SECTION 9 TERMINALS

9.1 SCOPE OF SECTION

This Section sets out the requirements for terminals and covers the classification, specification and installation of terminals.

NOTE: Terminals and crash cushions fulfil similar functions. Crash cushions are covered in Section 10.

9.2 GENERAL

Terminals shall be used at the start and end of longitudinal road safety barrier systems.

NOTE: Terminals are critical to the performance of the barrier system.

Terminals shall be designed to reduce the severity of impacts with the end of a longitudinal road safety barrier and function as a redirective barrier when impacted along the side at a certain distance from the end of the terminal.

A terminal treatment shall be required to perform the following functions:

(a) To anchor the barrier system such that the longitudinal strength is developed in an impact.

(b) To be weak enough that, if hit by an errant vehicle under specified impact conditions (other than motorcycles), it will not cause the vehicle's occupants to suffer injury or death by severe deceleration or spearing of the passenger compartment of the vehicle.

Terminals on the departure end of a longitudinal barrier where they are unlikely to be hit in the reverse direction may not need to be crash tested but need to be able to demonstrate that they provide sufficient anchorage for the longitudinal barrier to perform satisfactorily.

NOTE: For commentary on this Clause, see Paragraph I9.2 of Appendix I.

9.3 CLASSIFICATION

9.3.1 General

Terminals shall be classified as either—

(a) gating; or

(b) non-gating.

NOTE: For commentary on this Clause, see Paragraph I9.3 of Appendix I.

9.3.2 Gating terminals

Gating terminal systems are designed to allow a vehicle impacting the nose, or the side of the terminal at an angle near the nose, to pass through the terminal and behind the barrier. They may breakaway, hinge or pivot when impacted.

A gating terminal shall be designed to allow controlled penetration of the vehicle through the barrier system when impacting between the end of the terminal and the point of redirection of the terminal or barrier.

9.3.3 Non-gating terminals

Non-gating terminals do not allow vehicles to pass through the leading section of the terminal as they are designed to contain an impacting vehicle and redirect it along the length of the terminal towards the longitudinal barrier. On colliding with the end of the terminal, the vehicle will be redirected away from the barrier or terminal. The point of redirection for a non-gating system is typically at the nose.

9.3.4 Run out area

A run out area shall be provided behind all terminals to allow a vehicle to go through the gating part. It is to be traversable and free of hazards for impacts that occur prior to the point of redirection. The run out area extends beyond the 'point of redirection' and can include part of a gating terminal. The default run out area is to be 18.5 m 6 m from the 'point of redirection' unless otherwise specified.

9.4 INSTALLATION CRITERIA

Prior to set-out, the System Installer shall confirm that the terminal is appropriate for the longitudinal barrier it is being connected to.

Proprietary terminals shall be constructed in accordance with the drawings, specifications and tolerances provided by the system documentation.

When cable assemblies are used, all nuts shall be tightened to a minimum torque of 50 Nm on the assemblies unless specified otherwise.

All bolts used in W-beam and Thrie-beam terminals other than nuts on cable assemblies, shall be tightened to a snug-tight condition.

All bolt heads on the traffic side of W-beam and Thrie-beam terminals shall be flush with the rail surface unless otherwise specified. If part of the tested system, a cover shall be attached to protect vulnerable road users.

Any changes to a terminal shall be evaluated in accordance with Clause 4.4.

NOTE: For commentary on this Clause, see Paragraph I9.4 of Appendix I.

SECTION 10 CRASH CUSHIONS

10.1 SCOPE OF SECTION

This Section sets out requirements for crash cushions and covers the classification, specification and installation of these devices.

NOTE: Terminals and crash cushions fulfil similar functions. Terminals are covered in Section 9.

Crash cushions shall be classified as either—

(a) redirective; or

(b) non-redirective.

Redirective crash cushions shall either be classified as gating or non-gating whilst all non-redirective crash cushions are gating.

