 33: Example of chassis cut restriction for rail joining

- Favour making joins in the chassis rail for heavy duty and highly stressed applications at 45 degrees +/-15 degrees (see Figure 33).
- Consider other acceptable methods of chassis joint design (see figures 34, 35 and 36).

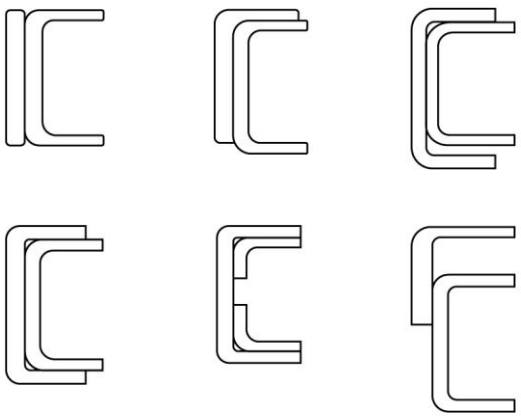

Figure 34: Cross sections of typical reinforcement methods

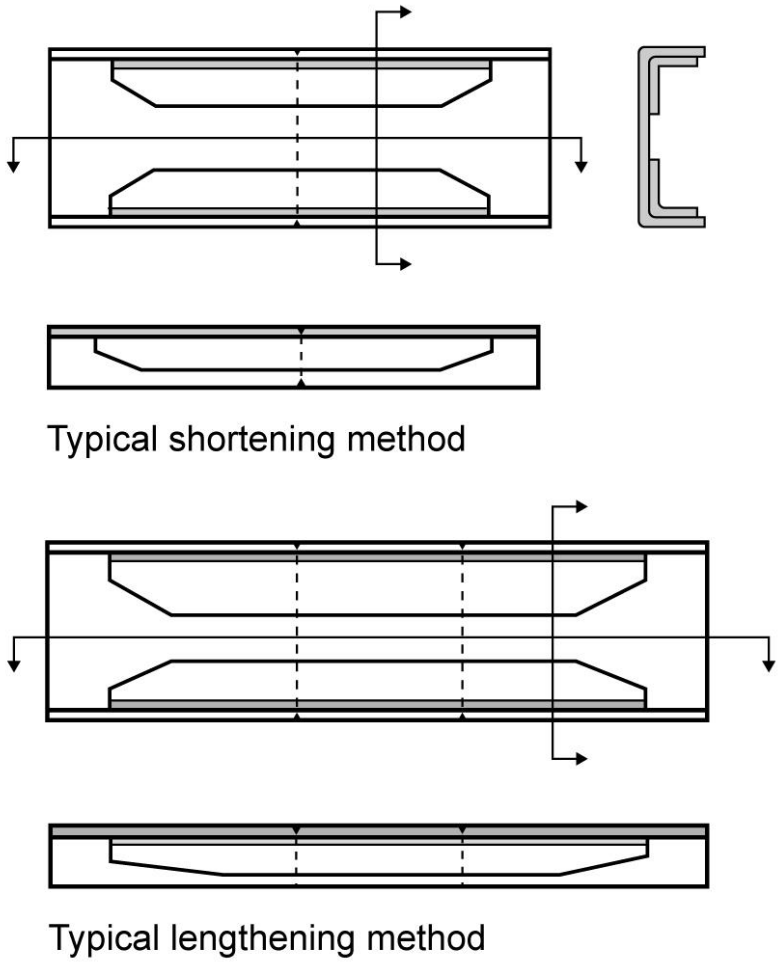

Figure 35: Typical methods of reinforcement, shortening and lengthening

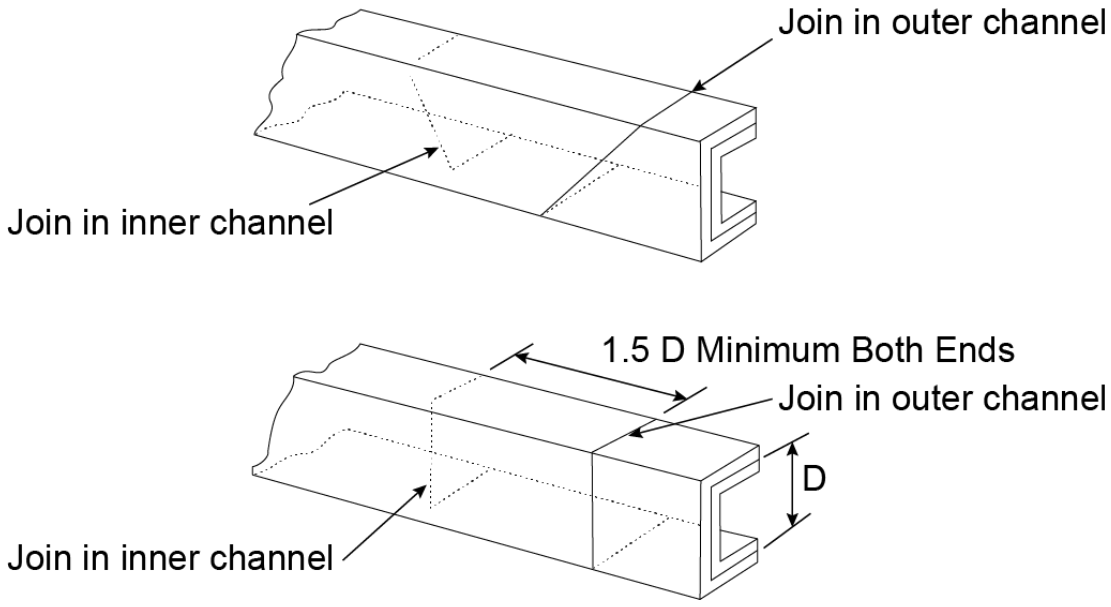

Figure 36: Types and locations of joins

H1 Checklist— Wheelbase extension outside OEM options (example)

H1 Checklist — Wheelbase extension outside OEM options

This checklist is for use by approved vehicle examiners (AVEs) to certify wheelbase extensions that are outside the vehicle manufacturer's options.

Vehicle and modifier details

Vehicle make:	Vehicle model:	Month and year of manufacture:
VIN (if applicable):	**Vehicle chassis no. (if applicable):**	**Vehicle modifier (company name):**

Advanced braking systems

Braking systems Check Yes, No, N/A as applicable:		Yes	No	N/A
1	Is the advanced braking system (where fitted) un-affected or re-certified after the vehicle modification?	☐	☐	☐

Modification details

Modification criteria Check Yes or No as applicable:		Yes	No
1	Has the modification been performed in accordance with the manufacturer's guidelines?	☐	☐

Installation details

Frame Check Yes, No, N/A as applicable:		Yes	No	N/A
1	Are all of the dimensions of the frame rail (including all sections of a multichannel frame) identical to that offered by the manufacturer for the equivalent model or acceptable as per the relevant engineer's calculation?	☐	☐	☐
2	Are the dimensions of the additional reinforcement identical to those stated in the calculations?	☐	☐	☐
3	Are the material specifications and tensile yield strength of the original frame rail, frame rail extension and additional reinforcement compatible?	☐	☐	☐
4	Is the modified chassis frame of sufficient strength for the proposed application?	☐	☐	☐
5	Is the stress at maximum load less in the modified frame than in a standard unmodified vehicle with the same chassis rail and an equal or longer wheelbase, or within the acceptable factor of safety as per relevant engineer's calculations?	☐	☐	☐
6	Is the type of additional reinforcement as per the manufacturer's recommendations or as per VSB6 Section H?	☐	☐	☐
7	Is the location and attachment of additional reinforcement as per the manufacturer's recommendations or VSB6 Section H?	☐	☐	☐
8	Are all the additional cross members of the same design, material specifications, dimension and equivalent attachment as that offered by the manufacturer for the original vehicle?	☐	☐	☐
9	Is the spacing of the cross members on the modified chassis no more than the manufacturer's standard cross member spacing for that model vehicle or alternatively this VSB6 Section H?	☐	☐	☐
10	Are the chassis modifications in accordance with the manufacturer's recommendations or, where the manufacturer's recommendations are unavailable, VSB6 Section H?	☐	☐	☐
Vehicle specifications	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
11	Has the vehicle been shown to comply with the requirements of applicable VSB6 Section G — Brakes?	☐	☐	☐
12	Has the *vehicle stability system*, if fitted, been validated by the vehicle or equipment manufacturer as being correctly set up for the changed specification?	☐	☐	
Welding	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
13	Has welding been performed in accordance with the manufacturer's recommendations, or, where the manufacturer's recommendations are unavailable, VSB6?	☐	☐	☐
14	Has the welding been performed by a suitably qualified tradesperson and to accepted industry standards?	☐	☐	☐
Heat treated frame rail	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
15	When establishing the size of additional reinforcement, has allowance been made for the reduction in material strength due to welding?	☐	☐	☐
Driveline	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
16	Have the modification(s) to the driveline been completed in accordance with VSB6 Section B — Transmissions and VSB6 Section C — Tail shafts, as applicable?	☐	☐	☐

Vehicle chassis no./VIN:	Date:	Signed:

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H1 Checklist — Wheelbase extension outside OEM options

This checklist is for use by approved vehicle examiners (AVEs) to certify wheelbase extensions that are outside the vehicle manufacturer's options.

