VER 1.0

PRODUCT MANUAL

NXR-TL2 FIXED BOLLARD
CRASH SAFE BOLLARD

AS/NZ 3845:2017 PART 2 - TEST 101
AASHTO MASH 2016 TEST LEVEL 2 (TL2) - CRASH TESTED

COMPARABLE PERFORMANCE ACROSS SAFETY STANDARDS

PAS 68:2013 FIXED BOLLARD S|2500(N1G)|64|90:0.2/0.5

ASTM F3016 S30-P1-PU

ASTM F2656 FS-65

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CRASH SAFE BOLLARD™

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DOCUMENT CONTENT

VERSION CONTROL

Document: *Crash Safe Bollards™ Product Manual*

Principal Author: *Jim Labilles*

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ABOUT THIS DOCUMENT

This document provides comprehensive guidance for the installation, operation, and maintenance of Crash Safe Bollards™, engineered for superior safety and reliability in high-impact scenarios. It is intended to assist contractors, engineers, and maintenance personnel in understanding the system's features and requirements to ensure optimal performance.

PURPOSE

The purpose of this document is to:

- Outline the key features and benefits of Crash Safe Bollards™.
- Provide step-by-step instructions for proper installation and commissioning.
- Detail routine maintenance and post-collision servicing procedures.
- Ensure compliance with safety standards and extend the lifespan of the bollard system.

DOCUMENT AUDIENCE

This document is intended for:

- Certified contractors and installers.
- Engineers responsible for system design and integration.
- Maintenance personnel conducting inspections and repairs.
- Regulatory bodies evaluating compliance with safety standards.

SCOPE

The manual covers the following key aspects:

Safety Information

Precautions to ensure safe handling and operation during installation, use, and maintenance.

Barrier System Information

A detailed introduction to the design, components, and operation of Crash Safe Bollards™.

Installation Guide

Step-by-step instructions for installing the bollard system, including foundation preparation and assembly.

Maintenance Requirements

Guidance on routine inspections, component replacement, and post-collision procedures.

DOCUMENT UPDATES

This manual reflects the latest design features and testing results of Crash Safe Bollards™. Future updates will be issued as needed to incorporate design enhancements, updated standards, or additional guidance.

SAFETY INFORMATION

⚠ ATTENTION

LIMITATION OF LIABILITY

The manufacturer assumes no responsibility for damages or injuries resulting from improper installation, misuse, or unauthorised modifications of the Crash Safe Bollards™. Liability is limited to defects in materials or workmanship under normal use and as specified in the warranty terms. Always ensure compliance with local regulations and safety standards during installation and use.

INTENDED USE

Crash Safe Bollards™ are designed to provide enhanced safety by absorbing impact energy during vehicle collisions, protecting both vehicle occupants and public spaces. They are intended for installation in areas requiring controlled access or safety perimeters, such as urban infrastructure, commercial precincts, and high-risk zones. Use of the bollards must comply with the specifications and guidance provided in this manual.

⚠ GENERAL WARNINGS

To ensure the safe and effective installation and use of Crash Safe Bollards™, please carefully read and understand the following warnings and cautionary statements:

Heavy Machinery and Equipment Hazards

- Installation requires the use of heavy machinery, including cranes, excavators, and other powered equipment, which contain moving parts that can cause serious injury if not handled properly.
- Ensure all machinery is operated ONLY by qualified personnel trained in equipment safety protocols.

Manual Handling Risks

- The installation process involves handling heavy metal components that can cause physical strain or injury.
- Always use proper lifting techniques and, where possible, mechanical aids or additional personnel to assist with lifting heavy components.

Document Familiarity

Thoroughly read and understand this installation manual before beginning any installation activities. Failure to follow instructions may result in unsafe conditions or damage to the product.

Substitution of Components

Do not substitute any part of the product with non-approved components. Substitutions will compromise the safety, performance, and compliance of the system.

Site Safety Precautions

- Conduct a thorough site assessment prior to installation, including checks for underground utilities, to prevent accidental damage or hazards.
- Secure the installation area to prevent unauthorised access or accidental injuries during the installation process.

Personal Protective Equipment (PPE)

All personnel involved in the installation must wear appropriate PPE, including (but not limited to) hard hats, safety gloves, steel-toed boots, high-visibility vests, and safety goggles.

