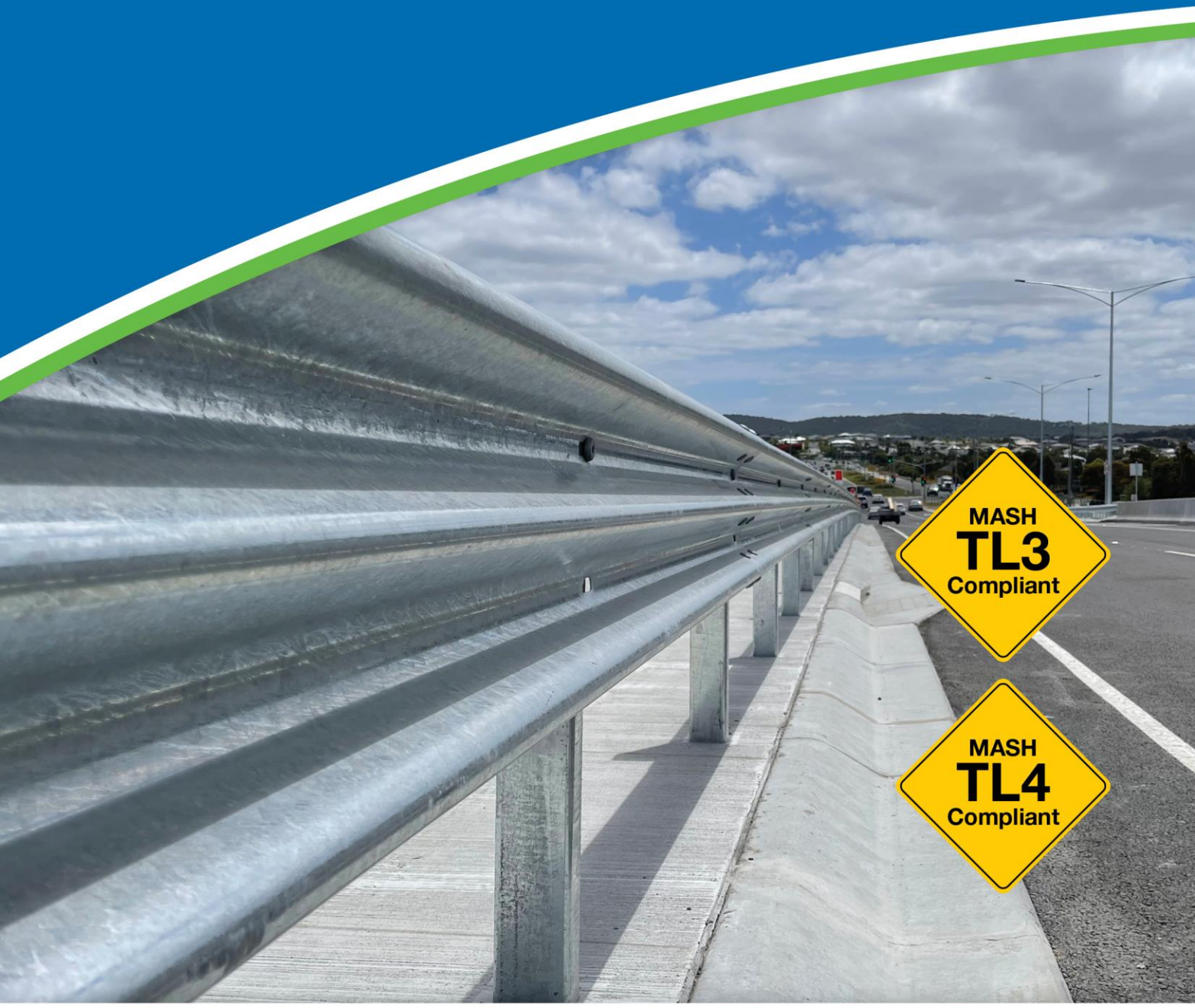
SENTRY

Thrie-Beam Barrier



SafeDirection
CRASH BARRIER SOLUTIONS

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Leading Safety

Successfully crash tested to MASH Test Level 3 & 4

Approved by the Austroads Safety Barrier Assessment Panel (ASBAP)

Complies with AS/NZS 3845.1:2015 Road Safety Barrier Systems and Devices

Low Deflection

Shields roadside hazards close to the travelled way

Stable vehicle containment and redirection

Approved Connections

MAX-Tension Guardrail End Terminal

Austroads SBTA 21-005 Transition

Sentry W-Beam

RiderPro Motorcycle Barrier

Approved Variants

Back-to-Back (Median)

Posts with Base Plates

Fast Assembly

Standard 2m post spacing

Same fasteners as public domain systems

Simple rail to post bolt alignment

Narrow Geometry

Just 200mm system width

1.0 Introduction

Sentry Thrie-Beam System is the latest innovation and advancement in guardrail barrier designs providing compliance with MASH Test Level 3 & Test Level 4.

Thrie-beam guardrail is a stronger version of the w-beam guardrail systems. The additional corrugation in the rail combined with the higher mounting height, stiffens the barrier and improves its ability to contain larger vehicles.

Sentry Thrie-Beam System has advanced the containment level of public domain thrie-beam guardrail by introducing patented technology into the thrie-beam guardrail release mechanism. This results in a safer barrier design with fewer components allowing more metres of barrier to be deployed per public dollar to protect Australian motorists.