Compliance

Modification	Check Yes, No as applicable:	Yes	No
1	Does this modification meet all the requirements of the manufacturer's guidelines / Modification Code H1?	☐	☐
2	Does the modified vehicle satisfy the requirements of the relevant heavy vehicle standards regulation and regulation mass limits imposed by the relevant heavy vehicle regulator?	☐	☐
3	Have all of the modification details and all calculations applicable to the modification been recorded in accordance with the record keeping requirement of VSB6?	☐	☐
4	Is the quality of the work to an accepted industry standard?	☐	☐
5	Does the vehicle continue to comply with ADRs and heavy vehicle standards regulations affected by the modification?	☐	☐

Authorisation

Other than modification criteria, if the answer to any relevant question is NO the modification is not acceptable.			
Comments:			
Examined by:	**Company (if applicable):**		**AVE no.:**
Signed:	**Modification certificate no.:**	**Modification plate no.:**	**Date:**

Vehicle chassis no./VIN:	Date:	Signed:

Modification Code H2 — Wheelbase reduction outside OEM options

1. Scope

Modifications covered under this code:

Covered

- reduction of existing chassis length
- re-location of axle/suspension assemblies
- replacement of original chassis with one of shorter length, but only in accordance with the manufacturer's modification requirements.

Not covered

- fitting of components that are not compatible with original vehicle components
- chassis modifications that do not meet the requirements of VSB6
- replacement of original chassis with one of shorter length where the modification is not permitted by the manufacturer's modification requirements.

2. Related standards

Modified vehicles must comply with all related Australian Design Rules, Australian Standards, acts and regulations. Below are some but not all of the areas that may be affected by the modifications in this code and require certification testing or evidence to demonstrate compliance.

The certifier must ensure that the modified vehicle continues to comply with all related Australian Design Rules.

This…	Must comply with…
Chassis alterations	VSB6 Modification Code H4
Body mounting	VSB6 Modification Code J1
Tail shaft	VSB6 Modification Code C1
Brake line relocation	VSB6 Modification Code G1
Relocation of axles	VSB6 modification codes D1 and F1
Exhaust	VSB6 Modification Code A4
Brake re-certification	VSB6 Modification Code G4

3. Certification procedure

The certification procedure for this modification code is as follows:

1.	Modifier	Determine if the modification is within manufacturer specifications. • If **yes**, refer to Modification Code H3. • If **no**, the modification will need to be done in accordance with this modification code.
2.	Modifier	Consult with an accredited H2 AVE for guidance on how to perform the modification.
3.	Modifier	Perform modification in accordance with AVE advice and this code.
4.	Modifier	Organise approval inspection by an accredited H2 AVE.
5.	H2 AVE	Perform inspection, complete H2 checklist and determine if compliance has been achieved. • If **yes**, proceed to step 6. • If **no**, do not proceed, advise modifier rework is required to ensure compliance. Return to step 2.
6.	H2 AVE	Issue modification certificate, affix modification plate, and submit paperwork as required by the relevant AVE registration scheme.

AVEs must be satisfied that vehicle modification requirements are being met. It is advised that before modifications are carried out they are discussed with the certifying AVE.

4. Compliance requirements

Required:

- Test the vehicle to show compliance with the following tests of ADR 35/.. as applicable to the vehicle at its date of manufacture:
  - Service Brake Lightly Laden Effectiveness Test
  - Lightly Laden Secondary Brake Test
  - Lightly Laden Partial Failure Test
  - Service Brake Laden Effectiveness Test
  - Laden Secondary Brake Test
  - Laden Partial Failure Test.

Recommended:

- Ensure the shortened wheelbase is not less than the shortest optional wheelbase from the manufacturer for that model.

5. Design requirements

In addition to the following guidelines, see guidelines provided in VSB6 Section H — Overview.

Required:

- When the rear axle is relocated, relocate the associated cross-members and reinforcements to give the correct suspension arrangement.
- If necessary, reduce the rear overhang to maintain compliance with ADR 43/.. or the relevant in-service heavy vehicle regulation as applicable.

Recommended:

- When reducing the wheelbase, consult the vehicle manufacturer regarding the most effective method, such as cutting or rolling the drive group forward.
- Take into account the regulation mass limits imposed by the relevant in-service heavy vehicle regulation, as shorter axle spans may result in lower axle mass limits.
- Try to reduce a vehicle's wheelbase by moving the complete rear axle assembly forward along the chassis if the vehicle has a constant depth chassis rail.
- If the driveline of the vehicle is altered in any way as a result of the chassis being shortened, undertake a review of the driveline using VSB6 Section C — Tail shafts.

6. Installation requirements

- In addition to the above guidelines, see guidelines provided in VSB6 Section H — Overview.

H2 Checklist — Wheelbase reduction outside OEM options (example)

H2 Checklist — Wheelbase reduction outside OEM options

This checklist is for use by approved vehicle examiners (AVEs) to certify wheelbase reductions that are outside the vehicle manufacturer's options.

Vehicle and modifier details

Vehicle make:	Vehicle model:	Month and year of manufacture:
VIN (if applicable):	**Vehicle chassis no. (if applicable):**	**Vehicle modifier (company name):**

Advanced braking systems

Braking systems	Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Is the advanced braking system (where fitted) un-affected or re-certified after the vehicle modification?	☐	☐	☐

Modification details

Modification criteria	Check Yes or No as applicable:	Yes	No
1	Has the modification been performed in accordance with the manufacturer's guidelines?	☐	☐

Installation details

Chassis	Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Are all of the dimensions of the chassis rail (including all sections of a multichannel chassis) identical to that offered by the manufacturer for the equivalent model or acceptable as per the relevant engineer's calculation?	☐	☐	
2	Are the dimensions of the additional reinforcement identical to those stated in the manufacturer's guidelines or in the calculations?	☐	☐	
3	Are the material specifications and tensile yield strength of the original chassis rail, chassis rail extension and additional reinforcement compatible?	☐	☐	
4	Is the modified chassis of sufficient strength for the proposed application?	☐	☐	
5	Is the stress at maximum load less in the modified chassis than in a standard unmodified vehicle with the same chassis and an equal or longer wheelbase, or within the acceptable factor of safety as per relevant engineer's calculations?	☐	☐	
6	Is the type of additional reinforcement as per manufacturer's recommendations or as per VSB6 Section H?	☐	☐	
7	Is the location and attachment of additional reinforcement as per the manufacturer's recommendations or VSB6 Section H?	☐	☐	
8	Are all the additional cross members of the same design, material specifications, dimension and equivalent attachment as that offered by the manufacturer for the original vehicle?	☐	☐	☐
9	Is the spacing of the cross members on the modified chassis no more than the manufacturer's standard cross member spacing for that model vehicle, as per the manufacturer's recommendations or alternatively this VSB6 Section H?	☐	☐	
10	Are the chassis modifications in accordance with the manufacturer's recommendations or, where the manufacturer's recommendations are unavailable, VSB6 Section H?	☐	☐	
Vehicle braking system	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
11	Has the vehicle been shown to comply with the requirements of applicable VSB6 Section G — Brakes?	☐	☐	
12	Has the *vehicle stability system*, if fitted, been validated by the vehicle or equipment manufacturer as being correctly set up for the changed specification?	☐	☐	
Welding	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
13	Has welding been performed in accordance with the manufacturer's recommendations, or, where the manufacturer's recommendations are unavailable, VSB6?	☐	☐	☐
14	Has the welding been performed by a suitably qualified tradesperson and to accepted industry standards?	☐	☐	☐
Heat treated chassis rail	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
15	When establishing the size of additional reinforcement, has allowance been made for the reduction in material strength due to welding?	☐	☐	☐
Driveline	**Check Yes, No, N/A as applicable:**	**Yes**	**No**	**N/A**
16	Have the modification(s) to the driveline been completed in accordance with VSB6 Section B — Transmissions and VSB6 Section C — Tail shafts, as applicable.	☐	☐	☐

Vehicle chassis no./VIN:	Date:	Signed:

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H2 Checklist — Wheelbase reduction outside OEM options

This checklist is for use by approved vehicle examiners (AVEs) to certify wheelbase reductions that are outside the vehicle manufacturer's options.