Weather Conditions

Avoid installation during adverse weather conditions, such as heavy rain, snow, or strong winds, as these may increase the risk of accidents or improper installation.

Electrical Hazards

If the installation site involves proximity to electrical lines, ensure that all work complies with local regulations and guidelines to avoid electrocution or damage to utilities.

Inspection Before Use

After installation, conduct a thorough inspection to verify the bollards are correctly installed, secured, and aligned. This inspection must be performed by trained personnel certified by an ASHTAS-approved training provider. A post-installation site inspection document must also be completed and approved before the commissioning process can be finalised.

Training and Competence

Only personnel trained and certified by an ASHTAS-approved training provider should undertake the installation and maintenance of the bollards. Proper training ensures safe and effective installations, minimising risks associated with improper setup. Ensuring that all involved personnel meet this standard is critical to maintaining the system's safety and reliability.

⚠ RISK CONSIDERATIONS

When installing and maintaining the Crash Safe Bollards™, it is crucial to be aware of the following potential risks to ensure the system functions effectively and minimises potential hazards:

Speed Zone Limitations

The bollards have been tested for roads with vehicle speeds of up to 70 km/h. Installing them on roads where speeds exceed this limit increases the risk of vehicles breaching the protected zone.

Improper Installation

Incorrect installation may result in reduced performance, structural failure, or the bollard becoming a hazard itself.

Undetected Underground Hazards

Failing to identify and account for underground utilities or unstable soil conditions could lead to damage, installation delays, or safety risks.

Environmental Conditions

Extreme weather conditions, such as flooding, high winds, or freezing temperatures, may compromise the bollard's foundation or performance.

Vehicle Size and Weight Tested Certified Parameters

Impacts from vehicles exceeding the certified weight and size parameters may overwhelm the bollard's capacity.

Operational Misuse

Bollards may be subject to misuse, such as unauthorised modifications/substitution of parts or inappropriate use of the protected zone.

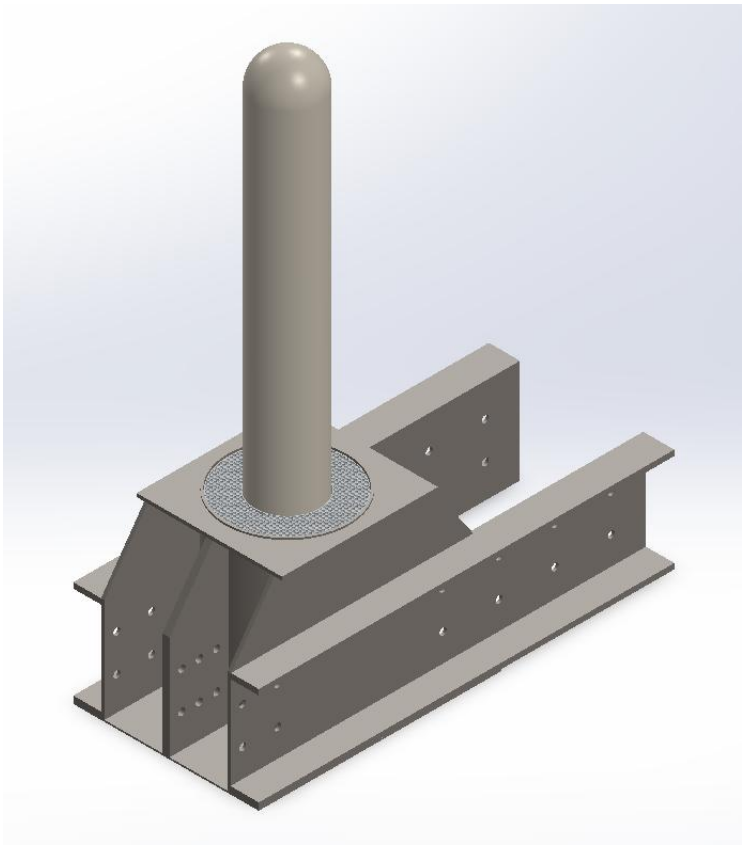
Insufficient Site Assessment and Planning

A comprehensive risk assessment of the installation area, taking into account traffic conditions, road gradients, and nearby vulnerabilities, is essential before deploying the Crash Safe Bollard™. This ensures the bollard system is optimally positioned to provide maximum safety and effectiveness.

WARNINGS USED IN THIS DOCUMENT

The general warning symbol signifies a hazard that could result in injury or fatality. Within the text, this symbol is accompanied by caution levels, which are explained below. In the illustrated section, supplementary instructions provide further clarification linked to the descriptions in the text.
DANGER
Signifies an immediate hazard that will result in death or severe injury if not avoided.
WARNING
Highlights a potential hazard that could result in death or severe injury.
CAUTION
Indicates a potential hazard that may lead to minor or moderate injuries.
ATTENTION
Identifies a risk that could result in damage to or destruction of the product.

BARRIER SYSTEM INFORMATION



Crash Safe Bollards™ are engineered to provide robust protection in high-risk areas, combining advanced design with rigorous testing to meet Australian safety standards. This section outlines the key specifications, features, and compliance details of the product, ensuring a clear understanding of its capabilities and applications.

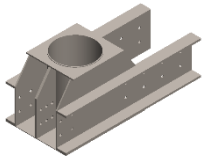
Crash Safe Bollards™ features two crash attenuation systems designed to absorb impact energy during vehicle collisions. The primary and secondary crash cells activate simultaneously and deform on impact. The primary crash cell has a higher energy absorption capacity compared to the secondary crash cell. However, the secondary crash cell is designed to reactivate after the initial impact, ensuring continued energy absorption in the event of a subsequent collision while the system awaits maintenance.

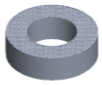
CRASH TESTING SUMMARY

	TEST 100	TEST 101
CTS-Test No	20185	20143
Impact Velocity	70 km/h	70 km/h
Vehicle Mass	1100 kg	2270 kg
Impact Angle	90°	90°
Max Pitch Angle	7°	52°
Max OIV	17.37 m/s	14.98 m/s
Max ORA	20.34 g	9.55 g

PARTS INFORMATION

01 – Bollard Shaft	
	Material: 20MnV6 Hollow Bar
	1500 mm Length excluding dome head
	180mm OD (NOM)
	150mm ID (NOM)
	Weight: 110 kg

02 – Hub Assembly	
	Material: Mild Steel
	535 mm (length)
	500 mm (height)
	1200 mm (depth)
	Weight: 170 kg

03 – Primary Crash Cell	
	Material: Aluminium Alloy
	340 mm OD
	186 mm ID
	100 mm Height
	Weight: 0.6 kg

04 – Secondary Crash Cell	
	Material: Composite Rubber
	340 mm OD
	186 mm ID
	330 mm Height
	Weight: 34 kg

⚠ ATTENTION

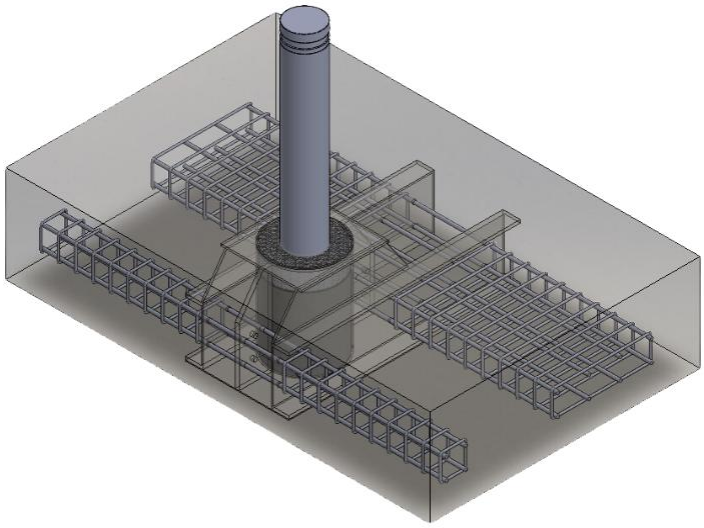
Additional parts necessary for the installation of the Crash Safe Bollards™ are not shown in this section of the document nor are sold by the manufacturer as part of the barrier system. These parts must be procured separately as their quantity and lengths are highly dependent on the installation parameters of the site:

- Concrete Steel Reo Bar - 16mm Reinforcing Deformed Rebar
- 10mm ligature (large and small)
- 40MPa Concrete with a maximum 20mm aggregate

Details of these parts are provided in the Installation Section of this document.