2.0 Specifications

Compliance:	MASH Test Level 3
	MASH Test Level 4
	AS/NZS 3845.1:2015
Standard post length:	2000mm
System width:	200mm
Standard post spacing:	2.0m centres

System Finish: Hot dip galvanised to AS/NZS 4680

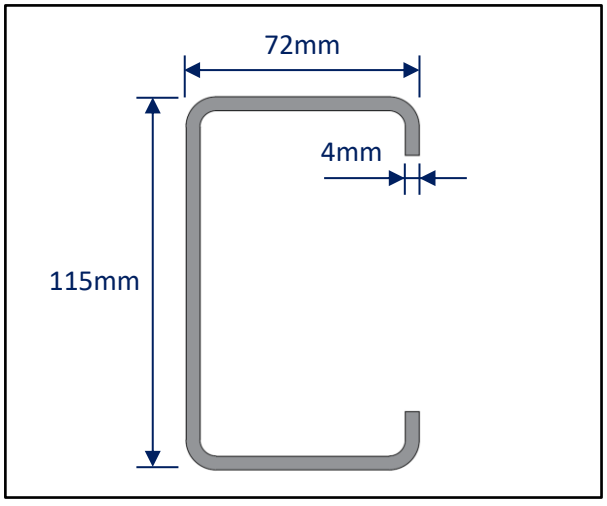

Figure 1: Sentry Post Profile

3.0 Material Traceability

Safe Direction operates a quality management system, independently certified to the requirements of ISO 9001:2015.

A multi-stepped procedure is used by Safe Direction to verify the compliance of the material used in the production of Sentry posts and thrie-beam guardrail to AS/NZS 1594.

Posts and rails are stamped with traceability batch identification numbers.

4.0 How Sentry Thrie-Beam Works

Sentry Thrie-Beam achieves a controlled redirection of errant vehicles by releasing the thrie-beam guardrail from the post at an optimal load to retain rail height, limit dynamic deflection and to allow the post to collapse without tripping the vehicle.

The separation of the rail from the post is achieved by a deformable washer. The washer controls the release of the rail within the impact zone providing stable vehicle containment and redirection with minimal vehicle roll.

Sentry Thrie-Beam uses standard thrie-beam guardrail and standard fasteners meaning there is minimal risk of inadvertent use of non-compliant items.

Upon release of the thrie-beam rail, the C-posts collapse upon impact yielding proximate to the ground surface.

The working mechanism of Sentry Thrie-Beam is a patented concept. The concept is the latest innovation in thrie-beam guardrail designs and sets a new benchmark in simplicity and performance.

5.0 Crash Test Performance

Sentry Thrie-Beam has been fully crash tested and evaluated according to the specifications for Test Level (TL) 4 and TL3 of the AASHTO Manual for Assessing Safety Hardware (MASH). The MASH specification is an update to and supersedes NCHRP Report 350 for the purposes of evaluating new safety hardware devices.

MASH is also the basis of testing procedures for road safety systems as stated in *AS/NZS 3845.1: 2015 Road Safety Barrier System and Devices.*

The introduction of MASH follows changes to the vehicle fleet, researching of real-life impact conditions and updated criteria for evaluating barrier performance.

The MASH TL4 crash test matrix requires the following three (3) impacts:

- 10,000kg rigid truck travelling at 90km/h and 15°.
- 2270kg pick-up truck travelling at 100km/h and 25°.
- 1100kg passenger car travelling at 100km/h and 25°.

6.0 Sentry Thrie-Beam Crash Test Results

Vehicle Type	Impact Condition	Impact Energy	Barrier Deflection	Working Width
	1100kg small car travelling at 100km/h and 25 degrees	75.8 kJ	1.1m	1.1m
	2270kg pick-up truck travelling at 100km/h and 25 degrees	156.4 kJ	1.45m	1.53m
	10,000kg rigid truck travelling at 90km/h and 15 degrees	209.3 kJ	1. 53m	2.8m

7.0 Design Considerations

7.1 Barrier Deflection

Dynamic deflection is the maximum lateral displacement of the barrier during a vehicle impact. When a vehicle strikes a barrier, the dynamic deflection varies according to the characteristics of the impacting vehicle, including vehicle mass, impact speed, angle of impact and the characteristics of the barrier system.

7.2 Working Width

The working width is the minimum distance required to prevent an impacting design vehicle from colliding with an object behind a barrier system. This includes both the dynamic deflection of the barrier and the extra width to allow for the roll (vertical rotation) of an impacting vehicle.

Working width is an important design consideration when shielding above-ground fixed hazards such as trees, sign supports or bridge piers.

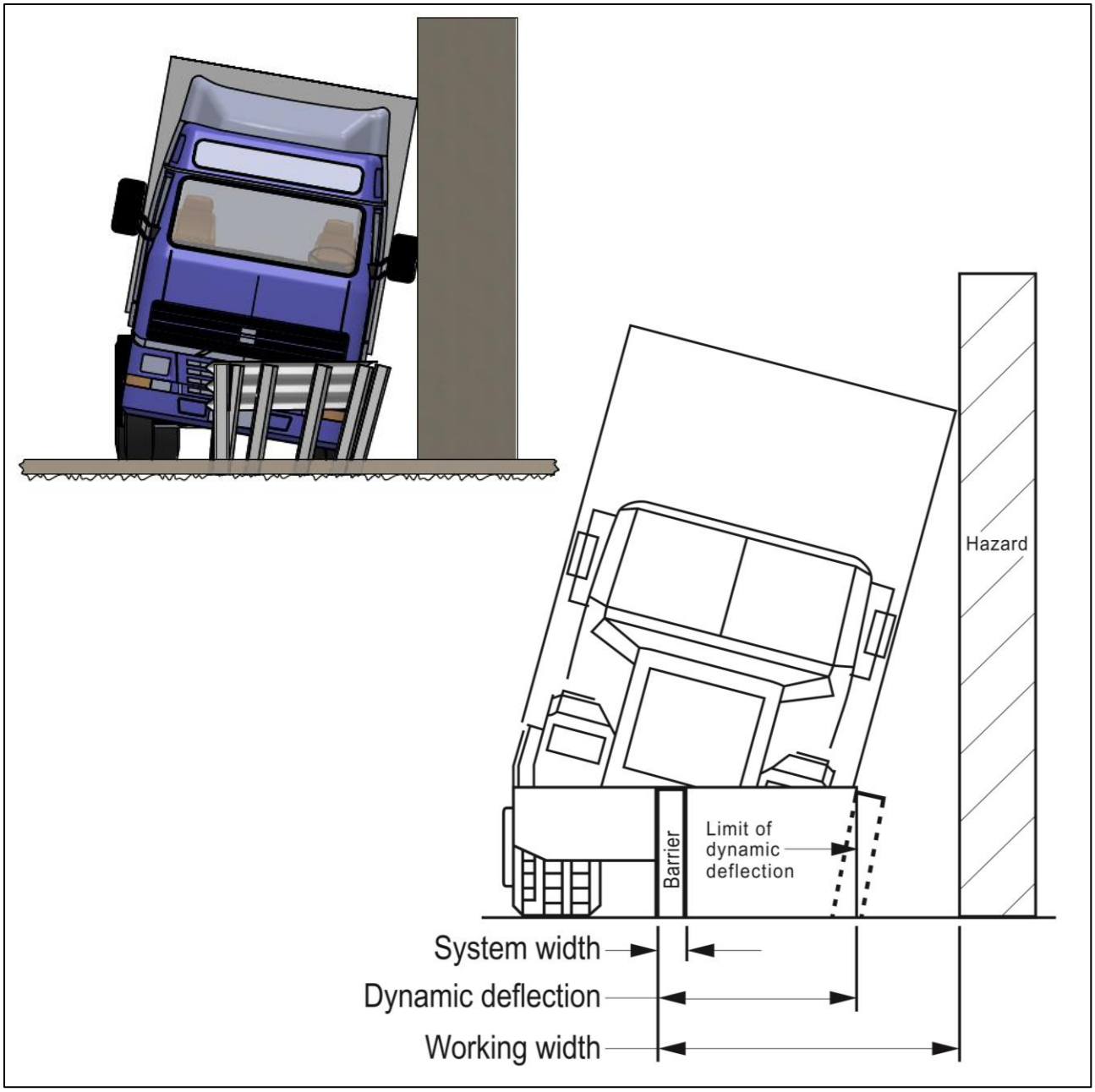

Figure 2: Dynamic Deflection & Working Width Terminology

7.3 Shy Line Offset

When safety barriers are located too close to traffic, drivers in the adjacent traffic lane tend to reduce speed, drive off-centre in the lane, or move into another lane.

Generally, there should be uniform clearance between traffic and roadside features. Uniform alignment enhances road safety by providing the driver with a certain level of expectation, thus reducing driver concern for and reaction to the roadside features.

The distance from the edge of the traffic lane beyond which a roadside feature will not be perceived as an obstacle and result in motorists reducing speed or changing lanes on the road is called the shy-line offset.

Where long continuous lengths of barrier are used, this shy-line effect is not so critical, especially if the commencement of the barrier can be gradually transitioned from beyond the shy-line.

Recommendations for the shy line offset are contained in Table 1.

Table 1: Shy Line Offset

Design Speed (km/h)	Shy Line Offset (m)
50	1.1
60	1.4
70	1.7
80	2.0
90	2.2
100	2.4
110	2.8

Source: Austroads Guide to Road Design Part 6

7.4 Flaring

Motorists are less likely to perceive roadside barriers to be a hazard if the barrier is introduced gradually to the roadside environment through the use of a 'flare'. The flare rate is the ratio of the length of the flared part of the barrier (measured parallel to the road) to the barrier offset.

Flaring the safety barrier system provides the following benefits:

- The end terminals can be positioned further from the travelled path reducing the potential for a head-on impact.
- The shy line effects where a hazard is close to the travelled path is minimised.
- Flaring provides a gradual transition to a major hazard close to the roadway (such as a bridge parapet or railing).

The maximum flare rates that should be used on an approach to a road safety barrier are shown in Table 2. Following the guidelines of Table 2 ensures that the flare does not significantly increase the opportunity for high-angle impacts with the barrier.

Table 2: Flare Rate

Design Speed (km/h)	Flare Rate (within Shy Line Offset)	Flare Rate (outside Shy Line Offset)
50	13:1	7:1
60	16:1	8:1
70	18:1	10:1
80	21:1	11:1
90	24:1	12:1
100	26:1	14:1
110	30:1	15:1

Source: Austroads Guide to Road Design Part 6

The flare rate for end terminals may vary from those contained in Table 2. Please refer to specific Product Guides for allowable flare rates for end terminals.

7.5 Advance Grading

It is recommended that the area in advance of Sentry Thrie-Beam be limited to a grading of 6H:1V to ensure that the vehicle's suspension is neither extended nor compressed at the moment of impact with the barrier.

7.6 Proximity to Batter Hinge Points

Space in the road corridor is premium. In an effort to maximise space for other infrastructure and landscaping, the proximity of the post to the batter hinge point is often reduced during the design process, without evidence or justification through crash testing.

Best practice ensures that the vehicle remains on the verge, that there is no damage to the batter following an impact and that the embankment provides adequate support to resist the impact loads.

The Austroads Safety Barrier Assessment Panel's preference is for the distance to the hinge point be sufficient to accommodate the barrier's design deflection and provide adequate lateral support for the system.

On constrained sites, please consult with Safe Direction for guidance on minimum distances, post spacing and post embedment depth, noting that recommendations need to consider available distance to the hinge point, soil conditions and batter slope.

7.7 System Installed Height

Sentry Thrie-Beam has been crash tested with the top of the thrie-beam guardrail 1050mm above ground level.

The thrie-beam guardrail is positioned approximately 10mm above the top of post. This is an important design consideration for vulnerable road users.

The tolerance on system height is ± 20mm.

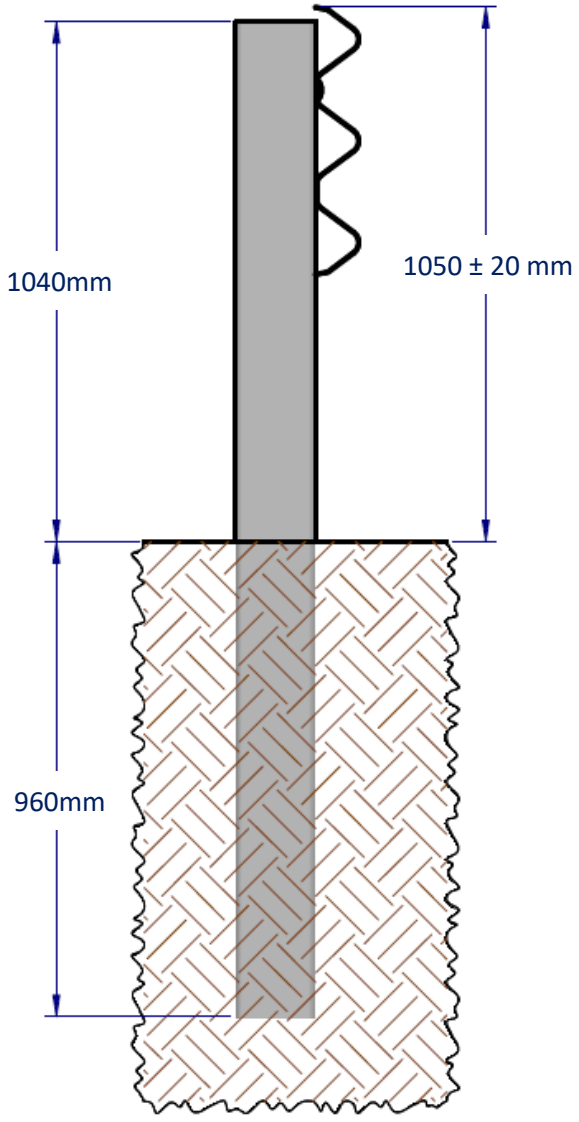

Figure 3: Sentry Thrie-Beam Post Embedment Depth

7.8 Minimum Installation Length

The crash tested lengths of Sentry Thrie-Beam are not meant to reflect minimum installation lengths. It is a requirement under the MASH standard to crash test long installation lengths and minimise the influence of the end terminal in providing safe containment and redirection. This is regarded as 'worst case impact scenario'.

It is recommended, where space permits, to install continuous safety barrier rather than designing a barrier to shield a specific hazard(s). A continuous safety barrier aims to protect the entire roadside and prevent vehicle rolling, impacts with hazards or head-on collisions.

Where site conditions do not permit the use of long barrier sections, the recorded contact lengths with Sentry Thrie-Beam providing safe vehicle containment and redirection were 12m for a MASH TL3 impact and 20m for a MASH TL4 impact.

7.9 Installation on Curves

Guardrail barriers perform well on the outside of curves, even those of relatively small radius, as the concave shape (in plan view) supports the development of tension in the thrie-beam rail.

In the field, straight sections of thrie-beam can be used to form a radius of 45m or greater. When a radius of less than 45m is required, the thrie-beam rails are required to be factory curved. For ordering purposes, the orientation of curvature (i.e. concave or convex) and the radius is required by the manufacturer.

Refer to Section 13.0 for guidance on measuring curvature.

7.10 Posts on Baseplates

Underground services and/or structures such as culverts may prevent Sentry Thrie-Beam from being installed with posts driven into the ground. In these circumstances Sentry Thrie-Beam may be installed with posts on baseplates secured to a concrete strip footing.

The Sentry Thrie-Beam post on baseplate is secured with four (4) M20 chemical anchors. The thrie-beam rail to post connection and thrie-beam rail height above road level are the same as adopted for driven post installation.

7.11 Median Installations

Sentry Thrie-Beam may be configured with back-to-back thrie-beam for installation in narrow medians and the prevention of dangerous head-on collisions.

Note: Back-to-back Sentry Thrie-Beam may only be attached to back-to-back Sentry Median W-Beam Barrier.

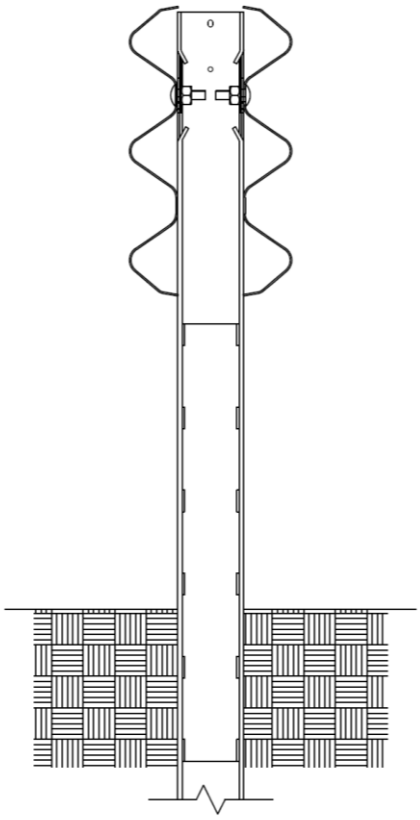

Figure 4: Sentry Thrie-Beam Median

8.0 Connections & Attachments

8.1 Connection to Sentry W-Beam

The use of an asymmetric transition is required to transition from thrie-beam to w-beam guardrail. The asymmetric transition panel is 1905mm long (nett laying length) and is available as an approach or departure configuration (viewed from the road centreline).

The asymmetric transition tapers the height to top of the guardrail beam from 1050mm to approximately 860mm.

The height of the w-beam is then lowered over 8m to a height of 800mm providing compatibility with Sentry W-Beam.

Note: The 1905mm (6'3") nett laying length of the asymmetric transition differs from the standard 2m post spacing of Sentry Thrie-Beam and Sentry W-Beam.

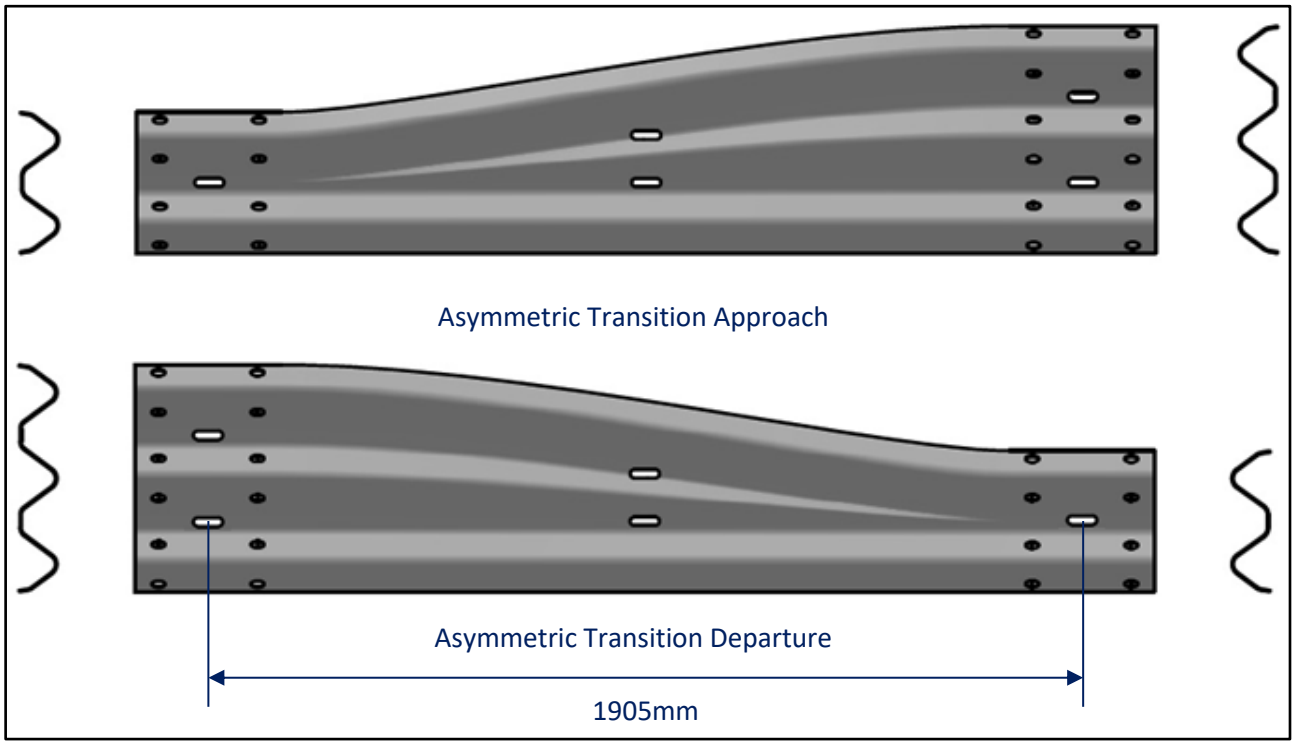

Figure 5: Asymmetric Transitions

8.2 Connection to the Max-Tension

The Max-Tension is a MASH TL3 compliant, energy-absorbing tangential guardrail end terminal, designed to minimise the severity of impacts occurring at the end of the safety barrier system.

The Max-Tension also anchors the safety barrier system and introduce the necessary tensile and flexural strength required for safe vehicle containment and re-direction throughout the length-of-need section.

It is recommended that Sentry Thrie-Beam be anchored at the leading and trailing end of the installation with Max-Tension guardrail end terminals.

The Max-Tension guardrail end terminal is installed using w-beam guardrail, therefore it is necessary to transition from thrie-beam using an asymmetric transition before commencing installation of the Max-Tension end terminal. Thrie-beam cannot be used within the Max-Tension end terminal section.

Note: The upper limit for the crash test assessment of guardrail end terminals is MASH Test Level 3.

8.3 Attachment of RiderPro

RiderPro is a motorcyclist safety barrier system designed to reduce the impact severity for riders when colliding with a roadside guardrail barrier. RiderPro is positioned below the guardrail beam and prevents a dismounted motorcyclist from contacting the supporting posts of the guardrail barrier system.

RiderPro provides safe rider containment and redirection through the combination of spring mounting brackets and lightweight, corrugated panels.

RiderPro may be attached to single-sided or back-to-back (median) Sentry Thrie-Beam.

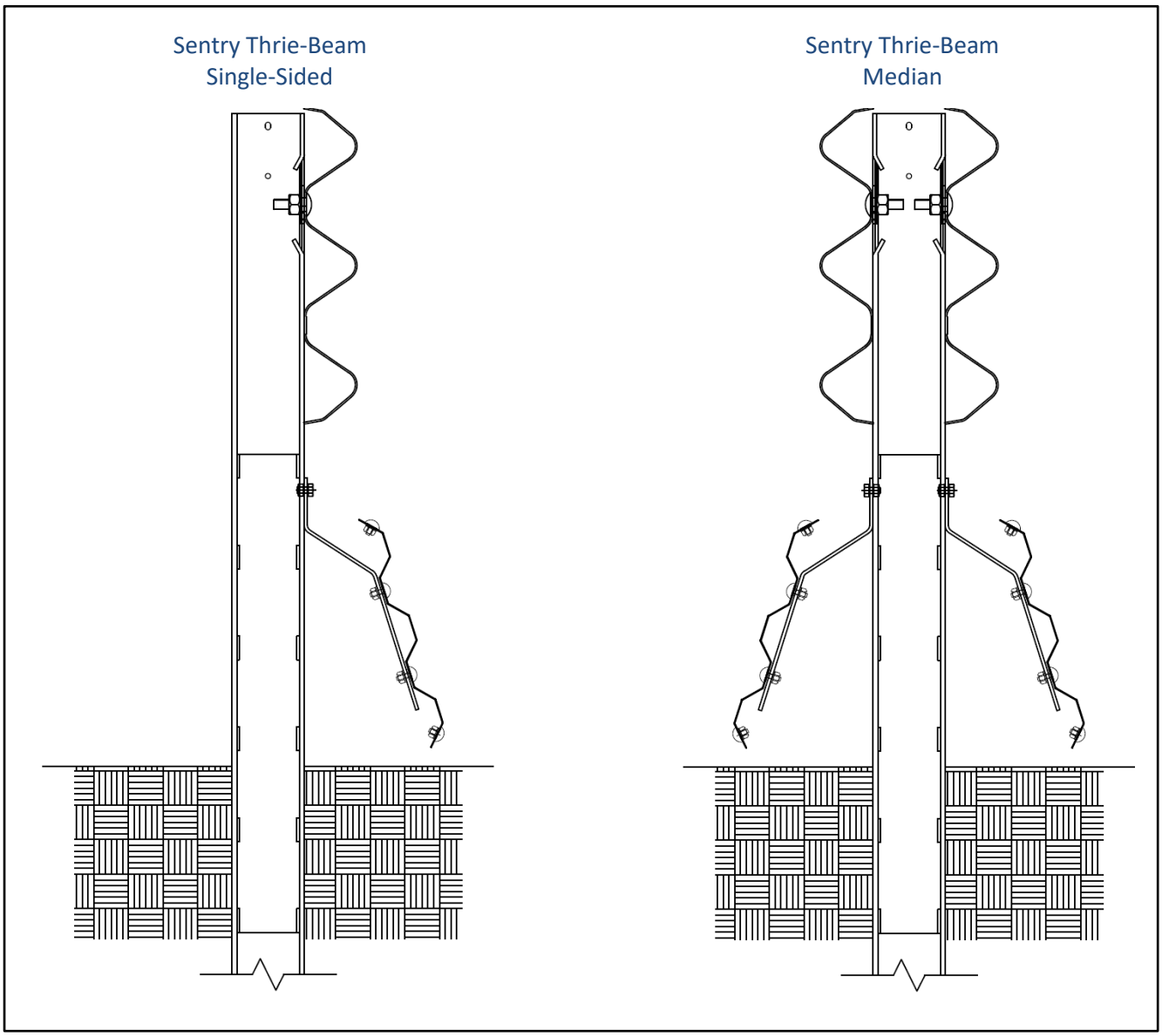

Figure 6: Sentry Thrie-beam with RiderPro

8.4 Connection to a Rigid Barrier

Wherever it is necessary join Sentry Thrie-Beam to a rigid barrier, the interface must be designed to ensure that the overall system will perform safely when impacted by a design vehicle.

The Austroads SBTA 21-005 Transition provides a smooth, snag-free connection between Sentry Thrie-Beam and concrete barrier.

Note: Connection to the Austroads SBTA 21-005 Transition is only suitably for single-sided Sentry Thrie-Beam.

9.0 Sentry Thrie-Beam Component Identification (Not to Scale)

Deformable Washer

M16 x 40mm Post Bolt

M16 x 32mm Splice Bolt

M16 Oversize Nut

2000mm Sentry Post (20kg each)

4m Thrie-Beam Guardrail (72kg each)

1.9m Asymmetric Transitions (32kg each)

10.0 Tools Required

Tools required for the installation of Sentry Thrie-Beam are the same as those used for the installation of public domain thrie-beam barriers. This includes:

- Post driving equipment or auger.
- Air compressor.
- Pneumatic drill driver with 32mm attachment.
- Metal snips.
- String line.
- Tape measure.
- Hammer.
- 12mm diameter pinch bar.
- Slings or chains.

10.1 Recommended PPE

It is recommended that the following personal protective equipment (PPE) be provided for the safe installation of Sentry Thrie-Beam:

- Safety footwear.
- Gloves.
- Hearing protection.
- High visibility clothing.
- PPE as required for the use of post driving equipment or auger.

11.0 Site Establishment

11.1 Traffic Control

Prior to the commencement of any work, the site should be evaluated for risks to workers, pedestrians and other road users. The establishment of traffic control should provide safe travel for passing vehicles and/or pedestrians and appropriately protect workers near the roadside.

11.2 Underground Services

The installation of Sentry Thrie-Beam requires the supporting posts to be embedded into the ground. Prior to the installation of posts an investigation for potential underground hazards is recommended.

11.3 Overhead Obstructions

The site should be evaluated for potential overhead obstructions that may present a risk during the installation process. These obstructions typically include power lines, signage or trees.

11.4 Unloading Exclusion Zone

Only appropriate load-rated slings or chains should be used for safe unloading. It is recommended that an exclusion zone be maintained around the unloading process. This provides distance between moving machinery and workers in the event that goods or the machinery move unexpectedly.

Unloading and the storing of the product on a level surface is recommended. Storing product adjacent to the installation area eliminates the requirement for workers to carry items over long distances.

12.0 Sentry Thrie-Beam Installation

The major steps in the installation of Sentry Thrie-Beam are as follows:

- Set-out.
- Installing the C-posts.
- Attachment of the thrie-beam guardrail.
- Installing the asymmetric transitions.

12.1 Set-Out

It is recommended that a string line be used to establish the alignment of the post locations. When establishing the post locations, take care to note the following:

- Sentry Thrie-Beam does not use offset blocks. The width of the system is just 200mm.
- The standard post spacing of Sentry Thrie-Beam is 2.0m.
- The post spacing of the asymmetric transitions and Max-Tension terminals is 1.905m.
- The system width of Sentry Thrie-Beam differs from the system width of terminals and transitions.
- The Sentry Thrie-Beam posts are not to be installed within the terminal or w-beam region.

12.2 Post Installation

Potential Hazards: *Use of post driving equipment or auger, contact with underground hazards, excessive noise, hand injury from pinch points and injury from movements and posture.*

Recommended Control Measures: *Observe the safe work instructions as per machinery requirements, ensure the area has been inspected for underground hazards, wear appropriate hearing protection, wear gloves and observe correct techniques when lifting (bend at the knees).*

The posts may be installed by:

- Driving with an appropriate driving head to the required depth, approximately 960mm, or
- Auguring a minimum 200mm diameter hole approximately 960mm deep, placing the post in the hole and backfilling. The backfill material is to be placed in 150mm lifts and compacted with tamping equipment.

Once installed, the top of the post should measure 1040mm above ground level.

12.3 Attaching the Thrie-Beam Rails

Potential Hazards: *Injury from movements and posture, hand injury from pinch points, strain to wrists from tightening bolts and excessive noise from use of impact driver.*

Recommended Control Measures: *Observe correct techniques when lifting rails (bend at the knees), wear gloves, use a pinch bar to align holes, use an impact drill to tighten bolts and wear appropriate hearing protection.*

Standard 4m thrie-beam guardrails are used throughout the Sentry Thrie-Beam system. The rails are secured to the posts using a M16 x 40mm mushroom head bolt. The bolt passes through the upper slot in the thrie-beam rail.

The deformable washer is positioned behind the post slot and secured with an oversize M16 nut.

The thrie-beam lap is orientated so that the leading edge of the splice is shielded from the nearside approaching traffic. Rails are spliced together using twelve (12) standard M16 x 32mm mushroom head bolts and oversize nuts. The oversize nuts are tightened using a drill driver and 32mm attachment.

The use of a pinch bar will assist in aligning the splice holes as the bolts are inserted. The use of a driving pin to elongate the splice holes is NOT permitted.

There is no torque requirement for the tightening of the post bolts or splice bolts. They should be tightened to a snug position.

Once secured to the posts, the finishing height of the thrie-beam will be approximately 10mm above the top of the posts.

13.0 Curving of Thrie-Beam Rails

Thrie-beam guardrail barriers perform well on the outside of curves, even those of relatively small radius, as the concave shape (in plan view) supports the development of tension in the w-beam rail.

In the field, straight sections of thrie-beam can be used to form a radius of 45m or greater. When a radius of less than 45m is required, the thrie-beam rails are required to be factory curved.

For ordering purposes, the orientation of curvature and radius is required. Alternately, providing the chord length (C), the height of rise (H) or angle (Ø) will allow Safe Direction to calculate the radius of curvature.