Compliance

Modification	Check Yes or No as applicable:	Yes	No
1	Does this modification meet all the requirements of the manufacturer's guidelines / Modification Code H2?	☐	☐
2	Is the quality of the work to an accepted industry standard?	☐	☐
3	Does the modified vehicle satisfy the requirements of the relevant heavy vehicle standards regulation and regulation mass limits imposed by the relevant heavy vehicle regulator?	☐	☐
4	Have all of the modification details and all calculations applicable to the modification been recorded in accordance with the record keeping requirement of VSB6?	☐	☐
5	Does the vehicle continue to comply with ADRs and heavy vehicle standards regulations affected by the modification?	☐	☐

Authorisation

Other than modification criteria, if the answer to any relevant question is NO the modification is not acceptable.

Comments:			
Examined by:	**Company (if applicable):**		**AVE no.:**
Signed:	**Modification certificate no.:**	**Modification plate no.:**	**Date:**

Vehicle chassis no./VIN:	Date:	Signed:

Modification Code H3 — Wheelbase alterations within OEM options

1. Scope

Modifications covered under this code:

Covered

- wheelbase extension or reduction within the first manufacturer's options
- re-location of axle/suspension assemblies
- replacement of original chassis with a chassis of longer or shorter length, but only in accordance with the manufacturer's modification requirements.

Not covered

- fitting of components that are not compatible with original vehicle components
- chassis modifications that do not meet the requirements of VSB6
- wheelbases outside the range offered as an option by the original manufacturer
- replacement of original chassis with a chassis of longer or shorter length where the modification is not permitted by the manufacturer's modification requirements.

2. Related standards

Modified vehicles must comply with all related Australian Design Rules, Australian Standards, acts and regulations. Below are some but not all of the areas that may be affected by the modifications in this code and require certification testing or evidence to demonstrate compliance.

The certifier must ensure that the modified vehicle continues to comply with all related Australian Design Rules.

This…	Must comply with…
Chassis extension	Manufacturer's recommendations or VSB6 Section H — Chassis
Cross-members	Manufacturer's recommendations or VSB6 Section H — Chassis
Body mountings	VSB6 Modification Code J1
Tail shaft	Manufacturer's specifications or VSB6 Modification Code C1
Brake line relocation	Manufacturer's specifications or VSB6 Modification Code G1
Relocation of axles	VSB6 Modification Code D1
Exhaust	VSB6 Modification Code A4

3. Certification procedure

The certification procedure for this modification code is as follows:

1.	Modifier	Determine if the modification is within manufacturer specifications. • If **yes**, the modification will need to be done in accordance with this modification code and manufacturer's specifications. • If **no**, the modification will need to be done in accordance with Modification Code H1, or Modification Code H2.
2.	Modifier	Consult with an accredited H3 AVE for guidance on how to perform the modification.
3.	Modifier	Perform modification in accordance with AVE advice and this code.
4.	Modifier	Organise approval inspection by an accredited H3 AVE.
5.	H3 AVE	Perform inspection, complete H3 checklist and determine if compliance has been achieved. • If **yes**, proceed to step 6. • If **no**, do not proceed, advise modifier rework is required to ensure compliance. Return to step 2.
6.	H3 AVE	Issue modification certificate, affix modification plate, and submit paperwork as required by the relevant AVE registration scheme.

AVEs must be satisfied that vehicle modification requirements are being met. It is advised that before modifications are carried out they are discussed with the certifying AVE.

4. Compliance requirements

- In addition to the following guidelines, see guidelines provided in VSB6 Section H — Overview.

Recommended:

- Ensure modified vehicle specifications remain within the options offered by the vehicle manufacturer.
- If the proposed chassis modifications render the vehicle identical to a model that is available from the manufacturer, and providing all chassis joins (if applicable) are welded satisfactorily and reinforced, no additional evaluation of the chassis modifications is required.

5. Design requirements

In addition to the above guidelines, refer to the general information provided in VSB6 Section H — Overview.

6. Installation requirements

In addition to the above guidelines, see guidelines provided in VSB6 Section H — Overview.

H3 Checklist — Wheelbase alterations within OEM options (example)

H3 Checklist — Wheelbase alterations within OEM options

This checklist is for use by approved vehicle examiners (AVEs) to certify wheelbase alterations that are within the vehicle manufacturer's options.

Vehicle and modifier details

Vehicle make:	Vehicle model:	Month and year of manufacture:
VIN (if applicable):	**Vehicle chassis no. (if applicable):**	**Vehicle modifier (company name):**

Advanced braking systems

Braking systems	Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Is the advanced braking system (where fitted) un-affected or re-certified after the vehicle modification?	☐	☐	☐

Modification details

Modification criteria	Check Yes, No as applicable:	Yes	No
1	Has the modification been performed in accordance with the manufacturer's guidelines?	☐	☐

Installation details

Chassis	Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Are the nominal dimensions of the chassis rail section the same as that offered by the manufacturer for the equivalent model?	☐	☐	
2	Are the dimensions of the reinforcement(s) identical to those stated in the calculations?	☐	☐	
3	Are the material specifications and tensile yield strength of the chassis rail extension equivalent to that of the original chassis rail?	☐	☐	
4	Is the modified chassis of sufficient strength for the proposed application?	☐	☐	
5	Is the location and attachment of the additional reinforcement as per the manufacturer's recommendations, or, where the manufacturer's recommendations are unavailable, VSB6?	☐	☐	
6	Are all the additional cross members of similar design, material specifications, dimension, location and attachment as that offered by the manufacturer for the equivalent model as per manufacturer's recommendations or alternatively VSB6 Section H - Overview?	☐	☐	
7	Has the top hat/box section chassis been modified in accordance with the vehicle manufacturer's modification guidelines	☐	☐	☐
Vehicle specifications	Check Yes, No, N/A as applicable:	Yes	No	N/A
8	Is the axle configuration (i.e. 4x2, 6x4 etc.), axle type, suspension type and installation, brake system, tyre size and GVM/GCM ratings the same as that offered by the manufacturer for an equivalent model, or are the variations in vehicle specifications covered by codes stated on the certificate of modification?	☐	☐	
9	Is the wheelbase within the range offered by the manufacturer for the equivalent model?	☐	☐	
10	Has the vehicle stability system, if fitted, been validated by the vehicle or equipment manufacturer as being correctly set up for the changed specification?	☐	☐	☐
Welding	Check Yes, No, N/A as applicable:	Yes	No	N/A
11	Has the welding been performed in accordance with the manufacturer's recommendations, or, where the manufacturer's recommendations are unavailable, VSB6?	☐	☐	☐
12	Has the welding been performed by a suitably qualified tradesperson and to accepted industry standards?	☐	☐	☐
Heat treated chassis rail	Check Yes, No, N/A as applicable:	Yes	No	N/A
13	When establishing the size of additional reinforcement for a heat treated chassis rail, has allowance been made for the reduction in material strength due to welding?	☐	☐	☐

Vehicle chassis no./VIN:	Date:	Signed:

H3 Checklist — Wheelbase alterations within OEM options

This checklist is for use by approved vehicle examiners (AVEs) to certify wheelbase alterations that are within the vehicle manufacturer's options.

Compliance

Modification	Check Yes, No as applicable:	Yes	No
1	Does this modification meet all the requirements of the manufacturer's guidelines / Modification Code H3?	☐	☐
2	Is the quality of the work to an accepted industry standard?	☐	☐
3	Have all of the modification details and all calculations applicable to the modification been recorded in accordance with the record keeping requirement of VSB6?	☐	☐
4	Does the vehicle continue to comply with ADRs and heavy vehicle standards regulations affected by the modification?	☐	☐

Authorisation

Other than modification criteria, if the answer to any relevant question is NO the modification is not acceptable.			
Comments:			
Examined by:	**Company (if applicable):**		**AVE no.:**
Signed:	**Modification certificate no.:**	**Modification plate no.:**	**Date:**

Vehicle chassis no./VIN:	Date:	Signed:

Modification Code H4 — Chassis alteration

1. Scope

Modifications covered under this code:

Covered

- chassis alteration required to support other modifications such as repair, reinforcing or changes required to the chassis for the modification of suspension etc.
- cross-member alteration.

Not covered

- change in original wheelbase
- fitting of components not compatible with original vehicle components
- chassis modifications that do not meet the requirements of VSB6.

2. Related standards

Modified vehicles must comply with all related Australian Design Rules, Australian Standards, acts and regulations. Below are some but not all of the areas that may be affected by the modifications in this code and require certification testing or evidence to demonstrate compliance.

The certifier must ensure that the modified vehicle continues to comply with all related Australian Design Rules.

