Guideline

Application and Use of Truck and Trailers Mounted Attenuators (TMAs) at Roadworks

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Contents

1 Purpose

The purpose of these guidelines is to provide a set of technical specifications, operational procedures and the minimum training qualifications required by persons responsible for supervising and operating Truck Mounted Attenuators (TMAs) at road work sites in Queensland.

2 Objectives

The primary objective of these guidelines is to improve the safety of road workers through providing physical protection via TMAs when road closures or temporary safety barriers are not reasonably practical. TMAs also protect the occupants of errant vehicles through attenuating an impact.

The secondary objective is to provide guidance for training of TMA operators, in order to achieve a consistent approach in the use of TMAs in Queensland.

3 Terminology

This section provides abbreviations and definitions of terms used throughout the document.

Table 3 (a) – Acronyms

Acronym	Expansion
AASHTO	American Association of State Highway and Transportation Officials
ADR	Australian Design Rule
AIB	Automatic Impact Braking
AS	Australian Standard
GVM	Gross Vehicle Mass
MASH	Manual for Assessing Safety Hardware
MUTCD Part 3	Queensland Manual of Uniform Traffic Control Devices Part 3: Works on Roads
NCHRP	National Cooperative Highway Research Program
NHVR	National Heavy Vehicle Regulator
TGS	Traffic Guidance Scheme
TL	Test Level
TMA	Truck of Trailer Mounted Impact Attenuator (see definition)

Table 3 (b) – Definitions

Term	Expansion
AIB	A system that, in the event of an impact with the rear of the Impact Attenuator Unit, will apply the brakes of the TMA host vehicle automatically. The system must apply brakes on all wheels of the rear axle/s of the host vehicle.
Competent person	A person who has acquired through training, qualification and/or experience, knowledge and skills to carry out a particular task.
GVM	Means the maximum loaded mass of a vehicle: a) stated on the vehicle's compliance plate, or b) stated in a way prescribed under a regulation.

Term	Expansion
Host vehicle	A Host vehicle is a vehicle that has an impact attenuator unit attached to it permanently or to which a trailer mounted impact attenuator unit can be attached.
Impact	In mechanics, an impact is a high force or shock applied over a short time period when two or more bodies collide. Such a force or acceleration usually has a greater effect than a lower force applied over a proportionally longer time period. An impact that may affect the integrity or operation of the vehicle and/or Impact Attenuator Unit.
Impact Attenuator Unit	An Impact Attenuator Unit, also known as a 'crash cushion' or 'crash attenuator', is a device intended to reduce the damage done to structures, vehicles and motorists resulting from a motor vehicle collision. Impact attenuator units are designed to absorb the vehicles' kinetic energy and/or redirect the vehicles away from the hazard, and from roadwork machinery or workers.
TGS	A Traffic Guidance Scheme is a diagram that illustrates the layout, signs, devices and general arrangement to warn and guide traffic around, past, or, when necessary, through a work site or temporary hazard.
TL2	Applies to Impact Attenuator Units that meet NCHRP Test level 2 (basic) requirements (TL2) 70 km/h.
TL3	Applies to Impact Attenuator Units that meet NCHRP Test level 3 (basic) requirements (TL3) 100 km/h.
TMA	A combination of Host Vehicle and Impact Attenuator Unit, either mounted to the Host Vehicle or towed by the Host Vehicle. The combination must meet the requirements of this document.
TMA Operator	A person meeting the requirements of Part B of this document.