NOTE: Examples of different types of crash cushion are discussed in the commentary in Paragraph J10.1 in Appendix J.

10.2 SPECIFICATION OF CRASH CUSHIONS

The following factors shall be considered when specifying a crash cushion:

(a) *Type* Redirective or non-directive.

(b) *Classification* If a redirective crash cushion is required, then the following shall be specified:

  (i) Whether the crash cushion is to be a gating or non-gating crash cushion.

  (ii) The point of redirection shall be identified.

(c) *Test level* Some crash cushions have achieved multiple test levels and for some products the System Owner can provide configurations for different design speeds rather than various test levels.

(d) *Configuration* Crash cushions may be available in different configurations, including the width, anchoring in terms of rigid backstops, different colours of nose cones. Side panel and rail laps may vary depending on unidirectional or bi-directional passing traffic. For crash cushions, the side panels are aligned to accommodate the direction of travel.

(e) *Transitions* There may be a number of options available depending on the direction of impact (unidirectional or bidirectional) and the hazard or barrier system that the crash cushion is to be connected to.

(f) *Foundation options* Some crash cushions have a range of foundation options and only certain options may be applicable to the specific site that the crash cushion is to be installed.

(g) *Site conditions* There are design limitations such as maximum cross-fall and the like which may limit the use of certain devices.

NOTE: There are other considerations users may wish to consider when specifying crash cushions. These are discussed in the commentary in Paragraph J10.2 in Appendix J.

10.3 INSTALLATION CRITERIA

Tolerances on placement, height, verticality and foundations for proprietary crash cushions shall be in accordance with the system documentation. If the tolerances are not specified, the general tolerances specified in Clause 2.3 and the following shall apply:

(a) Variation of the foundation cross-section dimensions and length ..... ±20 mm.

(b) Height of the foundation relative to the adjacent finished surface levels..... ±5 mm.

(c) Cross-fall of the foundation ..... ±1%.

(d) Height of the crash cushion..... ±20 mm.

System documentation shall include the following:

(i) Maximum approach slope in front of the crash cushion.

(ii) The maximum cross slope of the crash cushion.

(iii) The requirement for any clear area behind the crash cushion to enable side panels to retract during impact.

NOTE: For commentary on this Clause, see Paragraph J10.3 of Appendix J.

SECTION 11 INTERFACES

11.1 SCOPE OF SECTION

This Section sets out requirements for interfaces as well as details of selected public domain transitions considered suitable under this Standard.

NOTE: For commentary on this Clause, see Paragraph K11.1 of Appendix K.

11.2 CLASSIFICATION AND TESTING

11.2.1 General

Interfaces are used when two longitudinal road safety barrier systems are used on a road so that continuous protection is provided. These barrier systems may have different geometries and approximately the same stiffness, or these barriers may have significantly different stiffness.

Interfaces can be classified as being a transition, or an overlap.

If a transition is not possible, an overlap of systems shall be provided (for further requirements, see Clause 11.2.3).

11.2.2 Transitions

A transition shall be used when transitioning from a less stiff to a much stiffer barrier system so as to prevent ‘pocketing’ and failure. It is recommended that a transition be used when a stiffer barrier precedes a less stiff barrier. These transitions should be tested, evaluated or modified as documented in Section 4.

A transition shall be required where if an errant vehicle can impact the less stiff barrier system before hitting the stiffer barrier system.

NOTE: Refer to Clause 4.3.7.2 for testing requirements of transitions and to Paragraph K11.2.2 in Appendix K for commentary on this Clause.

11.2.3 Overlaps

An overlap is a type of interface where same or different safety barriers are installed as stand-alone systems with a lateral separation and no connection between the two. Points of redirection of both barriers shall be positioned to ensure the whole system provides continuous protection and that neither barrier’s performance is compromised by the design of the interface.

Overlaps should be tested if the separation between the barriers is less than the deflection of the barrier closest to the road.

NOTE: Refer to Clause 4.3.7.3 for testing requirements of overlaps and to Paragraph K11.2.3 in Appendix K for commentary on this Clause.

11.3 INSTALLATION

Prior to installation, the Installation Designer shall confirm that the interface is appropriate for the barrier systems in question.

Proprietary transitions shall be constructed in accordance with the drawings, specifications and tolerances provided in the system documentation, and have been accepted by the Road Authority.

In the absence of tolerances provided by the system documentation, or public domain systems, the tolerances specified in Clause 3.2 shall apply.

A transition shall have a traffic face that is as smooth and free of obstacles as possible and all bolt heads on the traffic side shall be flush with the rail surface unless otherwise specified by the System Owner of a proprietary system or the Road Authority for a public domain system. All bolts used in public domain W-beam and Thrie-beam transitions other than nuts on cables assemblies, shall be tightened to a snug-tight condition.

NOTE: For commentary on this Clause, see Paragraph K11.3 of Appendix K.

SECTION 12 LONGITUDINAL BARRIER GATES

12.1 SCOPE OF SECTION

This Section sets out the requirements for longitudinal barrier gates that are installed within road safety barrier systems.

12.2 GENERAL

It may be necessary to provide access through road safety barrier systems, particularly when barriers are installed as a median barrier in long continuous lengths.

Access shall be provided either by overlapping of barrier systems as specified in Clause 11.2.3 or by the use of a gate.

A longitudinal barrier gate shall consist of the following:

(a) *Longitudinal barrier* Longitudinal barriers shall be subject to the same requirements of the appropriate barrier type, i.e. rigid, semi-rigid or flexible barriers.

(b) *Interfaces* Interfaces shall be subject to the requirements of Section 11.

The system shall be tested in accordance with Section 4 in the configuration that it is installed in.

NOTES:

1 For example, if the gate has wheels that are in the down position (that is in contact with the ground) when installed, the gate is tested in this configuration.

2 For commentary on this Clause, see Paragraph L12.2 of Appendix L.

12.3 DOCUMENTATION

In addition to the normal documentation required for a road safety barrier system (see Section 2), the following shall also be required:

(a) Area required to open the gate.

(b) Estimated time for opening the gate.

(c) Limitations of the use of the gate, e.g. cross-fall, surface type and the like.

(d) Operating procedures for opening of the gate which is to cover equipment required for opening, including machinery that may be required to open the gate and any special tools.

(e) Power requirements, if the gate is powered.

(f) Width of opening provided by the gate.

NOTE: For commentary on this Clause, see Paragraph L12.3 of Appendix L.

12.4 INSTALLATION CRITERIA

All gate installations shall comply with the System Owner's or System Supplier's instructions.

Tolerances on placement, height, verticality and foundations for gates shall be in accordance with the system documentation, System Owner's or System Supplier's specification. If the tolerances are not specified, the general tolerances specified in Clause 3.2.2 and the following shall be applied:

(a) Variation of the cross-section dimensions and length of the foundation..... ±20 mm.

(b) Height of the foundation relative to the adjacent finished surface levels..... ±5 mm.

(c) Cross-fall of the foundation ..... ±1%.

The posts shall not be shortened to accommodate conditions at a site.

NOTE: For commentary on this Clause, see Paragraph L12.4 of Appendix L.

12.5 GATE REQUIREMENTS

Gate requirements shall be as follows:

(a) If the gate is an automated opening, it shall be equipped with a manual opening facility, for operation in the event of power failure.

(b) Manual gates shall be designed so as to be easily opened by only two persons.

(c) Gates shall be lockable so as to prevent tampering and unwarranted opening.

(d) Manual gates shall be able to be opened without the need of power, air or tools.

NOTE: For commentary on this Clause, see Paragraph L12.5 of Appendix L.

APPENDIX A

COMMENTARY ON SECTION 1 (SCOPE AND GENERAL)

(Informative)

A1.1 SCOPE

Permanent safety barriers can be divided into three general types in descending order of deflection:

(a) Flexible.

(b) Semi-rigid.

(c) Rigid.

Another view is that for different barrier types, the amount of energy attenuated by the barrier or the vehicle changes. For flexible barriers most of the impact energy is attenuated by the barrier, for rigid barriers most of the energy is attenuated by the vehicle and for semi-rigid barriers both the vehicle and the barrier attenuate about the same amounts of energy. The barrier types can be based on its stiffness, dynamic deflection, and vehicle crash severity rather than on its construction.

Flexible barriers manage impact kinetic energy through substantial movement, deformation and deflection of the barrier system. These barriers are typically wire rope barriers. Generally, flexible barriers redirect vehicles by the tensile restraint offered by the cables or beams or the connections between the elements and to some minor degree by rotation/bending of the relatively flexible posts driven or fixed into the foundation medium such as soil, etc.

Semi-rigid barriers manage impact kinetic energy through limited movement, yielding (including rupture), deformation and deflection. Typical examples are W-beam or Thrie-beams on steel or timber posts with appropriate block-outs, steel rails on posts or interconnected steel or concrete units. These barriers absorb energy from the test vehicle impact by rotating or bending of the strong posts and bending-deflection with tensile restraint of the rail or, in the case of interconnected units, by the resistance to rotation at the connections and resistance to movement though friction/static mass.

Rigid barriers manage impact kinetic energy through limited, if any, movement, yielding deformation or small deflection of the barrier. Most of the energy is through vehicle movement and deformation. These barriers are usually concrete barriers embedded in the pavement or attached to footings. The title ‘rigid barriers’ implies exceedingly stiff barriers that do not deflect. However, these barriers deflect to some limited extent.

This Standard need not require existing barriers to be replaced and it predominately applies to new installations.

A1.2 EXCLUSIONS

There is no commentary for this Clause.

A1.3 APPLICATION

There is no commentary for this Clause.

A1.4 REFERENCED DOCUMENTS

There is no commentary for this Clause.

A1.5 DEFINITIONS

Further to the discussion on entities, it may be the case, but not a requirement, that entities could undertake the following tasks:

System Owner sets the attributes of the system or device describing appropriate and inappropriate sites for the system or device.

System Manufacturer manufactures to the device or components in conformity with the patent and the full-scale tests. The System Manufacturer may also fabricate the system or device from components.

System Supplier is generally a local agent who often provides warranties and the documentation in accordance with the full-scale tests and other system attributes set by the System Owner. Hire companies are the System Supplier if they provide temporary work systems of devices for another entity to install. This entity could be the System Owner and/or the System Manufacturer.

There is no commentary for definitions 1.5.1 to 1.5.42.

A number of terms are defined in Appendix A of the Austroads *Guide to Road Design*, Part 6.

A1.6 NOTATIONS

There is no commentary for this Clause.

A1.7 GENERAL REQUIREMENTS FOR ROAD SAFETY BARRIER SYSTEMS

There is no commentary for this Clause.

A1.8 USE OF SUBSTITUTE MATERIALS AND OTHER COMPONENTS

There is no commentary for this Clause.

A1.9 VULNERABLE ROAD USERS

Safety devices can be a hazard to all road users in some circumstances. They can be particularly hazardous to motorcyclists and other vulnerable road users if they have not been appropriately designed for some impact scenarios. While motorcycle crashes into roadside barriers may be rare and the Severity Index (SI) of a barrier when impacted by a motorcyclist is significantly less than that for a hazard such as a tree, pole, bridge pier etc., the crash cost for a motorcycle crash could still be less for the hazard than that for a proposed barrier, depending on the length of the hazard and the proposed barrier.

It is important that all practical means are used to make devices less likely to injure vulnerable road users and to assess the risk appropriately.

A1.10 MAINTENANCE AND INSTALLATION

Installation and maintenance staff should be appropriately trained. The development of accredited training programs and the accreditation of installation and maintenance staff is encouraged.

It is important that all practical means are used to make devices less likely to injure vulnerable road users.