This…	Must comply with…
Chassis member alterations	VSB6 Section H — Overview, Calculation of chassis strength
Body mounting	VSB6 Modification Code J1
Brake line relocation	VSB6 Modification Code G1
Relocation of axles	VSB6 Modification Code D1

3. Certification procedure

The certification procedure for this modification code is as follows:

1.	Modifier	Determine if the modification is within manufacturer specifications. • If **yes**, the modification will need to be done in accordance with manufacturer specifications. • If **no**, the modification will need to be done in accordance with this modification code.
2.	Modifier	Consult with an accredited H4 AVE for guidance on how to perform the modification.
3.	Modifier	Perform modification in accordance with AVE advice and this code.
4.	Modifier	Organise approval inspection by an accredited H4 AVE.
5.	H4 AVE	Perform inspection, complete H4 checklist and determine if compliance has been achieved. • If **yes**, proceed to step 6. • If **no**, do not proceed, advise modifier rework is required to ensure compliance. Return to step 2.
6.	H4 AVE	Issue modification certificate, affix modification plate, and submit paperwork as required by the relevant AVE registration scheme.

AVEs must be satisfied that vehicle modification requirements are being met. It is advised that before modifications are carried out they are discussed with the certifying AVE.

4. Compliance requirements

In addition to the following guidelines, see guidelines provided in VSB6 Section H — Overview.

Recommended:

- Ensure the modified vehicle remains within options offered by the vehicle manufacturer.
- If modifications render the vehicle identical to a model available from the manufacturer then, providing all chassis joins are welded satisfactorily and reinforced, no additional evaluation of the chassis modifications is needed.

5. Design requirements

In addition to the following guidelines, refer to the general information provided in VSB6 Section H — Overview.

Required:

- Ensure all new holes in the chassis are in line with the ‘Drilling holes in chassis’ segment in VSB6 Section H — Overview.

Chassis repair

Eliminating causes of chassis failure

When repairing or replacing the chassis, consider the factors that may have led to the chassis damage or failure and eliminate the cause. These factors may include:

- holes drilled in chassis rail flanges or too close to other holes
- incorrect welding procedures (e.g., undercutting, no preheat, slag inclusions, transverse welding of flanges)
- abrupt change of section (e.g., a square end on a reinforcement or body sub-frame)
- overloading of chassis (e.g., vehicle loaded beyond its designed capacity)
- insufficient reinforcement
- incorrect cross-members (e.g., torsionally stiff cross-members)
- suspension too stiff (suspension capacity greater than chassis capacity)
- incorrect body mounting (i.e., rigidly mounted tanker)
- excessive chassis cut-outs (even a grinding notch on a flange can propagate a crack)
- accident damage.

Repair the chassis with consideration to the cause of the damage or failure. This could involve reinforcing the chassis due to inadequate rail strength or merely tapering an existing reinforcement section or replacing a cross-member.

> ↘ Vehicle manufacturers publish repair guidelines that detail approved repair methods as well as practices that are prohibited. These repair guidelines should be considered before undertaking any repairs to a vehicle’s chassis.

As a cracked or broken chassis rail typically is a result of the chassis being overstressed, this indicates that additional reinforcement will be required in the region of the failure.

Common areas where chassis cracking occurs:

Behind the rearmost front spring hanger bracket

This area of the chassis rail has numerous stress raisers such as:

- holes for:
  - mounting engine support brackets
  - cab mounts
  - spring hangers
  - fuel tank brackets
  - battery box etc.
- the change in section due to the start of the body sub-frame
- the input of torque reaction from the engine, and
- the loads from the spring hanger.

Required:

- When repairing a crack in this area after the cause is eliminated, drill the end of the crack to prevent it from travelling further and then re-weld the crack in accordance with Section H - Overview.
- Do not terminate chassis rail reinforcement within this area.
- Fit an additional reinforcement that extends forward of the rearmost front spring hanger bracket by a distance equal to twice the chassis rail height (2H).
- Accommodate the engine and cab mounting brackets and extend rearward past the start of the body sub-frame by at least 3H. Install the reinforcement in accordance with Section H - Overview.

Cross-member gussets

Cross-member gussets are a common place for cracking to occur. Heavy vehicle chassis are typically designed for large amounts of flex, twisting and movement (unlike light vehicles). This movement induces numerous stress raisers such as:

- along welds
- at changes of section
- along corners
- around bolt holes.

Recommended:

- Do not repair gussets, instead replace gussets with new gussets of the same style.
- Increase the thickness of a gusset provided that it does not exceed the web thickness of the chassis rail or manufacturing specifications.
- A way to overcome gusset cracking is to use a load distribution plate under the gusset bolts (see Figure 37).

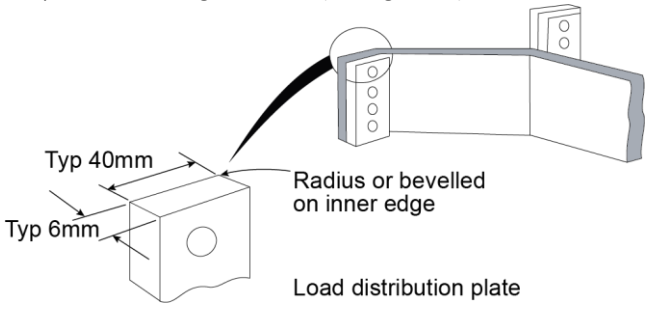

Figure 37: Typical example of load distribution plate

Gusset failure in rear suspension area

The rear suspension of a vehicle is typically one of the most highly stressed areas, as such it is a common place for cracking or other failures to occur.

Recommended:

- If gusset failures occur in the rear suspension or end of frame, consider fitting a rear suspension liner (reinforcement) to reduce cross-member loads, or fit thicker cross-member end plates.

Procedures to be avoided

Required:

Unless otherwise stated by the manufacturer:

- replace cracked heat-treated (high tensile) chassis rails rather than repair them
- replace bent heat-treated (high tensile) chassis rails rather than straighten them.

Chassis rail straightening

Recommended:

- Before straightening a bent chassis rail, remove all chassis components in the area of damage and examine for cracks and damage.
- Replace components when damage is evident.
- Ensure a straightened chassis rail is straight and square over its entire length and does not show evidence of buckling, indentation, cracking or elongation of holes.
- Do not use cross-members and other chassis components to help straighten the chassis rail. Only minimal bowing may be present prior to assembly.

Increase in GVM and GCM

Required:

- For a vehicle to qualify for an increase in GVM or gross combination mass (GCM), ensure the vehicle is capable of performing and operating safely at the proposed increased rating.
- Before undertaking modifications that result in increasing the vehicle rating, ensure the chassis is assessed as a critical component.
- When additional axles or replacement axles with a greater load carrying capacity than the original are fitted, analyse the vehicle frame to ensure that it is of sufficient strength to accommodate the proposed increase in GVM/GCM (and in line with VSB6 Section H — Overview, Calculation of chassis strength).
- Ensure all new holes in the chassis are in line with the ‘Drilling holes in chassis’ segment in VSB6 Section H — Overview.
- One way to assess chassis requirements for each rating is to associate the bending strength of the chassis with the load carrying capacity (i.e., GVM) and the torsional strength of the chassis (capable of accommodating engine torque to pull a load, not carry it) with the GCM rating.
- For vehicles intended primarily for normal road use, (i.e., not for extended use on unsealed roads or other special applications), the maximum stress at maximum static load for a modified chassis should give a factor of safety of three on the yield strength of the chassis rail material.
- For vehicles intended for use in applications other than normal road use, i.e., extended use on unsealed roads and special application vehicles, arrange for an engineering evaluation to be performed on levels of performance before the modification is made.
- GVM is often limited by chassis capacity and dependent on chassis rail size.

Recommended:

- Do not let the maximum stress in a vehicle's chassis exceed the stress calculated from the worst case (highest stressed) vehicle produced by the manufacturer with that same chassis rail (i.e., the model with the highest GVM rating and longest wheelbase utilising the same chassis rail).

Suspension changes

Required:

- Consult VSB6 Section F — Suspension when fitting an alternative suspension to the chassis.
- Ensure the design of the cross-members is suitable for the proposed suspension (see VSB6 Section H — Overview, Calculation of chassis strength).
- If the suspension rating is less than the original, ensure the vehicle is re-rated in accordance with VSB6 Section S — Vehicle rating.
- Fit all suspension brackets with a full complement of the correct grade and size of bolts.

Recommended:

- Attach axle bump stops to the web of the chassis rail.
- Unless original manufacturer practice is otherwise, do not use flange attachment.
- Use a rear suspension liner to distribute loads from the spring hangers evenly into the chassis.
- Ensure that the suspension manufacturer's controls for the suspension, braking and ride height control systems work with the vehicle manufacturer's systems.

Additional axles

- Fitting an additional axle facilitates an increase in the vehicle's GVM. The chassis rail therefore has to be sufficiently strong to accommodate additional axle and proposed increase in GVM (see above 'increase in GVM and GCM').
- For an example of chassis analysis to fit an additional rear axle, see '6. Examples — calculations
- *Calculation* of weight distribution
  - Calculation of weight distribution for a vehicle requires determination of the centre of gravity (CoG) for the various elements involved. These are normally available from the vehicle and equipment manufacturer data sheets. Using an outline diagram, to approximate scale, will simplify the process and provide a useful aid to check body length and other critical dimensions.