4 Reference and applicable documents

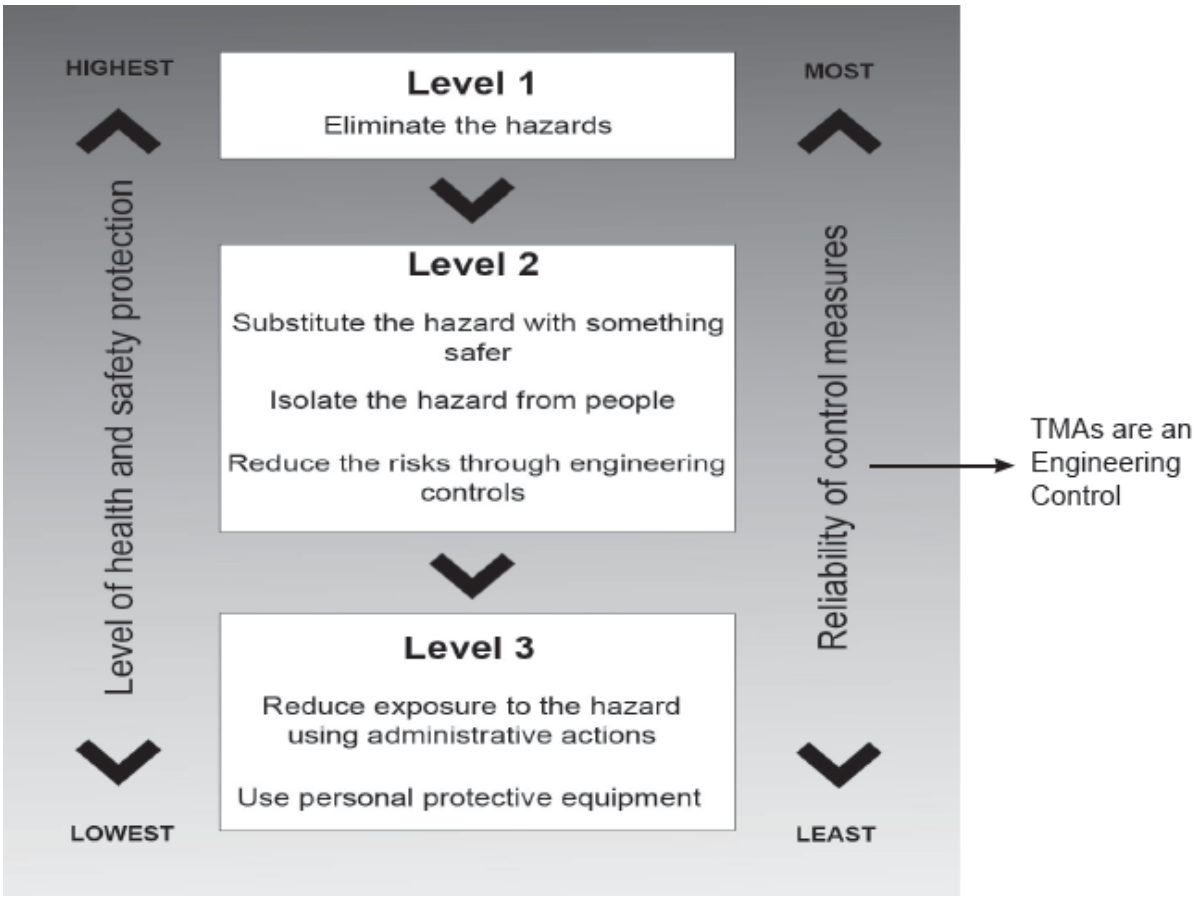
- Queensland Manual of Uniform Traffic Control Devices Part 3: 'Works on Roads'
- NCHRP Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features (1993)
- The Traffic Signs Manual, Chapter 8: 'Traffic Safety Measures and Signs for Road Works and Temporary Situations' United Kingdom (2006)
- BS EN 1317-1 Road Restraint Systems – Part 1: Terminology and General Criteria for Test Methods
- BS EN 1317-2 Road Restraint Systems – Part 2: Performance classes, acceptance criteria and test methods for safety barriers
- ISO 6487 Road vehicles - Measurement techniques in impact tests - Instrumentation
- AS 4192-2006 Illuminated flashing arrow signs
- AASHTO Manual for Assessing Safety Hardware
- AS/NZS ISO 31000 Risk Management

5 Risk management

The *Queensland Work Health and Safety Regulation 2011* classifies work on or adjacent to roads that is used by traffic other than pedestrians as high risk work and prescribes the need to identify hazards and control risks.

The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the 'hierarchy of risk control'. The WHS regulations require duty holders to work through this hierarchy when managing risk under the WHS regulations.

Figure 5 – (title?)