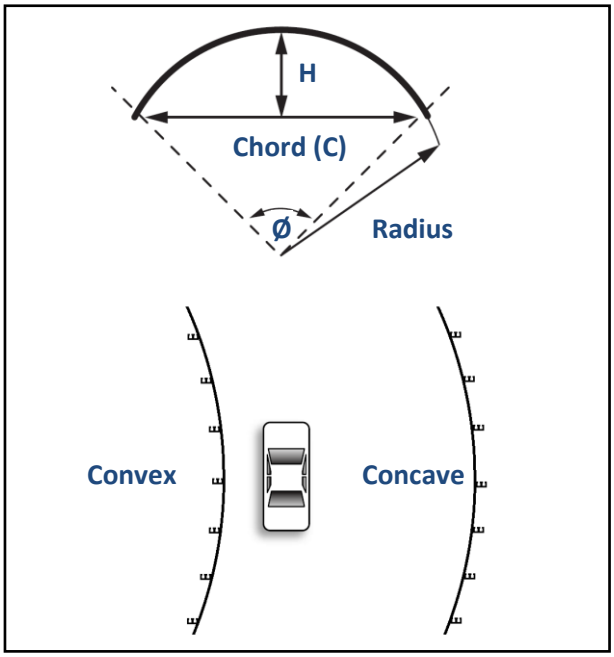

Figure 7: Curving Orientation

14.0 Installation Tolerances

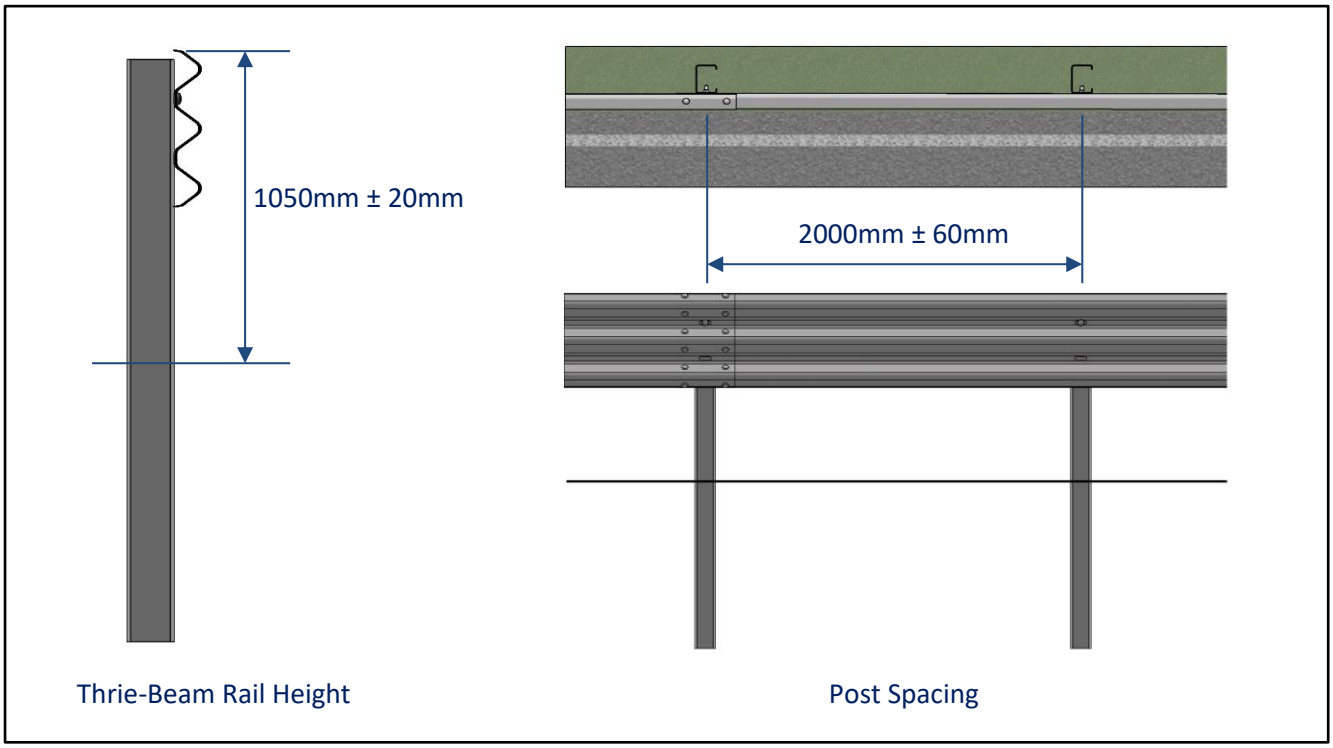

Figure 8: Sentry Thrie-Beam Installation Tolerances

Sentry Thrie-Beam Inspection Form

Inspection Date	
Client	
Project Reference	
Name of Inspector	
Company	

❑ Yes ❑ No	The system is suitably anchored with approved state road agency end terminals.
❑ Yes ❑ No	Asymmetric transitions are used to connect to w-beam guardrail.
❑ Yes ❑ No	The posts are spaced at maximum 2.0m centres.
❑ Yes ❑ No	The height measured to the top of the posts is 1040mm ± 20mm.
❑ Yes ❑ No	The posts are correctly orientated with the open slot on the traffic side.
❑ Yes ❑ No	The height measured to the top of the rails is 1050mm ± 20mm.
❑ Yes ❑ No	The thrie-beam rail is secured to each post with one (1) M16 x 40mm mushroom head bolt, deformable washer & nut.
❑ Yes ❑ No	The thrie-beam rails are spliced with twelve (12) M16 x 32mm mushroom head bolt & oversized nuts.
❑ Yes ❑ No	The rail lap is orientated so that the leading edge of the splice is shielded from approaching traffic.
❑ Yes ❑ No	All bolts are tightened.
❑ Yes ❑ No	The fill material around the posts is suitably compacted.
❑ Yes ❑ No	Any minor damage to the galvanised finish is repaired using two coats of an organic zinc rich paint.
❑ Yes ❑ No	The area around the barrier is free of debris.
Comments/Notes	

15.0 Maintenance

Sentry Thrie-Beam is a low maintenance barrier. Except for repairs due to impacts, it is recommended that an annual inspection be undertaken to assess the following:

- Debris has not accumulated around the barrier which may impede the function of the barrier.
- Vegetation around the barrier is appropriately maintained.
- Nuisance impacts have not gone undetected.
- The anchor assembly at the end terminals is taut and the bearing plate is correctly aligned.

16.0 Repair

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 3. Typically, impacts with Sentry Thrie-Beam will require replacement of damaged sections of rails and posts. It is also recommended that new bolts be used where rails and posts have been replaced.

Additional tools required for repair include:

- Acetylene torch to cut away damaged rail.
- Heavy duty chain to remove damaged posts.
- Sledge hammer.
- Post extractor.

Similar to the installation sequence, it is recommended that the guidelines contained in Section 11.0 be observed in the establishment of traffic control and an unloading exclusion zone in addition to investigation for underground services and overhead obstructions.

16.1 Removal of Damaged Posts

Potential Hazards: *Hand injury from pinch points, hand injury from damaged edges and injury from sudden movement as the posts are released.*

Recommended Control Measures: *Wear gloves and maintain an appropriate exclusion zone around the post until removed.*

Damaged posts should be removed using an appropriate post extractor. Once the damaged post is removed, the ground material should be suitably compacted before a replacement post is installed.

16.2 Removal of Damaged Rails

Potential Hazards: *hand injury from pinch points, hand injury from damaged edges, injury from sudden movement as rails are released and excessive noise from use of impact drill.*

Recommended Control Measures: *Wear gloves and wear appropriate hearing protection.*

Using an impact drill, remove the splice bolts at the rail connection. Rails that have twisted or bent during impact may need to be cut into manageable sections using an acetylene torch.

Table 3: Damage Assessment Guidelines

Type of Damage	Description of the Damage	Remedial Action
Damage to the galvanised coating on the posts.	The sum total of the damaged area does not exceed 40cm^2 (0.5% of the total surface area).	An organic zinc rich paint is to be applied to the repair area in two coats.
	The sum total of the damaged area exceeds 40cm^2 (0.5% of the total surface area).	The post is to be replaced.
Damage to the galvanised coating on the rails.	The sum total of the damaged area does not exceed 250cm^2 and no individual damaged area exceeds 40cm^2.	An organic zinc rich paint is to be applied to the repair area in two coats.
	The sum total of the damaged area exceeds 250cm^2 or an individual damaged area exceeds 40cm^2.	The rail is to be replaced.
Damage to the posts.	The post is bent.	The post is to be replaced.
Damage to the rails.	The rail is dented, twisted or flattened.	The rail is to be replaced.
	There are nicks in any part of the rail.	
	The slots in the rail are distorted.	
Damage to fasteners.	The body of the bolt is distorted.	The fastener is to be replaced.
	The thread of the bolt is damaged.	
	The deformable washer is damaged.	
Disturbance of material around the posts.	The material around a post is loose.	The material is to be suitably compacted.

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☎ 1300 063 220 sales@safedirection.com.au

ABN 53 156 459 684

safedirection.com.au