The example below is for a typical vehicle mounted lifting system (VMLS) mounted behind cab on a two axle truck which has a wheel base of 4250 mm.

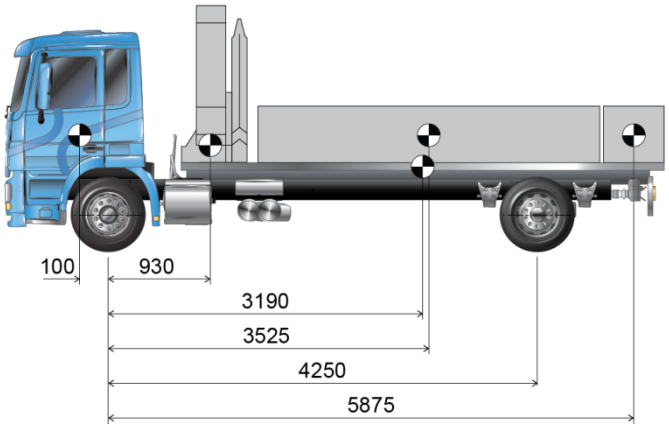

Figure 24: Weight distribution example (units in millimetres)

Weight imposed on:

- front axle = weight/wheelbase x distance rearwards of front axle
- rear axle = weight - weight imposed on front axle

Table – Calculation of weight distribution

Item	Total weight	CoG distance from front axle	Imposed mass (kg)	
			Front axle	Rear axle
Cab/chassis	3890 kg	2764 mm	2530	1360
Subframe	180k g	3190 mm	45	135
VMLS	1180 kg	930 mm	922	258
Driver	150 kg	-100 mm	154	-4
Body	1100 kg	3855 mm	102	998
Payload 1	4000 kg	3525 mm	682	3318
Payload 2	900 kg	5875 mm	-344	1244
Total	11400 (GVM)		4091	7309

- Calculation of chassis strength segment in VSB6 Section H — Overview.

Suspension

Required:

- Fitting an additional axle requires fitting of an alternative suspension (see above 'suspension changes').

H4 Checklist — Chassis alteration (example)

H4 Checklist — Chassis alteration

This checklist is for use by approved vehicle examiners (AVEs) to certify alterations of the chassis.

Vehicle and modifier details

Vehicle make:	Vehicle model:	Month and year of manufacture:
VIN (if applicable):	**Vehicle chassis no. (if applicable):**	**Vehicle modifier (company name):**

Advanced braking systems

	Braking systems — Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Is the advanced braking system (where fitted) un-affected or re-certified after the vehicle modification?	☐	☐	☐

Modification details

	Modification criteria — Check Yes or No as applicable:	Yes	No
1	Has the modification been performed in accordance with the manufacturer's guidelines?	☐	☐

Installation details

	Chassis — Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Are all additional holes in the chassis created in accordance with the requirements of Section H — Overview?	☐	☐	
2	Are all additional holes in the web of the chassis rail, except where the original manufacturer's specifications allow holes in the flange of the chassis rail?	☐	☐	
3	Are additional holes spaced apart at least three times the diameter of the largest hole, in line with Section H Overview or in line with the manufacturer's recommendations?	☐	☐	
4	Were the modified chassis rails straight and square prior to assembly?	☐	☐	
5	Are all cross members designed, positioned and attached as per the manufacturer's specifications, or, where the manufacturer's specifications are unavailable, as per VSB6?	☐	☐	☐
6	Are the ends of reinforcement sections suitably designed to smoothly transition to the chassis rail?	☐	☐	☐
7	Does the thickness of the chassis rail material exceed the thickness of the reinforcement section?	☐	☐	☐
8	Do the profiles of all chassis cut-outs have a smooth transition to the original chassis profile and are all edges dressed smooth?	☐	☐	☐
9	Is the chassis of sufficient strength for its application?	☐	☐	☐
10	Has the top hat/box section chassis been modified in accordance with the vehicle manufacturer's modification guidelines	☐	☐	☐
	Welding — Check Yes, No, N/A as applicable:	Yes	No	N/A
11	Has the welding been performed in accordance with the manufacturer's recommendations, or, where the manufacturer's recommendations are unavailable, VSB6?	☐	☐	☐
12	Has the welding been performed by a suitably qualified tradesperson and to accepted industry standards?	☐	☐	☐
	Vehicle specifications — Check Yes, No, N/A as applicable:	Yes	No	N/A
13	If a suspension change has been carried out, has the suspension installation been performed and certified in accordance with VSB6 Section F?	☐	☐	☐
14	If an additional axle has been fitted, has the axle installation been performed and certified in accordance with VSB6 Section D/E as applicable?	☐	☐	☐

Vehicle chassis no./VIN:	Date:	Signed:

H4 Checklist — Chassis alteration

This checklist is for use by approved vehicle examiners (AVEs) to certify alterations of the chassis.

Compliance

Modification	Check Yes or No as applicable:	Yes	No
1	Does this modification meet all the requirements of the manufacturer's guidelines / Modification Code H4?	☐	☐
2	Is the quality of the work to an accepted industry standard?	☐	☐
3	Does the vehicle continue to comply with ADRs and heavy vehicle standards regulations affected by the modification?	☐	☐
4	Does the modified vehicle satisfy the requirements of the relevant heavy vehicle standards regulation and regulation mass limits imposed by the relevant heavy vehicle regulator?	☐	☐
5	Have all of the modification details and all calculations applicable to the modification been recorded in accordance with the record keeping requirement of VSB6?	☐	☐

Authorisation

If the answer to any relevant question is NO, other than as outlined below, the modification is not acceptable.
The answer to modification details question 1 may be NO.
If the answer to installation details questions 10, 11 or 12 regarding chassis cut outs is NO, the modification may be acceptable provided that the chassis is shown to be suitably reinforced in the critical regions.

Comments:			
Examined by:	**Company (if applicable):**		**AVE no.:**
Signed:	**Modification certificate no.:**	**Modification plate no.:**	**Date:**

Vehicle chassis no./VIN:	Date:	Signed:

Modification Code H5 — Trailer chassis modifications

1. Scope

Modifications covered under this code:

Covered

- chassis modifications where the registration category or configuration of the trailer to be modified is not changed
- trailer chassis extension or reduction, including dimension between point of articulation and:
  - rear overhang line
  - rear end
- chassis alterations for the fitting of suspension substitutions (including relocation of suspension systems)
- installation or removal of cross-members
- attachment of components to the chassis such as container twist locks.
- Chassis repairs

Not covered

- trailer chassis modifications to change the trailer's basic type, e.g., semitrailer to dog trailer, pig trailer to dog trailer, semitrailer to dolly, etc. When a trailer type is altered, the trailer is regarded as being remanufactured rather than modified and as such, a new entry onto the RAV and new VIN issued to correctly identify the trailer and the manufacturer
- modifications that change the registration category of the trailer
- changes in the GTM or ATM of trailers (see VSB6 modification codes S7 and S12).
- fitting of alternative suspension systems (see VSB6 Modification Code F2)
- fitting of kingpins or other tow couplings (see VSB6 Section P)
- mounting of bodies on trailers (see VSB6 Modification Code J1).

2. Related standards

Modified vehicles must comply with all related Australian Design Rules, Australian Standards, acts and regulations. Below are some but not all of the areas that may be affected by the modifications in this code and require certification testing or evidence to demonstrate compliance.

The certifier must ensure that the modified vehicle continues to comply with all related Australian Design Rules.

This…	Must comply with…
Mass re-rating	VSB6 Section S — Vehicle rating
Fitting of alternative suspension	VSB6 Modification Code F2
Trailer brake system upgrade approved design certification for non-standard trailers	VSB6 Modification Code G8
Trailer brake system upgrading — standard	VSB6 Modification Code G3
Kingpin or tow coupling installation	VSB6 Section P — Tow couplings
Body mounting	VSB6 Section J — Body

3. Certification procedure

The certification procedure for this modification code is as follows:

1.	Modifier	Determine if the modification is within manufacturer specifications. • If **yes**, the modification will need to be done in accordance with manufacturer specifications. • If **no**, the modification will need to be done in accordance with this modification code.
2.	Modifier	Consult with an accredited H5 AVE for guidance on how to perform the modification.
3.	Modifier	Perform modification in accordance with AVE advice and this code.
4.	Modifier	Organise approval inspection by an accredited H5 AVE.
5.	H5 AVE	Perform inspection, complete H5 checklist and determine if compliance has been achieved: • If **yes**, proceed to step 6. • If **no**, do not proceed, advise modifier rework is required to ensure compliance. Return to step 2.
6.	H5 AVE	Issue modification certificate, affix modification plate, and submit paperwork as required by the relevant AVE registration scheme.

AVEs must be satisfied that vehicle modification requirements are being met. It is advised that before modifications are carried out they are discussed with the certifying AVE.

4. Compliance requirements

In addition to the following guidelines, refer to the general information provided in VSB6 Section H — Overview.