The Queensland Manual of Uniform Traffic Control Devices Part 3: 'Works on Roads' provides guidance in relation to hazard identification and risk control as it relates to all applications of road works. These guidelines embrace these requirements together with the principles as contained in AS/NZS ISO 31000 Risk Management.

Following is an extract of Clause 2.2.3 from MUTCD Part 3.

2.2.3 Risk Management

Risk management entails the identification and analysis of all safety risks likely to arise during works on road including the setting up, operating, changing and ultimate dismantling of a traffic guidance scheme, followed by the determination of appropriate measures to mitigate those risks. The process is appropriate at all levels of planning and operation including the following:

a) When preparing standardised plans and safe work method statements for the conduct of minor routine and mobile works.

b) When preparing traffic guidance schemes for more extensive or complex works where site specific risks will assume importance.

In each case the process should be carried out by first identifying all the hazards likely to arise, evaluating them in terms of likelihood of occurrence and adverse consequences using historical data, experience or other means. The proposed procedural statement or traffic guidance scheme should then be checked in detail to ensure that adequate means of controlling or reducing those risks found to be significant, are in place.

This Part of the Manual sets out guidance and optimal treatments (see Clause 1.2.2). Variations to these optimal treatments shall only be made on the basis of a documented risk assessment undertaken in accordance with TRUM Note 7.8 and subject to Clause 2.2.5.

Part A: Technical specifications

This section provides technical specifications in the following areas:

1. Host vehicle
2. Impact Attenuator Unit certification
3. Truck Mounted Impact Attenuator unit
4. Trailer Mounted Impact Attenuator unit
5. TMA repairs, modifications and inspections
6. Traffic control devices

1 Host vehicle

This section provides standard functional specifications for the host vehicle. This includes areas such as seating, seatbelt harnesses, masts, visibility of the host vehicle and standard control panel arrangement.

Individual State or Territory authorities may have different or specific registration requirements, therefore it is advisable that the relevant authorities be contacted prior to modifications being made to any vehicles.

The host vehicle shall conform to the following requirements:

a) Must comply with the applicable regulatory requirements, such as ADR, registration requirements and applicable legislation, including the *Transport Operations (Road Use Management—Vehicle Standards and Safety) Regulation 2010*. In some cases, a full engineering analysis by a suitable qualified person, supported by testing where applicable, will be necessary before the modified vehicle is accepted. This testing may include determination of front axle loading when the impact attenuator unit is deployed.

b) Be approved for on road use.

c) Be a minimum of 15 tonnes GVM (refer to Appendix A).

d) Be a single cab truck with an automatic transmission.

e) The mounting of any fixtures are to be engineered to 20 times the weight of the fixture.

f) Be painted in accordance with the requirements of the MUTCD Part 3, Clause 3.12.4.

g) Be fitted with an Automatic Impact Brake (AIB) system that, in the event of an impact with the rear of the Impact Attenuator Unit, will apply the brakes of the TMA host vehicle automatically. In the event of such incidents, it is critical to have an isolation switch or system which will allow the AIB system to be deactivated, this will allow for the impacted TMA vehicle to be removed from positions or locations that could cause an unnecessary obstruction or blockage to the roadway.

   As a minimum, the AIB System must apply the brakes on all wheels of the rear axle/s of the host vehicle. The AIB system must only be activated when the Impact Attenuator unit is fully deployed and the host vehicle speed is no greater than 40 km/h.

   It is recommended that the AIB system be fitted, so activation of the system is automatic when the Impact Attenuator unit is fully deployed and the host vehicle is travelling at a speed no greater than 40 km/h.