INSTALLATION GUIDE

SINGLE-UNIT CONFIGURATION



The single-unit installation of the Crash Safe Bollards™ is designed to provide a robust energy-absorbing barrier system tailored for standalone applications. The installation requires an excavation measuring 2.2 m (L) x 1.4 m (W) x 0.5 m (H). Each unit includes the Crash Safe Bollards™ Barrier and other auxiliary parts.

Excavation Dimension:

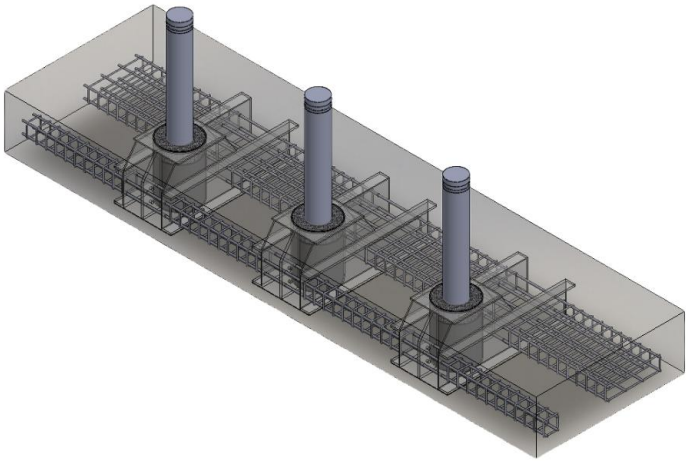
- 2.2m (L) x 1.4m (W) x 0.5m (H)

Installation Parts:

- 1x Crash Safe Bollards™ Barrier System
- 10x N16 x 2.1m Reinforcing Deformed Rebar
- 20x N10 - Large Ligatures
- 20x N10 - Small Ligatures
- Concrete - 40Mpa | 20mm max aggregate

This configuration is suitable for scenarios where individual protection points are required, ensuring optimal performance and structural integrity.

MULTIPLE-UNIT (3) CONFIGURATION



The multiple-unit installation of Crash Safe Bollards™ demonstrates a scalable barrier system designed for extended protection across larger areas. In this example scenario, the configuration consists of three Crash Safe Bollards™ Barrier Systems installed within a shared excavation measuring 5.0 m (L) x 1.4 m (W) x 0.5 m (H). The required components for this setup include

Excavation Dimension:

- 5.0m (L) x 1.4m (W) x 0.5m (H)

Installation Parts:

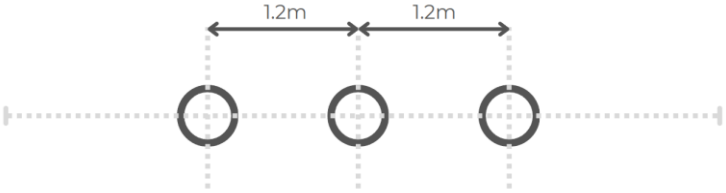
- 3x Crash Safe Bollards™ Barrier System
- 10x N16 x 4.9m Reinforcing Deformed Rebar
- 44x N10 - Large Ligatures
- 44x N10 - Small Ligatures
- Concrete - 40Mpa | 20mm max aggregate

This example highlights the auxiliary parts required for a three-unit configuration; however, the quantity of reinforcing rebar and ligatures may vary depending on the total number of Crash Safe Bollards™ installed. The modular nature of the system allows for flexible configurations tailored to specific site requirements, ensuring consistent safety and structural integrity across multiple units.

MAX WIDTH BETWEEN BOLLARD CENTRES

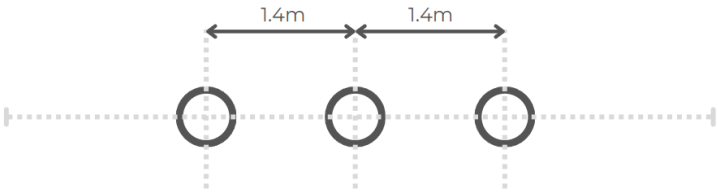
The preferred width between bollard centres is 1.2 meters, ensuring optimal protection and containment of the typical track width of Australian sedans.

Preferred:



However, if site conditions necessitate greater spacing, the distance can be extended but MUST NOT exceed a maximum of 1.4 meters. These spacing guidelines ensure that smaller sedan-type vehicles do not go through the security perimeter.

Maximum Tolerable:



PRE-INSTALLATION REQUIREMENTS

Site Assessment and Planning

DANGER

Conduct a thorough assessment of the installation site. Ensure that all underground utilities, such as gas, water, or electrical lines, are identified to prevent accidental damage. Assess soil conditions for stability and confirm that the site can support the bollard's operational forces. Conduct a risk assessment of traffic patterns, road gradients, and potential pedestrian areas to ensure the bollards are installed in the most effective and safe locations.

Equipment and Personnel

DANGER

Heavy machinery, such as cranes, excavators, and drills, are required for installation. Ensure that all machinery is operated by qualified personnel trained in equipment safety protocols. Only trained and competent personnel should undertake the installation of the bollards. Ensure all involved have read and understood the installation manual to avoid unsafe conditions or damage to the bollards. Adequate training and familiarity with the installation process are critical to ensuring a safe and successful installation.

Weather Conditions

WARNING

Avoid performing the installation during adverse weather conditions such as heavy rain, extreme heat, or strong winds, which can increase the risk of accidents or improper installation. Plan the installation during favourable weather conditions to ensure safety and accuracy.

Personal Protective Equipment (PPE)

WARNING

All personnel involved in the installation must wear appropriate PPE, including hard hats, safety gloves, steel-toed boots, high-visibility vests, and safety goggles. This is essential to protect against potential injuries from machinery, heavy components, or environmental hazards.

Authorised Manufacturers or Distributors

CAUTION

To ensure the quality, safety, and compliance of the Crash Safe Bollards™, it is essential to source the product directly from the manufacturer or an authorised legal distributor. Purchasing from unauthorised sources may lead to receiving counterfeit or substandard products, which could compromise the bollard's performance, safety standards, and warranty. Always verify the legitimacy of the supplier to guarantee that the product meets the required specifications and regulatory certifications for safe installation and operation.

INSTALLATION PROCEDURE

1. Site Preparation

    - Conduct a thorough site assessment to identify underground utilities or potential hazards. The designer and manufacturer of the Crash Safe Bollards™ recommend utilising ground-penetrating radar scans to scope underlying services.
    - Ensure the installation area is clear of obstructions and level for excavation.
    - Secure the installation zone to prevent unauthorised access during the process. Cordon off the site with proper fencing and clear labelling to notify the public of the civil works taking place, ensuring safety for both workers and pedestrians."

2. Excavation

Mark the designated area for installation as per the required dimensions depending on the installation type (single unit/multiple unit). Excavate the ground to the specified depth, ensuring uniformity across the area.

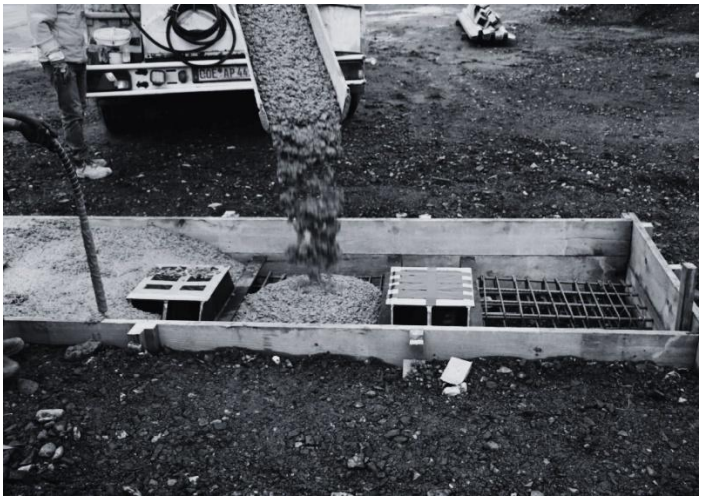
3. Assembly

    - Place a moisture barrier film to fit the dimension of the excavation.
    - Position the Crash Safe Bollards™ hub accordingly.
    - Assemble rebars among the Crash Safe Bollards™

- Securely tie the rebar and ligatures to form a stable reinforcement cage. The spacing between the ligatures MUST be approximately 90mm.
- Insert the secondary and primary crash cells
- Insert the bollard shaft
- Ensure that bollard shafts are standing straight using spirit levels. Verify the alignment of the Crash Safe Bollards™.

4. Concrete Pouring

Prepare the concrete mix as per the specification: 40Mpa strength with a 20mm maximum aggregate size. Pour the concrete carefully into the excavation, ensuring even distribution around the reinforcement and bollard. Use a concrete vibrator to remove air pockets and ensure proper concrete compaction and distribution.



5. Concrete Curing

Allow the concrete to cure as per the recommended duration for the 40Mpa mix (approx. 28 days). Protect the installation site from weather or accidental disturbance during the curing period.

6. Final Inspection

Inspect the installation for alignment, concrete finishing, and structural stability. Confirm the maximum width between bollard centres:

- Preferred: 1.2m
- Maximum Tolerable: 1.4m

Ensure that the Inspection and Test Plan (ITP) is completed post-installation to verify that all necessary checks and validations have been conducted before finalising the installation process, refer to Page 1 for the Quality Assurance (QA) and Inspection & Test Plan (ITP).

7. Cleanup and Handover

Remove excess materials and debris from the site. Reopen the area for use once all inspections are complete and the installation is certified safe.

MAINTENANCE AND POST-INCIDENT HANDLING & REPAIR

GENERAL MAINTENANCE

Crash Safe Bollards™ are designed for long-term durability and minimal maintenance requirements, ensuring that they retain their functionality and appearance over time.

Paint and Aesthetics

Regular visual inspections are recommended to maintain the bollard's aesthetic appeal. If the bollard's paint coating sustains damage or exhibits signs of wear, touch-up painting may be performed using rust-resistant paint to ensure a consistent finish and protection.

Low-Maintenance Design

The system has been engineered to minimise ongoing maintenance needs:

- Galvanized Hub Assembly
  The bollard's hub features a galvanised finish, offering robust rust prevention and protecting the system from corrosion even in harsh environments.
- Crash Cell Materials
  The crash cell components are constructed using materials that are not susceptible to rust, eliminating the need for additional treatments or replacements over the system's lifespan.

POST VEHICLE IMPACT

In the event of a vehicle impact, Crash Safe Bollards™ are engineered to absorb and dissipate impact energy, ensuring minimal damage to the system and surrounding infrastructure.

After any collision, the bollard's condition should be assessed to determine if maintenance or replacement is necessary.

IMPACT ASSESSMENT AND INSPECTION

Following any vehicle collision, perform a comprehensive inspection of the bollard system:

Visual Inspection

Check for visible signs of deformation or damage to the bollard shaft, concrete foundation, hub, and crash cells. Different deformation has been observed from different mass categories of vehicle

Impact with a 2270 kg Vehicle

During the crash testing of this barrier system with a vehicle with a mass of 2270 kg, the bollard shaft has been observed to have bent approximately 5^0 from its original 90^0 reference point. Due to this behaviour, the bollard shaft and the primary crash cell MUST be replaced to ensure the effectiveness of the barrier system.

Impact with an 1100 kg Vehicle

During the crash testing of this barrier system with a vehicle with a mass of 1170 kg, the bollard shaft did not have any structural damage. A comprehensive inspection must be conducted to ascertain the condition of the proponent. If structural integrity is verified, the proponent can be used again once the primary crash cell has been replaced.

Crash Cell Activation

Verify that primary crash cells have activated as designed. The secondary crash cell might not show any type of deformation or damage due to its maximum elongation property that cannot be met due to the geometry limitation of the hub assembly, hence, can be reused after the secondary crash cell has activated. The primary crash cell MUST be replaced after vehicle impact, while the secondary crash cell can be reused if no visual tear can be seen from its extremities.

Structural Integrity

Ensure that the concrete foundation retains its integrity. No deformation has been observed on the foundation including the hub during a impacting vehicle with a mass of 2270 kg travelling at 70kmh. The 2nd crash test (TEST 100) has proven that the concrete foundation can be reused post-impact (TEST 101). However, if visual cracks are observed on the concrete or the hub has deformed, the foundation must be excavated and a new re-installed.

SYSTEM RESET AND RE-ACTIVATION

After impact, the bollard's secondary crash cell will reset automatically. Full inspection of all parts of the barrier system MUST be conducted to fully reactivate the whole system.

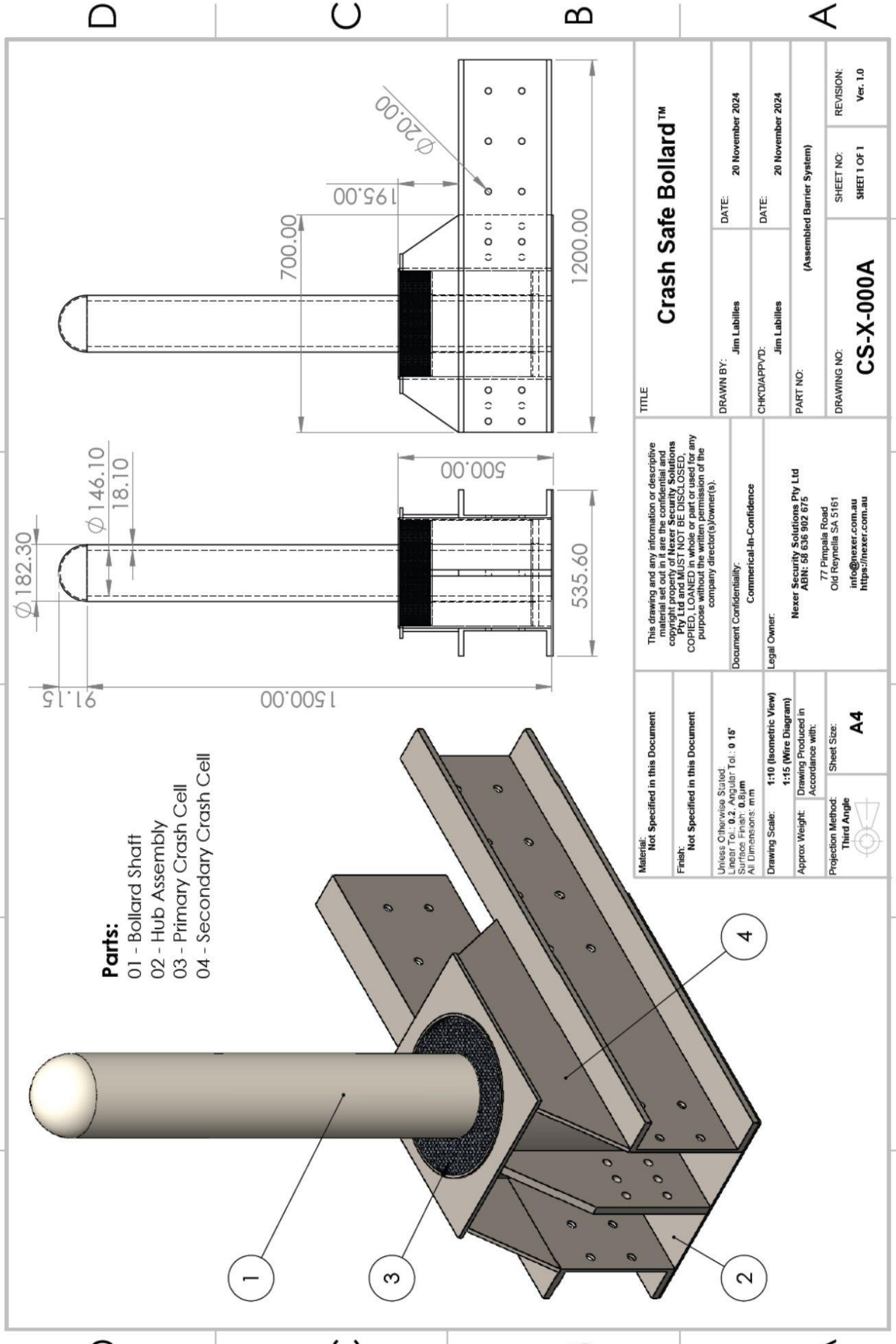
REPLACEMENT AND REPAIR

After any significant impact, such as a vehicle collision, a comprehensive inspection of the Crash Safe Bollard™ system must be conducted. All components exhibiting damage or structural compromise, including the bollard shaft, crash cells, or hub, must be replaced to ensure the system maintains its full protection capabilities. This approach ensures that the bollard continues to perform effectively and meets safety standards in future incidents.

Only original parts from the manufacturer are allowed as replacement parts for the Crash Safe Bollards™ barrier system to ensure the system operates as designed.

APPENDIX

TECHNICAL DIMENSIONS



QUALITY ASSURANCE (QA) AND INSPECTION & TEST PLAN (ITP)

Quality Assurance (QA) and Inspection & Test Plan (ITP) for Crash Safe Bollards™ Installation and Maintenance

ITP Scope Description

This Inspection & Test Plan (ITP) outlines the key steps and checks required during the installation, inspection, and maintenance of Crash Safe Bollards™. The scope includes verifying compliance with design specifications, safety standards, and ensuring the system's effectiveness post-installation. It also addresses inspection requirements following vehicle impacts to confirm structural integrity and determine the need for repairs or replacements.

Abbreviations

(ITP)	Inspection & Test Plan
(CSB)	Crash Safe Bollards™
(QA)	Quality Assurance
(MPa)	Megapascals (Concrete Strength)
(C)	Conformant
(NC)	Non-Conformant

ITP Input Information

Document	Reference	Revision
Barrier System Specification	Product Manual	v1.0
Safety Information	Product Manual	v1.0
Installation Requirement	Product Manual	v1.0
Site Plan	*Refer to client documents*	
Project Management Plan	*Refer to client documents*	
Design Management Plan	*Refer to client documents*	

Type of Work(s):

- ☐ New Installation
- ☐ Repair of Existing Installation

This ITP has been authorised in accordance with the manufacturer's quality assurance processes to ensure compliance with design specifications, installation standards, and safety regulations of the Crash Safe Bollard™

STAGE	Ref.	Activity or Quality Input	Requirement	Evidence of Compliance	Inspection Result	
					C	NC
Pre-Installation	1.1	Site Risk Assessment	Assess traffic conditions, foot traffic, nearby hazards, and adjacent vulnerabilities.	Risk assessment report Safe Work Method Statement (SWMS)		
	1.2	Competence	Installers must be certified by an ASHTAS-approved training provider.	Training records; and/or License Number and Training Provider		
	1.3	Permit Verification	All necessary site permits and approvals have been obtained.	Permit documents		
	1.4	Site Preparation	The work site has been cordoned off with fencing and labelled with safety signage.	Photos and inspection checklist		
Material Conformity	2.1	Crash Safe Bollards™ Components	Inspect bollard components for defects or damage. Proponents must be sourced from the distributor or its reseller ONLY.	Inspection report Procurement invoice		
	2.2.	Reinforcing Rebar	N16 rebar matches the specified dimensions	Material delivery notes and inspection		
	2.3	Ligatures	N10 ligatures (large and small) match the specified dimensions and quantity	Material delivery notes and inspection		
	2.4	Concrete Quality	40 MPa strength concrete with a maximum 20 mm aggregate size.	Concrete batch test results and/or delivery records		
Site Construction	3.1	Alignment	Bollards aligned according to design specifications.	Visual inspection and measurement records		
	3.2	Foundation Stability	The soil foundation base is compacted and stable before concrete pouring.	Soil compaction test results		
	3.3	Spacing Between Bollards	Bollard centres are spaced within 1.2 m (preferred) to 1.4 m (maximum tolerable).	Measurement records		
	3.4	Rebar Placement	Reinforcing bars and ligatures properly placed and spaced.	Photos and inspection checklist		
Testing, Commissioning, and Post Construction	4.1	Concrete Curing	Concrete cured according to manufacturer recommendations.	Concrete batch test results and/or delivery records		
	4.2	ITP Validation	All inspection and test items completed and verified.	Completed ITP checklist		
	4.3	Inspection Report	Document alignment, concrete finishing, and structural stability.	Signed inspection report		
	4.4	ITP Documentation	All inspection and test results recorded and signed off.	Completed and signed ITP forms		
	4.5	Safety Signage	Safety signage installed as required.	Photos and inspection checklist		
	4.6	Handover Approval	Final sign-off obtained for operational use.	Approved handover documents		
	4.7	Maintenance Schedule	Provide client with detailed maintenance plan.	Maintenance plan document		

Subcontractor: Confirmation of ITP Completion

We confirm that to the best of our knowledge and with respect to the stated scope of works all activities have been completed in accordance with the relevant requirements.
We have maintained an adequate 'weight of evidence' to demonstrate compliance which has been made available to relevant parties.

Name	Role	Date	Signature

Principal Contractor

We confirm that with respect to the stated scope of works and to the best of our knowledge works been completed in accordance with all relevant requirements.
An adequate 'weight of evidence' has been maintained to demonstrate compliance and made available to relevant parties.

Name	Role	Date	Signature

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