Where the modification results in a trailer that is identical to specifications offered by a manufacturer (including suspension, axle configuration, chassis design, braking system and kingpin to centre line of suspension dimension) certify each modification to appropriate modification codes. No additional design and engineering evaluation of the modifications is needed.

Required:

- Ensure the trailer complies with the relevant in-service heavy vehicle regulations for dimensions and vehicle standards regulations.
- Ensure the trailer chassis adequately supports and secures the load and has a satisfactory factor of safety under all designed operating conditions.
- Ensure it transmits prime mover tractive force and sustains braking and suspension forces, while accommodating shock loads and twisting from uneven road surfaces. The chassis must not be so flexible as to upset trailer and load-carrying stability.
- Factors that influence the designed slope and camber of the trailer include the turntable and suspension height, the location of the load support and securing features, and the proposed method of loading. Compared to flat-top general goods type semitrailers, container-type semitrailers generally need less slope for side loading and unloading by forklift, and less camber to ensure containers are supported at twist-lock locations.
- The modifier must consider the intended application of the trailer, in terms of the type of load and the road surface. Identify loads by categories such as uniformly distributed (e.g., in a cattle trailer), point load (e.g., in a container trailer), or a combination of these (e.g., in a general goods-carrying flat deck).

- Consider that road surfaces may range from exclusively smooth paved roads, through to exclusively rough ungraded un-sealed roads, or any combination of these.

Recommended:

Trailer makes or types vary according to manufacturer design philosophies and production methods, so standard options are few.

- To ensure safety and performance, do not perform trailer modifications without consulting the manufacturer or a professional engineer (registered with a professional registration body) experienced in heavy trailer design and modification.
- Where possible, keep the modified trailer within the options offered by the vehicle manufacturer. This simplifies design and sourcing of components and evaluation of the modification. Try to align the modification with the trailer's application and operating conditions and to demonstrate the design integrity using calculation methods.
- Take care when modifying monocoque type trailers, which are used in some cattle or road tank vehicle trailer designs. These trailers can use body sidewall structure (that is, the trusses or the tank) to strength and increase the rigidity of the chassis, or to replace the chassis completely. Changes to this structure could radically alter the trailer's strength and torsional characteristics and must be substantiated by engineering examination.
- Take care when modifying a road tank vehicle and ensure that the vehicle continues to comply with all applicable requirements, including those of AS2809 *Road Tank Vehicles for Dangerous Goods* and the *Australian Dangerous Goods Code*.

5. Design requirements

In addition to the following guidelines, see guidelines provided in VSB6 Section H — Overview.

It is better to shorten a longer wheelbase chassis than to extend a shorter one as it reduces the need for joins in the chassis rails.

Point of articulation to suspension centre dimension

Increase or chassis lengthening

Required:

- When relocating the suspension/axle or kingpin/attachment assembly, also relocate associated cross-members and chassis reinforcements.
- If the extended chassis is outside the original manufacturer's options, have a professional engineer registered with a professional registration body perform stress calculations to ensure allowable limits are not exceeded. The certifying AVE must keep these calculations on file the period specified in VSB6 Introduction.

Recommended:

- Where possible, increase the point of articulation to suspension centre dimension by moving the entire suspension/axle assembly or point of articulation kingpin/attachment assembly to the right position or by extending the front or rear overhang.
- Only cut and join the chassis when there is insufficient chassis length to achieve the above.
- If the modified point of articulation to suspension centre dimension exceeds that offered by the manufacturer, provide the chassis with reinforcement in accordance with this code.
- Check whether the extension of the trailer point of articulation to suspension centre dimension requires additional testing of the braking system to meet the requirements of VSB6 modification codes G3 or G8.
- Ensure the trailer continues to comply with the dimensional requirements of the relevant in-service heavy vehicle regulations.

Reduction or chassis shortening

Recommended:

- If possible, achieve reduction in point of articulation to suspension centre dimension by moving the entire suspension/axle assembly or point of articulation kingpin/attachment assembly to the appropriate position.
- When the suspension/axle assembly or point of articulation/kingpin/attachment assembly is relocated, relocate all associated cross-members and chassis reinforcements.
- If needed, reduce the trailer rear overhang or front swing clearance to maintain compliance with the relevant in-service heavy vehicle regulations.
- Do not allow the point of articulation to suspension centre dimension to be less than the shortest optional point of articulation to suspension centre dimension offered by the original manufacturer.
- If it is less, then conduct additional testing of the braking system to show compliance with the requirements of VSB6 modification codes G3 or G8 and consider that it may also result in a reduction in axle ratings due to restrictions from applying the bridge loading formula.

Chassis components

Chassis sections and components

Required:

- Use the vehicle manufacturer's chassis material and components if available. Where this is not available, ensure all material used to modify chassis rails are of the same dimensions and material specification as the original chassis.
- Ensure all chassis components are straight prior to assembly (with the exception of any camber designed into the main rails).
- Where the chassis, cross-members or other components are bowed, do not straighten them by the assembly or adjustment of the chassis or cross-members.
- Ensure all fabricated sections and components of the chassis have suitable radii on any bends and are free of cracks, notches and imperfections.
- Ensure all changes in sections have a smooth transition, typically not less than one in five.
- Use piping of the same bore as the original manufacturer when altering air or hydraulic lines and do not introduce additional restrictions at fittings.
- Ensure any alteration of the electrical system is waterproof and electrically sound.

Cross-members

Required:

- Ensure cross-member design and spacing is adequate to support the nature and magnitude of the load.
- Do not allow the maximum intermediate cross-member spacing to exceed that specified by the original manufacturer, unless a professional engineer registered with a professional registration body can calculate that the chassis strength and torsional rigidity is satisfactory.
- Ensure cross-members have sufficient strength to accommodate the forces imposed by the load under all conditions with an adequate factor of safety. For example, trailers designed to carry heavy wheel-type loads, such as earth-moving equipment, would have cross-members relatively closely spaced or larger than a standard trailer.

- Ensure suspension cross-members adequately support the suspension assembly to accommodate high bending forces in these regions. To achieve this, fasten the suspension hanger brackets to the cross-members directly, or through chassis rails.
- If the end of a chassis cross-member is used to mount a tow coupling, design and manufacture it to satisfy the requirements of ADR 62/..and ADR 63/.. as applicable. Tow members with a high D-value require substantial reinforcing and bracing.
- Weld or bolt cross-members to the main rails by the webs only.
- Do not weld or bolt cross-members through the rail flanges.
- Weld rolled steel joist (RSJ) cross-members by the web only.

Recommended:

- Install original vehicle manufacturer's cross-members, in accordance with their recommendations.
- Where this is not possible, use alternative cross-member design and attachment methods, including by select cross-members with bending, tensile strength, torsional strength and rigidity similar to the design of the original cross-members (e.g., do not use closed-section cross-members fabricated from RHS and pipe, which have high torsional rigidity compared with open sections such as RSJ's and channels, to replace open section members.
- Consider reinforcing the cross-member to main rail connection using a method such as the one in Figure 39.
- Allow cross-members carrying container locks to continue full width through the chassis rails, with a doubler plate on the chassis rail web and suitable stiffener under the cross-member (see figures 39 and 40).

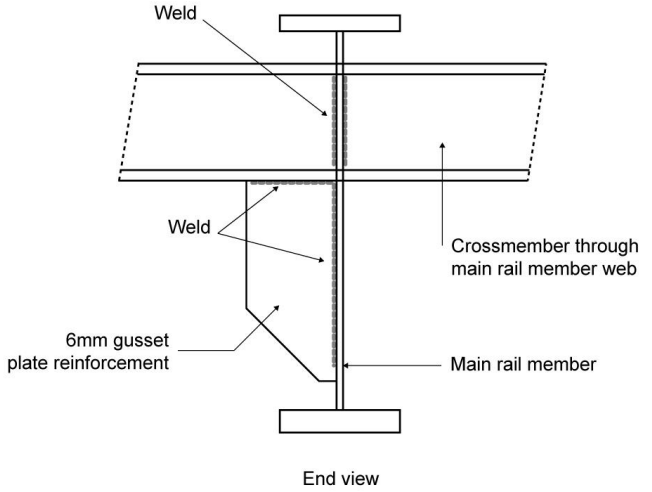

Figure 39: Typical cross-member attachment

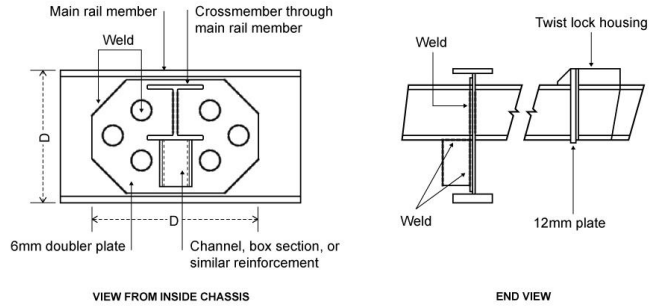

Figure 40: Typical container lock cross-member arrangement

For holes

Required:

- Ensure all new holes in the chassis are in line with the Drilling holes in chassis' segment in VSB6 Section H — Overview.