   Note: Modification of the braking system may affect ADR compliance and require approval through the NHVR Code of Practice for the Approval of Heavy Vehicle Modifications.

h) Be fitted with an AS/NZS 4192 ‘Illuminated flashing arrow signs’ approved size ‘C’ arrow board. The arrow board assembly shall be positioned on the truck in accordance with the requirements of MUTCD Part 3.

i) The arrow board and its mountings shall be engineered to a standard:

   i. That will allow for them to withstand the forces applied during forward travel motion based on maximum speed environment for heavy vehicles when travelling to site, i.e. 100 km/h, and

   ii. To withstand a force of 20 times the total mass of the arrow board and its mountings, and

   iii. If the arrow board assembly is designed to lift and lower, it must lift or lower within 15 seconds.

j) Have an 'in-cabin' control panel placed in close proximity to the operator and illuminated at night. The panel shall include methods of control for, but not limited to, the following:

   i. activation of communication equipment

   ii. activation of warning lights

   iii. activation of arrow board

   iv. raising and lowering of arrow board if applicable

   v. activation of rear view camera

   vi. raising and lowering of the Impact Attenuator Unit

k) Be fitted with an approved four-point harness seat belts and mountings (a four-point harness seat belt is also required in the passenger seat if the vehicle is used for training or assessment purposes).

l) Prevention of rearward seat collapse.

   To reduce the likelihood of rearward seat collapse in the event of a substantial rear impact:

   The driver's seat and seat mountings must be of sufficient strength to prevent rearward seat collapse when subjected to a loading of 740 ± 20 daN (daN - decanewton, a metric unit of force equal to 10 newtons), supplemented by a force equal to 6.6 times the mass of the complete seat, or

   Note: This loading must be applied horizontally rearward through the centre of mass of the seat/occupant combination and must be sustained for at least one second.

   An engineered and certified device, designed to restrict rearward seat collapse when the driver's seat and seat mountings are subjected to the loading described in Sub-clause 1), see above, must be installed behind the driver's seat.

   Note: The device should not increase the likelihood of injury to the seat occupant.

   Reference Appendix B for further information on rearward seat collapse.

m) Be fitted with high strength headboards to prevent debris from crashing through the cabin in the event of an impact. The backs of these headboards are to be blacked out, so as to contrast/highlight the arrow board and other detailing of the vehicle when viewed from the rear.

n) Be fitted with a minimum of two flashing yellow lamps, positioned on the vehicle in accordance with the requirements of MUTCD Part 3.

o) Have mounting facilities for signs to be mounted to the tailgate or headboard as required by relevant State/Territory road authority technical publications.

p) As a minimum, be fitted with communication equipment that will enable simultaneous and independent communication to all relevant personnel, e.g. 2 (two) 5-watt 41 channel UHF radios, operating on separate channels.

q) Be equipped with a warning device of sufficient intensity and volume to be easily heard by workers carrying out their normal duties at least 30 metres from the TMA.

r) Have an independent power back-up system installed that will adequately cater for all auxiliary equipment associated with use of the host vehicle as a TMA. For example, this may include the installation of auxiliary batteries or power packs.

s) Be fitted with a camera to allow the TMA operator to observe traffic approaching from the rear.

Note: Consideration should be given to the use of cameras suitable for both day and night operations, and installation of an associated data recording device to record vehicles approaching from potential impact areas.

t) Must have rear marker plates fitted to the rear of the vehicle.

2 Impact Attenuator Unit testing requirements

Impact Attenuators Units shall meet all mandatory testing requirements of the following:

- NCHRP 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features (1993) for Impact Attenuator Units built before the introduction of the following standard.
- AASHTO Manual for Assessing Safety Hardware for all other Impact Attenuator Units (MASH).

Typical form of evidence for compliance would be, or may include, test specification report of that particular make and model.

2.1 Impact Attenuator Unit test level ratings

The following table indicates Impact Attenuator Unit ratings.

Rating	Speed
TL2	70 km/h
TL3	100 km/h

Impact Attenuators Units shall have their test level rating clearly displayed on both side panels of the unit. The display shall be made up of a panel with black lettering (e.g. TL3) on a white 210 mm x 300 mm background.

3 Truck Mounted Impact Attenuator Unit

Host vehicle shall be as detailed in Part A Section 1:

a) Impact Attenuator Units shall be assembled and fitted to the host vehicle in accordance with the manufacturer's specifications.

b) Flashing yellow light/s shall be fitted to the rear of the Impact Attenuator Unit.

c) The rear surface of the Impact Attenuator Unit when deployed shall consist of Class 1W retro reflective red diagonal striping at least 100 mm wide on a white non-retro reflective background.

3.1 Truck Mounted Impact Attenuator Unit configuration

In addition to the requirements above, the following shall apply:

a) Dedicated yellow flashing light to automatically provide notice of the Impact Attenuator Unit being raised or lowered.

b) Automatic Impact Brake micro-switch is to be fitted to the rear of the Impact Attenuator Unit to activate the host vehicle brakes in the event of an impact.

c) In-cabin and external audible alarms to automatically provide notice of the Impact Attenuator Unit being raised or lowered.

d) Travel lock system installed that prevents inadvertent deployment of the Impact Attenuator Unit.

e) When not deployed, an adhesive-type (black on yellow) warning sign stating: 'Caution: keep clear this unit may lower at any time' must be visible from the rear of the Impact Attenuator Unit.

4 Trailer Mounted Impact Attenuator Unit

Trailer Mounted Impact Attenuator Units must be equipped with anti-rotational damper systems (designed to restrict gating of the unit into adjacent traffic lanes). Break away cables shall also be used to ensure that the electronic braking system is activated should the anti-rotational damper system fail.

The minimum recommended weight for the tow or host truck is 4536 kg. Gross Vehicle Weight (GVM). There is no specified maximum GVM for the tow or host vehicle (NCHRP report 350 conducted on Trailer Mounted Impact Attenuator Units with a TL3 rating).

It is important to note that as the weight of the support or host truck is increased, the 'roll ahead distance' upon impact is reduced.

5 TMA repairs, modifications and inspections

a) All repairs and/or modifications to TMAs and attachments shall be carried out by a competent person.

b) Following repair or modification, TMAs and attachments must be inspected and have certification documentation prepared by a competent person.

c) TMAs and attachments must be inspected at least once each year and have certification documentation prepared by a competent person.

6 Traffic control devices

All traffic control devices are to conform to the requirements of, and installed in accordance with, Part 3 of the MUTCD.

6.1 Vehicle mounted signs and devices

All vehicle mounted warning devices shall be in accordance with the requirements contained in the MUTCD Part 3. This includes all signs, illuminated flashing arrow sign and flashing yellow lamps.

- Illuminated flashing arrow sign
- Flashing yellow lamps may be used in conjunction with this sign, provided that the lamps are either appropriately shielded or laterally or vertically displaced from the edge of the sign to avoid visually corrupting the arrow shape or its directional effect.
- Variable Message Sign
- All variable message sign boards shown in the traffic guidance schemes and used in conjunction with attenuator operations as a minimum shall:
  - meet AS 4852.2
  - have a display of 1600 mm wide x 1150 mm high as a minimum, and
  - display no more than three messages.

6.2 Advance warning vehicles

Advance warning vehicles warn and inform of changes to traffic conditions ahead and give motorists time to adjust their driving patterns.

Advance warning vehicles shall have ‘B’ size arrow board or variable message board.

Part B: Qualification criteria for operators

This section provides guidance in TMA Driver Training requirements.

Mandatory requirements for training as TMA operators:

1. Hold a current and valid Heavy Vehicle licence of a suitable class to operate the TMA
2. Hold a General Construction Induction Card – CPCCOHS1001A (White Card)
3. Traffic Control Qualifications. TMA operators must be able to produce evidence that they have completed and maintained currency in traffic control training equivalent to RIIOHS302A 'Implement Traffic Management Plan'.

Examples of currently accepted equivalent courses:

- New South Wales 'apply traffic control plans' (yellow card)
- Queensland 'Implement Traffic Guidance Scheme – 30846QLD'

All other states and territories deliver RIIOHS302A in worksite/zone traffic management courses.

Traffic Control Work Zone skill set 'Implement traffic control guidance plan' from the Resources and Infrastructure Training Package (RII09).

This skill-set outlines the key competencies for a person involved in the implementation of traffic control at a worksite (e.g. TMA operator).

Attached below is extract from the Austroads' Report for *Implementing National Best Practice for Traffic Control at Roadwork Sites – June 2011*.

Functional role	**Profile functions/duties summary**	**Recommended skill-set (national training package competencies)**
Implement Traffic Control Guidance Scheme	Personnel are required to identify and select traffic control signs and devices and correctly position them in accordance with the approved TGS. It may be necessary for personnel to adjust the location of signs and devices within stated tolerances to suit the specific road environment. Personnel will be required to inspect and maintain signs and devices specified in the TGS during the work program.	RIIOHS201A – Work safely and follow WHS policies and work procedures. RIICOM201A – Communicate in the work place. RIIOHS302A – "Implement traffic management plan"

1 TMA operator training – gained qualifications and experience through competency based assessment

All TMA operators must successfully complete TMA Operator Training before operating the TMA. When training has been successfully completed, a statement that clearly identifies the trainee's name, when the training occurred (date of training), training content and trainer's details must be provided.

The following elements of competency need to be covered and assessed for training of TMA Operators.

1.1 Plan and prepare

- Access, interpret and apply compliance documentation relevant to work activity
- Obtain and discuss safety requirements for the site, e.g. Traffic Guidance Scheme (TGS) and Vehicle Management Plan (VMP)
- Set up TMA signage as required by TGS
- Select vehicles, plant and equipment consistent with requirements for the job.

1.2 Conduct truck and attenuator pre-operational checks

Check truck and attenuator (including TMA pre-start check and TMA Features and Functions).

1.3 Check TMA devices and identify positioning of TMA

- Position and check TMA signs and devices
- Check TMA vehicle warning lights and displays
- Identify TMA position according to TGS.

1.4 Use radio communication

- Check radio
- Test and verify radio contact between all vehicles and handheld
- Check radio contact periodically
- Use radio communication between vehicles to confirm correct positioning of vehicle.

1.5 Operate TMA

- Identify site hazards associated with TMA operations
- Identify and apply safe operating techniques for TMA
- Operate TMA to work instructions, including closing lanes and working in a mobile/progressively moving work situation.
- Move TMA safely between worksites.

1.6 Carry out operator maintenance

Conduct inspection and fault finding.

In addition, all support staff working with a TMA must be inducted into the TMA, including the communication processes.

Part C: Operational procedures

This section provides guidance in the Operation of TMAs.

1 Operational requirements

The following shall be observed when operating a TMA:

a) At all times, the host vehicle's seat belts shall be used

b) After an impact or crash that may affect the integrity of the host vehicle and/or impact attenuator unit, TMAs and attachments must be inspected (see Part A, Clause 5)

c) No items to be carried in the back of a host vehicle while it is performing the duties of a TMA

d) The mounting of any fixtures or equipment to the TMA shall be engineered to 20 times the weight of the fixture

e) Only the operator shall be in vehicle when the TMA is in use, except if the operator is undergoing training or assessment, in which case the trainer or assessor must occupy a seating position that has the same level of occupant protection as the driver's seat (see Part A Section 1 – Host Vehicle clauses 'l' and 'm')

f) On request, operators shall produce evidence of successful completion of an approved competency based TMA training course

g) When the Impact Attenuator Unit is in the deployed/lowered position, the vehicle may only travel within its own lane or carry out lane-changing manoeuvres in the same direction. The Impact Attenuator Unit must be raised when carrying out all other manoeuvres

h) The Impact Attenuator Unit may only be in the deployed/lowered position when the TMA is engaged at an approved road work site. This may include the preparation and disassembly of an approved TGS.

2 Use of TMAs

TMAs shall be used as prescribed in Part 3 of the MUTCD.

3 TMA work instructions

Work instructions shall be produced for the safe operation of TMAs.

Typically, these instructions should include information relating to the following:

- Using TMAs to undertake a static lane closure
- Using TMAs in a mobile convoy situation or progressively moving work situation.

Appendix A: 15-tonne Gross Vehicle Mass rationale

15-tonne Gross Vehicle Mass (GVM) requirement for TMA Host Vehicle

Critical to the development of a TMA that affords protection to the public, the road workers and the TMA operator, is the selection of the host vehicle. The vehicle must be appropriate for the use intended and also comply with all legislative requirements.

There are a number of requirements that affect the selection of the host vehicle. A discussion of critical requirements follows.

Minimum tare mass

For acceptable impact performance, minimum tare mass requirements for host vehicles are set by the manufacturers of impact attenuator units. The two currently available impact attenuators have minimum host vehicle tare mass requirements of 7.3 tonnes (Safe Stop) and approximately 9.07 tonnes (20,000 lbs) (Scorpion).

The host vehicle tare mass is the mass of the truck with all the components necessary for operation as a TMA.

Weight distribution

To enhance the effectiveness of the Automatic Impact Braking System (AIB), the rear axle/s should carry a significant proportion of the total TMA mass.

Use of ballasting

The use of ballasting is discouraged. The mounting points of all attachments to a TMA host vehicle are required to withstand a force of 20 times the mass of the attachment. While the attachment of the ballasting to the truck body may meet this requirement, the attachment of the body with ballast to the chassis is unlikely to meet the 20 times mass requirement without significant modification to the mounting points on both the body and to the truck chassis.

Chassis size and strength for impact attenuator unit mounting

Under impact, the loads imposed on an impact attenuator unit are transferred through the mounting assembly into the chassis of the truck. The truck chassis shall be of a size that allows mounting of the impact attenuator unit in accordance with the manufacturer's specifications. The truck chassis shall also be of sufficient strength to absorb applied loads without significant failure or distortion.

Conclusion

It is recommended that TMA host vehicles with a manufacturer's gross vehicle mass (GVM) rating of at least 15 tonnes will meet the above critical requirements.

Vehicles with a lesser GVM rating are unlikely to meet all or possibly any of the above critical requirements.

Appendix B: 15 Rearward seat collapse

Prevention of rearward seat collapse

Background

Queensland Department of Transport and Main Roads experienced a TMA incident where the driver's seat failed in a rearward direction. The driver's head hit the rear of the cabin and the driver also suffered back injuries, which have permanently prevented his return to work.

Rearward seat collapse

The purpose of this requirement is to reduce the likelihood of rearward seat collapse in the event of a substantial impact to the rear of a TMA. This will reduce the likelihood of injury to a TMA occupant.

The purpose of this requirement may be achieved by either of two methods:

1. By design or testing, determine that the seat and mountings are of sufficient strength to withstand in the rearward direction, similar loading to that applied to the seat and seat mountings in a forward direction for ADR compliance
2. By fitting a device behind the seat to restrict rearward seat collapse when the same loadings are applied in a rearward direction.

The rearward loading requirements are based on ADR 5/05 requirements.

ADR 5/05 relates to seat belt anchorage strength required to restrain an occupant in a frontal impact. In a rear impact, the seat belt has no effect and rearward movement of the occupant is restrained by the seat structure and seat mountings only.

The TMA guideline requirement is intended to afford a seat occupant a similar level of protection in the event of a rear impact that the ADRs provide in a frontal impact.

ADR 5/05 requires that for heavy goods vehicles (GVM > 12 t) with lap belt anchorages located wholly within the seat structure, the seat and the belt anchorages must withstand the following loading in the forward direction:

> A test load of 740 ± 20 daN supplemented by a force equal to 6.6 times the mass of the complete seat.

The TMA Guideline requirement imposes the same loading in a rearward direction to simulate the effects of a rear impact.

Evidence of compliance with these rearward loading requirements can be either by design verification or by representative test results. This evidence would give blanket cover (type approval) to that seat/vehicle combination and the vehicle/seat supplier or verifying engineer would supply certification of same.

If evidence of compliance with additional rearward loading requirements is not available, a device to prevent rearward seat collapse would be fitted.

Note: ADRs require that to test seat and seat anchorage strength, a rearward longitudinal deceleration of 20 g is applied to the whole shell of the vehicle, without an occupant.

Given this requirement and that the seat assembly is certified to withstand applied loads in a forward direction, the original equipment seats may meet the TMA Guideline requirements.

Appendix C: Traffic Guidance Schemes

The design, selection and implementation of traffic control measures should be based on MUTCD Part 3 Works on Roads.

It is of paramount importance in ensuring the safety of all persons, including members of the public at work sites, that there is a high standard of traffic control around, past or through those worksites. This can only be undertaken with a systematic consideration of conditions to be encountered at each site and selecting or designing a specific plan for the control of traffic.