For bolts and fasteners

Required:

- Ensure all bolts and fasteners are in accordance with the Bolts and fasteners' segment in VSB6 Section H — Overview.

Chassis repair

Eliminating causes of chassis failure

When repairing or replacing the chassis, consider the factors that may have led to the chassis damage or failure and eliminate the cause. These factors may include:

- holes drilled in chassis rail flanges or too close to other holes
- incorrect welding procedures (e.g., undercutting, no preheat, slag inclusions, transverse welding of flanges)
- abrupt change of section (e.g., a square end on a reinforcement or body sub-frame)
- overloading of chassis (e.g., vehicle loaded beyond its designed capacity)
- insufficient reinforcement
- incorrect cross-members (e.g., torsionally stiff cross-members)
- suspension too stiff (suspension capacity greater than chassis capacity)
- incorrect body mounting (i.e., rigidly mounted tanker)
- excessive chassis cut-outs (even a grinding notch on a flange can propagate a crack)
- accident damage.

Repair the chassis with consideration to the cause of the damage or failure. This could involve reinforcing the chassis due to inadequate rail strength or merely tapering an existing reinforcement section or replacing a cross-member.

> ↘ Vehicle manufacturers publish repair guidelines that detail approved repair methods as well as practices that are prohibited. These repair guidelines should be considered before undertaking any repairs to a vehicle's chassis.

Chassis cracking

As a cracked or broken chassis rail typically is a result of the chassis being overstressed, this indicates that additional reinforcement will be required in the region of the failure.

Common areas where chassis cracking occurs:

Behind the rearmost front spring hanger bracket

This area of the chassis rail has numerous stress raisers such as:

- the change in section due to the start of the body sub-frame
- the loads from the spring hanger
- holes for:
  - body mounts
  - spring hangers
  - storage boxes/fuel tanks etc.

Required:

- When repairing a crack behind the rearmost front spring hanger after the cause is eliminated, drill the end of the crack to prevent it from travelling further and then re-weld the crack in accordance with Section H - Overview.
- Do not terminate chassis rail reinforcement behind the rearmost front spring hanger.

- Fit an additional reinforcement that extends forward of the rearmost front spring hanger bracket by a distance equal to twice the chassis rail height (2H).

Cross-member gussets

Cross-member gussets are a common place for cracking to occur. Heavy vehicle chassis are typically designed for large amounts of flex, twisting and movement (unlike light vehicles). This movement induces numerous stress raisers such as:

- along welds
- at changes of section
- along corners
- around bolt holes.

Recommended:

- Do not repair gussets, instead replace gussets with new gussets of the same style.
- Increase the thickness of a gusset provided that it does not exceed the web thickness of the chassis rail or OEM specifications.
- One way to overcome gusset cracking is to use a load distribution plate under the gusset bolts (see Figure 41).

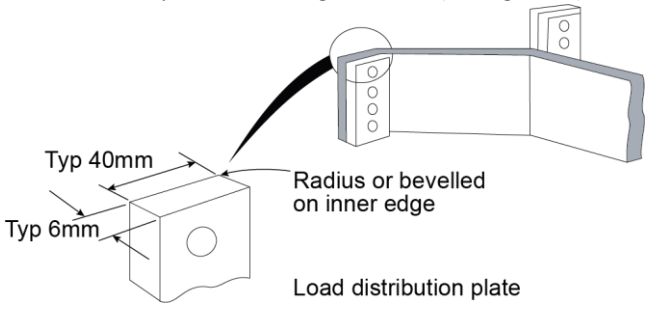

Figure 41: Typical example of load distribution plate

Gusset failure in rear suspension area

The rear suspension of a vehicle is typically one of the most highly stressed areas, as such it is a common place for cracking or other failures to occur.

Recommended:

- If gusset failures occur in the rear suspension or end of frame, consider fitting a rear suspension liner (reinforcement) to reduce cross-member loads, or fit thicker cross-member end plates.

Procedures to be avoided

Required:

Unless otherwise stated by the manufacturer:

- replace cracked heat-treated (high tensile) chassis rails rather than repair them
- replace bent heat-treated (high tensile) chassis rails rather than straighten them.

Modifications impacted by or impacting on chassis design

Suspension modifications

These requirements only apply to relocation of existing suspensions or fitting of an alternative suspension and must be read in conjunction with VSB6 Section F — Suspension.

Required:

- Ensure the design of cross-members is suitable for the type of suspension to be fitted and the new suspension is the correct width to fit the chassis.
- If there is a change to a non-standard suspension configuration, re-calculate and re-certify the braking system in accordance with VSB6 Section G to ADR 38/...
- Re-rate the trailer in accordance with VSB6 Section S —Vehicle rating if the suspension ATM/GTM rating is less than the original.

Recommended:

- Ensure that the design of the chassis rails and cross-members allow the load from the suspension spring hangers to be evenly distributed into the chassis.
- Ensure the chassis is given adequate cross-bracing at the suspension mounting positions.
- Use material for the cross-bracing as determined by the design of the suspension brackets.
- Incorporate cross-bracing at least equivalent to the original vehicle manufacturer's recommendations into the chassis at the suspension mounting positions.
- Reinforce the chassis rail web suitably at the connection of the suspension hanger bracket (see figures 42 and 43).

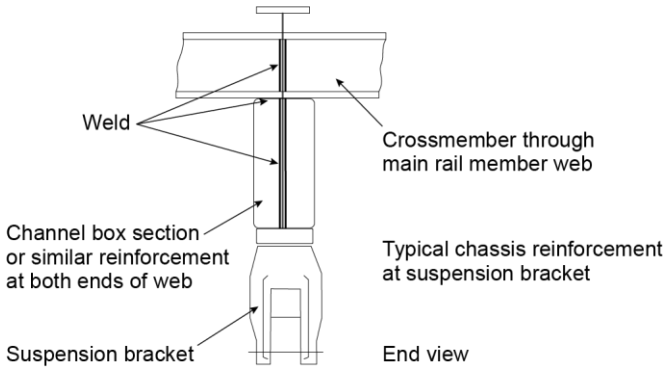

Figure 42: Example of typical chassis rail reinforcement at suspension bracket

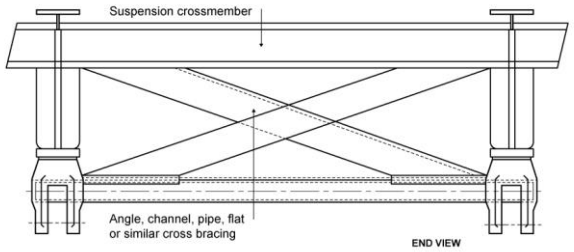

Figure 43: Example of typical chassis cross-bracing at suspension brackets

- If a non-optional suspension is fitted to the trailer, follow the suspension manufacturer's installation instructions and undertake a full analysis of the chassis/suspension package.

Fitting or removing axles

Any change in the number of axles will likely result in a change in the ATM/GTM rating of the trailer and a different suspension to be fitted (see above 'suspension modifications' and refer to VSB6 Modification Code F2).

Change in trailer mass rating

A common modification is to install an additional axle to allow an increase in the ATM/GTM rating of the trailer, such as to upgrade a tandem axle to a tri-axle semitrailer.

When seeking an increase in ATM/GTM rating, you need to show that the trailer chassis is strong enough to accommodate the increase, either by utilising an existing option offered by the original manufacturer or by engaging a professional engineer registered with a professional registration body to perform chassis strength calculations.

Required:

- Where the ATM/GTM of the trailer requires changing, ensure this is certified by an appropriately accredited AVE in accordance with VSB6 modification codes S7 and S12 as applicable.
- If the bending stresses exceed those found in the original designed chassis, consider that the chassis will likely need reinforcement.
- Ensure all chassis reinforcements are undertaken in accordance with this modification code.
- Demonstrate that the modified trailer's braking system is adequate for the increased mass rating (see VSB6 Section G — Brakes).

Recommended:

- If the modified chassis is outside the manufacturer's options, arrange for a professional engineer registered with a professional registration body to perform stress calculations to demonstrate that allowable limits are not exceeded.
- For trailers intended primarily for normal road use, (i.e., not for extended use on unsealed roads or other special applications), ensure the maximum stress at maximum static load for the modified chassis offers a factor of safety of three and greater on the yield strength of the rail material.
- For trailers intended for use in applications other than normal road use, (i.e., extended use on unsealed roads or other special applications), arrange for an engineering evaluation to be performed to determine a suitably increased factor of safety, which should be not less than five.

Fitting fifth wheels, kingpins or other tow couplings

Required:

- Ensure that the fitting of any fifth wheel, kingpin or other tow coupling satisfies the requirements of VSB6 Section P — Tow couplings, ADR 62/.., ADR 63/.. and ADR 64/.. as applicable.
- Ensure the modified chassis is strong enough to accommodate forces delivered via the fifth wheel, kingpin or other fitted tow couplings.

6. Installation requirements

In addition to the following guidelines, see guidelines provided in VSB6 Section H — Overview.

Cutting of chassis rails

When a chassis modification involves cutting a frame, regardless of the reason (e.g., to drop, taper, lengthen or shorten the rails), consider restoring its structural integrity.

Required:

- Consider, in particular, these two situations:

The load distribution on the chassis is improved and bending stress is reduced over the unmodified chassis	This may occur by reducing the point of articulation to suspension centre dimension. The load distribution may reduce bending stress on the chassis. • The modification is adequate without conducting stress calculations, provided that no joint in the chassis rails is located in an area of high stress, and that satisfactory methods are used to join and reinforce joints.
The load distribution on the chassis is degraded	This may occur by increasing the point of articulation to suspension centre dimension or adding another axle behind the rear most axle. The load distribution may increase bending stress on the chassis to values beyond those considered adequate for the unmodified chassis, considering the recommended factor of safety. • If the load distribution results in a greater bending moment than the standard options offered by the original manufacturer, organise for a professional engineer registered with a professional registration body to calculate whether the strength of the modified chassis is adequate. • Because increasing the point of articulation to the axle group centre line by even a small amount, for example, by 300 mm, may affect the bending stress in the chassis, ensure you **re-calculate stress before making the modification**.

- Do not place any join in the chassis at a point of high stress, for example, at the neck or in the vicinity of suspension hanger brackets. Avoid the area and immediate vicinity where a cross-member meets the chassis rails. Position joins in the deeper section of the chassis rails.
- Configure the join in the chassis rail in accordance with the original manufacturer's recommendations or, if unavailable, stagger the joins in the top flange, web and lower flanges (see Figure 44).

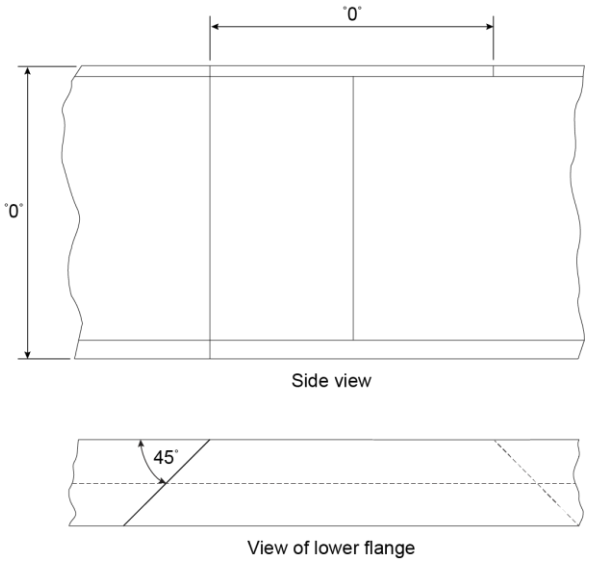

Figure 44: Example of typical join in main rail

- If possible, make joins in the lower flange at 45 degrees and reinforce straight joins in the lower flange (see below 'chassis rail reinforcement').

Welding of chassis

Required:

- Ensure all welding is done in accordance with the 'Welding of chassis' segment in VSB6 Section H — Overview.

Chassis reinforcement

If a chassis modification requires the chassis to be reinforced, refer to the Chassis reinforcing' segment in VSB6 Section H — Overview. Additional specific recommendations for trailer chassis reinforcement are listed here.

Recommended:

- Attach reinforcing sections (typically web stiffening plate weld and flange strapping plates) to the chassis securely by welding (see Figure 45).

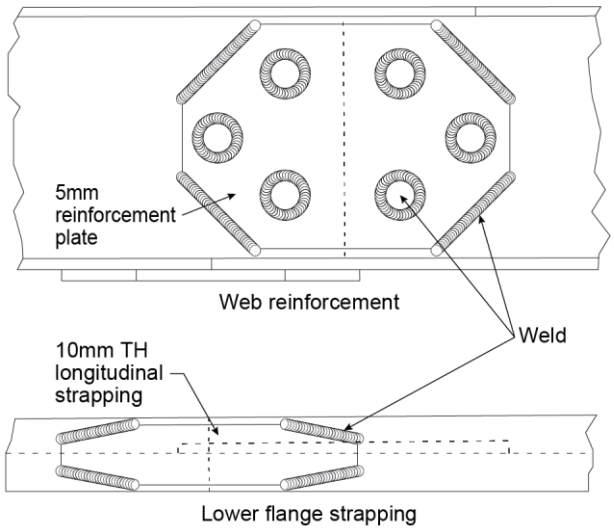

Figure 45: Example of trailer chassis reinforcement

Vehicles with stability control systems

Required:

- When modifications affecting dimensions or load ratings are carried out under this code on vehicles fitted with a form of vehicle stability control, the manufacturer must certify calibration of the control unit.

H5 Checklist — Trailer chassis modifications (example)

H5 Checklist — Trailer chassis modifications

This checklist is for use by approved vehicle examiners (AVEs) to certify modifications to the trailer chassis.

Vehicle and modifier details

Vehicle make:	Vehicle model:	Month and year of manufacture:
VIN (if applicable):	**Vehicle chassis no. (if applicable):**	**Vehicle modifier (company name):**

Advanced braking systems

Braking systems	Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Is the advanced braking system (where fitted) un-affected or re-certified after the vehicle modification?	☐	☐	☐

Modification details

Modification criteria	Check Yes or No as applicable:	Yes	No
1	Has the modification been performed in accordance with the manufacturer's guidelines?	☐	☐

Installation details

Frame	Check Yes, No, N/A as applicable:	Yes	No	N/A
1	Is the modified chassis configuration the same as the original (i.e., is the category of registration unchanged)?	☐	☐	
2	Is the slope, camber and skid plate height suitable for the intended application of the trailer?	☐	☐	
3	Has the chassis been shown to be of sufficient strength and of a suitable factor of safety for the trailer's proposed mass rating?	☐	☐	
4	Does the chassis have suitable torsional characteristics for the intended application of the trailer?	☐	☐	
5	Have materials of the correct dimension and specification been used in the modification of the chassis?	☐	☐	
6	Do all changes in the section have a smooth transition?	☐	☐	
7	Is the cross member design and spacing adequate for the intended application of the trailer and nature of the load?	☐	☐	
8	Are the cross members fastened only to the webs of the main rails?	☐	☐	
9	Are the cross member to main rail connections suitably reinforced?	☐	☐	
10	Are all suspension brackets suitably and adequately attached to the chassis?	☐	☐	☐
11	Are all joins in the chassis in regions of low stress, or if not, have the joins been adequately reinforced?	☐	☐	☐
Vehicle specifications	Check Yes, No, N/A as applicable:	Yes	No	N/A
12	Does the trailer meet the requirements of VSB6 Section G — Brakes?	☐	☐	
13	Do all towing devices on the trailer meet the requirements of VSB6 Section P — Tow couplings?	☐	☐	
14	Has the vehicle stability system, if fitted, been validated by the vehicle or equipment manufacturer as correctly set up for the changed specification?	☐	☐	☐
Welding	Check Yes, No, N/A as applicable:	Yes	No	N/A
15	Has the welding been performed in accordance with the manufacturer's recommendations, or, where the manufacturer's recommendations are unavailable, VSB6?	☐	☐	☐
16	Has the welding been performed by a suitably qualified tradesperson and to accepted industry standards?	☐	☐	☐

Vehicle chassis no./VIN:	Date:	Signed:

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H5 Checklist — Trailer chassis modifications

This checklist is for use by approved vehicle examiners (AVEs) to certify modifications to the trailer chassis.

Compliance

Modification	Check Yes or No as applicable:	Yes	No
1	Does this modification meet all the requirements of the manufacturer's guidelines / Modification Code H5?	☐	☐
2	Is the quality of the work to an accepted industry standard?	☐	☐
3	Does the vehicle continue to comply with ADRs and heavy vehicle standards regulations affected by the modification?	☐	☐
4	Does the modified vehicle satisfy the requirements of the relevant heavy vehicle standards regulation and regulation mass limits imposed by the relevant heavy vehicle regulator?	☐	☐
5	Have all of the modification details and all calculations applicable to the modification been recorded in accordance with the record keeping requirement of VSB6?	☐	☐

Authorisation

Other than modification criteria, if the answer to any relevant question is NO the modification is not acceptable.

Comments:			
Examined by:	**Company (if applicable):**		**AVE no.:**
Signed:	**Modification certificate no.:**	**Modification plate no:**	**Date:**

Vehicle chassis no./VIN:	Date:	Signed: