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2	04/06/2025	Revised draft post review and feedback by DG
3	07/07/2025	Revised draft post review and feedback by DG
4	14/08/2025	Final draft released for PC

Preface

This Standard was prepared by the Railway Infrastructure Survey Development Group, overseen by the RISSB Infrastructure Standing Committee.

The major changes in this edition are as follows:

(a) Removal of requirements pertaining to non-NGRS survey.

(b) Modernized the reference materials.

(c) Addition of identified hazards which this Standard aims to control.

Objective

The objective of this Standard is to:

(a) specify requirements relating to the design, construction, measurement, maintenance and monitoring of a railway survey system, to be able to support various engineering activities undertaken within, and applicable to a modern railway environment;

(b) achieve a standardized approach to the provision of railway engineering surveying; and

(c) provide mandatory and recommended guidance so that the rail survey system developed is aligned with the safe operation of the railway network, in accordance with the requirements of Rail Safety National Law.

Compliance

There are four types of provisions contained within Australian Standards developed by RISSB:

(a) Requirements.

(b) Recommendations.

(c) Permissions.

(d) Constraints.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term ‘shall’.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred. Recommendations are identified within the text by the term ‘should’.

Recommendations recognize that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied, or other controls are more appropriate or better.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term ‘may’.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term ‘must’.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities or interfacing organisations where the risk may be shared.

RISSB Standards address known hazards within the railway industry. Hazards, and clauses within this Standard that address those hazards, are listed in Appendix A.

Appendices in RISSB Standards may be designated either “normative” or “informative”. A "normative" appendix is an integral part of a Standard and compliance with it is a requirement, whereas an "informative" appendix is only for information and guidance.

Commentary

Commentary *C Preface*

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by ‘C’ preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

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Figures

Tables

Section 1 Scope and general

1.1 Scope

This document covers surveying systems for railways as defined under AS 7630.

This document is intended to cover railway survey systems based on the current National Geospatial Reference Systems (NGRS) for Australia and New Zealand. This document covers railway survey system requirements and promotes current good practice.

While non-NGRS surveys can still be present and relevant in the industry, NGRS is the preferred method for all future survey works being undertaken.

This document is not specifically intended to cover urban on-street tramway, light rail networks, cane railways, or heritage railways operating on a private reservation, but items from this document can be applied to such systems as deemed appropriate by the relevant Rail Infrastructure Manager (RIM).

1.2 Normative references

The following documents are referred to in the text in such a way that *some* or all of their content constitutes requirements of this document:

- AS 7630, *Railway Infrastructure - Track Classification*
- *Geocentric Datum of Australia 2020 (GDA2020)*
- *Geocentric Datum of Australia 1994 (GDA94)*
- *New Zealand Geodetic Datum 2000 (NZGD2000)*
- *New Zealand Vertical Datum 2016 (NZVD2016)*
- *Australian Height Datum (AHD71)*
- *Australian Height Datum (Tasmania) 1983 (AHD-TAS83)*
- *ICSM Guideline for Conventional Traverse Surveys Special Publication 1 – version 2.2:2020*
- *ICSM Guideline for Control Surveys by Differential Levelling Special Publication 1 – version 2.2:2020*
- *ICSM Guideline for Control Surveys by GNSS Special Publication 1 – version 2.2:2020*

NOTE:

Documents for informative purposes are listed in a Bibliography at the back of the Standard.

1.3 Defined terms and abbreviations

For the purposes of this document, the following terms and definitions apply:

1.3.1

Australian Height Datum (AHD)
current official national vertical datum for Australia

Note 1 to entry: From measurements taken in the late 1960s at 30 tide gauges around the mainland, and 2 tide gauges around Tasmania, 0.000 m AHD was assigned to the mean sea level of these results.

Note 2 to entry: Referred to as Australian Height Datum 1971 (AHD71) and Australian Height Datum (Tasmania) 1983 (AHD-TAS83)

1.3.2
datum plate
plates that are typically fastened to structures adjacent to the track and contain information relating to the track alignment. Also, **plaque**

Note 1 to entry: Datum plates can have a small adjustable aluminium or plastic block affixed to the face of the plate which acts as the reference point. As a minimum, they should display the following information relating to this block:

- kilometrage
- distance to the adjacent track design gauge face or centreline
- design track superelevation

Additional information, such as design height to low rail and track centres for example, can be provided if required.

1.3.3
BYDA
Before You Dig Australia

1.3.4
detail survey
survey carried out to provide information of sufficient accuracy and extent for the design of the railway or other infrastructure in brown or green field environments. Also, **topographic survey**

1.3.5
EDM
electromagnetic distance measurement

1.3.6
Geocentric Datum of Australia 1994 (GDA94)
superseded geodetic datum, first adopted nationally across Australia on 1 January 2000

Note 1 to entry: The map projection associated with GDA94 is the map grid of Australia 1994 (MGA94), which conforms to the universal transverse Mercator grid coordinate system. It was the first geocentric datum compatible with modern GNSS positioning techniques adopted within Australia. GDA94 is a plate-fixed static coordinate datum, based on a global framework, the International Terrestrial Reference Frame 1992 (ITRF92), held at the reference epoch of 1 January 1994

Note 2 to entry: GDA94 has been superseded by GDA 2020

1.3.7
Geocentric Datum of Australia 2020 (GDA2020)
current geographic coordinate system for Australia

Note 1 to entry: GDA2020 is based on a global framework, the International Terrestrial Reference Frame (ITRF), projected to a reference date of 1 January 2020 as a conventional plate-fixed or static datum.

Note 2 to entry: The map projection associated with GDA2020 is the Map Grid of Australia 2020 (MGA2020), which conforms to the Universal Transverse Mercator Grid coordinate system.

Note 3 to entry: GDA2020 is a plate-fixed static coordinate datum, based on a global framework, the International Terrestrial Reference Frame 2014 (ITRF2014), held at the reference epoch of 1 January 2020.

Note 4 to entry: The shift in horizontal coordinates from GDA94 is approximately 1.8 m.

1.3.8
Global Navigation Satellite System (GNSS)

satellite based positioning systems

Note 1 to entry: GNSS is the generic term for all similar systems.

1.3.9
GNSS CORS station
Global Navigation Satellite System Continuously Operating Reference Stations

1.3.10
Global Navigation Satellite System (GNSS) heighting
height (z coordinate) determined from GNSS observations based on the national ellipsoid model

Note 1 to entry: A correction shall be applied using reliable AHD-ellipsoid separation values (n values) to determine AHD values.

1.3.11
ICSM
Intergovernmental Committee on Surveying and Mapping

1.3.12
LiDAR
Light Detection and Ranging

1.3.13
Map Grid of Australia (MGA)
metric rectangular grid with cartesian coordinate system based on the Universal Transverse Mercator projection and the Geocentric Datum of Australia

Note 1 to entry: The unit of measure is the metre.

Note 2 to entry: It is important to know what epoch the MGA is referring to as there will be differing versions due to tectonic movement. Care needs to be exercised to nominate which epoch the published coordinates relate to (MGA94 or MGA2020).

1.3.14
monument
physical structure (for example, post or concrete block) defining major points, sometimes used for track control marks. Also, **survey monument**, **track control mark**

Note 2 to entry: In some jurisdictions, survey monuments comprise of a truncated concrete cylinder with track alignment information stamped upon the top.

1.3.15
National Geospatial Reference System (NGRS)
country's foundational geodetic infrastructure that supports high-precision positioning and robust management of spatial data

Note 1 to entry: It includes all aspects of a coordinate datum, along with tools, utilities and the standards and guidelines that facilitate its use.

1.3.16
New Zealand Geodetic Datum 2000 (NZGD2000)
current official geodetic datum for New Zealand

Note 1 to entry: It is based on the International Terrestrial Reference Frame 1996 (ITRF 1996) and uses the Geodetic Reference System 1980 (GRS80).

Note 2 to entry: It manages slow crustal deformation using a deformation model.

Note 3 to entry: It is a geocentric datum, compatible with GNSS.

Note 4 to entry: The unit of measure is the metre, and it was implemented in 1998.

1.3.17
New Zealand Vertical Datum 2016 (NZVD2016)
current official national vertical datum for New Zealand

Note 1 to entry: The reference surface for the New Zealand Vertical Datum 2016 (NZVD2016) is the New Zealand Quasigeoid 2016 (NZGeoid2016), with normal-orthometric heights in metres.

Note 2 to entry: It is consistent with NZGS2000, meaning that normal-orthometric NZVD2016 heights can be transformed to ellipsoidal NZGD2000 heights, and vice versa.

Note 3 to entry: It was adopted on 27 June 2016.

1.3.18
permanent survey mark
marks that form part of the State Survey Control Network. Also, **State Permanent Mark (SPM)**, **Permanent Mark (PM)**, or **State Survey Mark (SSM)**

Note 1 to entry: Permanent survey marks are unique to the state or territory, and as such are registered in the relevant state or territory survey control database (or register).

Note 2 to entry: The information registered may include coordinates, height, access notes and other administrative information.

1.3.19
plaque
plates or plaques that contain information relating the rail survey control marks, track control marks or monuments to the adjacent track alignment. Also, **datum plate**, **survey plaque**, **data plate**, **tag** or **label**

1.3.20
rail infrastructure manager (RIM)
As defined in Rail Safety National Law.

1.3.21
rail survey control network
network of permanent rail survey control marks that provide the survey framework for all engineering activities

Note 1 to entry: This rail survey control network consists of the physical marks, measurements, calculations and coordinates related to them.

1.3.22
rail survey control mark
permanent survey marks that are intended specifically for use in the railway environment and are installed in stable ground, solid rock, or in concrete in-situ, where the potential for disturbance is minimized

Note 1 to entry: Rail survey control marks are uniquely identified, and located at regular intervals along a rail corridor, providing the opportunity for connection to the adjacent State Survey Control Network if required.

Note 2 to entry: Made of high quality, durable and corrosion-resistant materials.

Note 3 to entry: Examples of these types of marks are provided in Appendix D.

1.3.23
State Survey Control Network
network of physical permanent uniquely identified ground marks, installed and maintained across a state or territory, which provide the realisation of the National Geospatial Reference System (NGRS)

1.3.24
track control mark (TCM)
mark specifically placed to provide a reference to the design alignment of the track to which it relates

General rail industry terms and definitions are maintained in the RISSB Glossary. Refer to: https://www.rissb.com.au/glossary/

Section 2 Planning

2.1 Railway survey system

A railway survey system refers to the comprehensive set of methods, technologies, and standards used to accurately measure, map, and document the spatial characteristics of railway networks.

Railway survey systems shall encompass all aspects of railway survey control and track control in relation to:

(a) system establishment and maintenance;

(b) control networks, values and marking;

(c) system documentation including record keeping of surveys;

(d) equipment requirements, validation requirements and calibration requirements and records; and

(e) personnel, including competency records as required by laws and regulations of the relevant jurisdiction.

Various types of survey will fit into the survey system, as defined by the RIM, and the requirements and details are not covered by this document. These can include mapping surveys, detail surveys, deformation monitoring surveys, cadastral surveys and other survey types as defined by the RIM.

Where compliance with the requirements of this document is not deemed to be reasonably practicable, the RIM shall assess and minimize identified non-compliance risks in so far as is reasonably practicable (SFAIRP).

2.2 Competency

All railway survey work and associated activities detailed within this document shall only be undertaken by, or under the direct supervision of, suitably qualified persons holding recognized qualifications and verified competency, as authorized and approved by the RIM, and:

(a) such authorized persons shall be responsible for the precise location of infrastructure using surveying techniques; and

(b) they are the only persons authorized to place, amend or relocate rail survey control marks, track control marks or monuments, and any associated survey plaques or tags.

All personnel undertaking survey work in the rail environment shall also be suitability qualified in the relevant safe working requirements and regulations of that jurisdiction.

Lists of typical railway survey activities are in Appendix B. These lists are not exhaustive but are designed to provide guidance in the efficient allocation of surveying resources.

2.3 Strategy

The railway survey system shall provide:

(a) an element of assurance that the railway network can operate in a safe manner; and

(b) a framework to support all engineering activities undertaken on a modern railway network.

The application of a railway survey system can have different requirements, depending on the environment in which it is located.

Appendix F provides information on how to classify instrumentation.

2.4 Categories of railway survey systems

Railway survey systems shall be based upon a national geospatial reference system - see Section 2.4.1.

Non-national geospatial reference systems may exist in the railway industry; however, all future rail survey systems shall be based on NGRS reference systems.

Any such special survey requirements shall be identified and confirmed with the RIM, prior to any survey activities commencing. National Geospatial Reference System

Railway survey systems shall be based on, and connected to, the National Geospatial Reference System (NGRS).

This enables coordinated track alignment to be described in the national framework, and for this information to be integrated with mapping and other features, for example in a Geographic Information System (GIS).

In Australia, all new surveys established shall use the current national horizontal and vertical reference systems, namely the Geocentric Datum of Australia (GDA2020), and the Australian Height Datum (AHD71) for the Australian mainland, and (AHD-TAS83) for Tasmania.

Legacy surveys which are already created using GDA94 should have records maintained to be identified as such.

In New Zealand, all surveys so established shall use the current national horizontal and vertical reference systems, namely the New Zealand Geodetic Datum 2000 (NZGD2000), and the New Zealand Vertical Datum 2016 (NZVD2016).

The horizontal and vertical datums used, and the origins and values of coordinates and heights, shall be recorded so that full traceability is documented.

Commentary *C2.4*

Readily available Equipment and services such as GNSS and AUSPOS/PositionZ makes conducting control surveys on the NGRS possible.

2.5 Instrumentation, tools and equipment

2.5.1 Specialized tools and equipment

Specialized tools and equipment should be robust enough to withstand harsh work environments.

Where necessary tools shall be calibrated prior to their use, and as part of regularly scheduled maintenance, as deemed appropriate by the RIM.

Examples of specialized tools and equipment are:

(a) right-angled offset prism

(b) coping tool

(c) track bar

(d) magnetic rail prism

Examples of this type of equipment are illustrated in Appendix C.

Any equipment used that has the potential to impact upon, or adversely affect any electrical, signalling or other critical equipment, shall be certified as insulated and safe for use in the rail environment.

The use of metallic and invar staves shall not be permitted on any railway projects. Only non-conductive certified staves shall be used.

Commentary *C2.5.1*

Specialized tools and types of equipment have been developed and refined by survey personnel working in the rail environment for many years. This equipment has been developed to meet the issues and exacting standards required for the purposes of rail survey control and track control.

2.5.2 Instrumentation and observational techniques

2.5.2.1 General

Surveys undertaken for the purpose of railway survey control and track control using conventional survey methods shall be carried out to uniform standards and using uniform observational techniques to ensure all surveys are compatible.

It is recognized that many survey tasks can be undertaken using innovative methods rather than conventional survey methods. However, before any work is undertaken using non-traditional survey methods or techniques, the proposed methodology shall be investigated and approved for use by the RIM.

Instrument specifications and observational techniques are based on those outlined in the Intergovernmental Committee on Surveying and Mapping (SP1) documents:

(a) *Guideline for Conventional Traverse Surveys* for total station instruments and techniques.

(b) *Guideline for Control Surveys by Differential Levelling* for differential levelling instruments and techniques.

(c) *Guideline for Control Surveys by GNSS* for GNSS equipment and techniques.

Surveys, other than for railway survey control and track control, shall be connected to the railway survey control network. Such surveys shall be suitable for the type of work being undertaken and use instrumentation and observational techniques that are agreed to by the RIM.

The RIM shall confirm that where any work is undertaken using non-conventional survey techniques, care shall be taken to ensure that the accuracy required for the purpose and/or output of the survey is maintained.

2.5.2.2 Instrumentation and Observational Techniques for Conventional and GNSS Surveys

Instrumentation for conventional survey shall conform to the *Guideline for Conventional Traverse Surveys* (SP1 Version 2.2), Table 1. Instrumentation shall allow an SU <2 mm. Observational techniques shall allow an SU <2 mm. The collimation test requirements may be relaxed.

Instrumentation for differential levelling shall conform to the *Guideline for Control Surveys by Differential Levelling* (SP1 Version 2.2), Table 1. Instrumentation shall allow a maximum misclose (between forward and back) of 12 mm * √k (km). Observational techniques shall allow a maximum misclose (between forward and back) of 12 mm * √k (km).

Instrumentation for GNSS surveys shall conform to the *Guideline for Control Surveys by GNSS* (SP1 Version 2.2), Table 1. The classic static observational method shall be used to achieve a survey uncertainty of <30 mm for horizontal position and <50 mm for ellipsoidal height. The railway survey control network shall be connected to the national geodetic network.

In Australia the connection to the national geodetic network shall be by use of the AUSPOS service or connection to local CORS stations utilizing the precise ephemeris.

RIM approval shall be obtained where the connection may be made using State Survey Marks with Hz uncertainty <30 mm and Vz uncertainty <50 mm.

In New Zealand the connection shall be by use of the POSITIONZ-PP service utilizing the precise ephemeris.

In addition to connection to the national geodetic network, a survey undertaken for railway survey control should assess any existing any survey control marks that are part of the existing railway survey control network sections on both ends of the current survey.

A least squares adjustment shall be carried out and include all survey control observations.

Where a survey fails a statistical analysis, an investigation shall be undertaken to identify the cause, with additional work undertaken as necessary to rectify the cause.

Railway track control shall be connected to the railway survey control network by conventional traversing techniques. Sufficient redundancy and check measurements shall be undertaken to ensure the accuracy of the track control mark data.

GNSS techniques shall not be used for observations to railway track control.

All survey equipment shall be maintained in good adjustment and condition as per the equipment manufacturers stated precisions.

Examples of information required to ensure equipment is in good working order include:

(a) an annual service certificate confirming that the instrument meets the minimum operating specifications;

(b) details of tests such as calibration, alignment and self-tests performed in the last 12 months which demonstrate that the instruments are achieving the required precision and accuracy; and

(c) details of EDM calibration using an EDM test baseline in the preceding 12 months, or after service, to ensure legal traceability of measurements.

Section 3 Implementation

3.1 Application of the rail survey control network

The network datum shall be realized through physical infrastructure that is accurately positioned within the NGRS to provide traceability and support precise positioning.

The rail survey control network shall have appropriate connections to the state or territory survey control network and to the NGRS. These connections shall be agreed to by the RIM before work commences.

The safety of survey personnel and equipment shall be assessed when designing rail survey control networks and installing rail survey control marks.

3.2 Rail survey control marks

Rail survey control marks are permanent survey marks and shall be assigned a unique identifier.

All marks used for rail survey control shall have the following characteristics:

(a) made of high quality, durable and corrosion-resistant materials;

(b) installed in stable ground or in solid rock; and

(c) installed in locations that minimize their likelihood of being disturbed.

Examples of the types of marks that can be used for rail survey control marks include:

(d) survey pillar;

(e) brass plug or triangle;

(f) star picket set in concrete; and

(g) stainless steel nail or screw and washer.

Examples of these types of marks are illustrated in Appendix D.

Where necessary, temporary rail survey control marks (such as pegs, nails in rock or star pickets) may be installed for a short term and a specific purpose.

However, permanent rail survey control marks shall be installed and observed as a mandatory requirement for project handover, as required and approved by the RIM.

3.3 Placement of rail survey control marks

Where practicable, the placement of rail survey control marks shall, at regular intervals, allow for connection to relevant state or territory survey control marks external to the rail corridor.

Rail survey control marks shall be:

(a) placed at regular intervals as determined by the RIM;

(b) positioned adjacent to the track, outside the danger zone, such that they are easily accessible and useable by all railway maintenance staff working in the operational corridor;

(c) placed in stable accessible ground;

(d) clear of running lines and obvious cable routes; and

(e) as far as is practicable, clear of access roads and other areas that can pose a risk to persons, rail or road traffic when occupying or accessing the mark.

Rail survey control marks shall be so placed to ensure that a complete coverage of the rail network is achieved.

Rail survey control marks should not be established outside of the railway corridor.

The appropriate risk assessment procedures and approval from the RIM shall be obtained, prior to any placement of rail survey control marks in restricted locations such as tunnels and viaducts.

Rail survey control marks shall be placed with the long-term strategic aim of survey control densification in mind, and with their usefulness in terms of intervisibility and future connections to adjacent surveys are factored.

3.4 Installation of rail survey control marks

Where possible, rail survey control marks shall be installed:

(a) in stable structures, such as concrete, stone, masonry or solid rock;

(b) countersunk with the surrounding surface, to ensure that the mark does not constitute a tripping hazard, and to minimize the risk of accidental damage or destruction;

(c) clear of the danger zone;

(d) as far as is practicable, clear of access roads or other hazards that can pose a risk to survey personnel and equipment safety when the mark is being occupied;

(e) in a manner, such that a levelling staff can be placed upon the mark without interference; and

(f) securely, using a bonding compound such as two-part epoxy or equivalent to ensure adequate adhesion.

The rail survey control mark shall be suitably identified by paint or surrounding star pickets, both to advise of its location and to afford a degree of protection from accidental damage.

In circumstances where it is not possible to install the rail survey control mark in stable ground, a suitable design and construction methodology shall be approved by the RIM and applied to ensure the stability and durability of the installed mark.

Such a mark may be:

(g) a stainless steel or brass rod, or galvanized star picket driven to refusal,

(h) capped with a concrete collar and preferably protected by a cast iron cover box flush with the finished surface; or

(i) where ground stability is suitable, a mark installed in concrete in-situ.

In all cases where ground penetration is a requirement, a services search of the site utilizing Before You Dig Australia (BYDA) and/or any state jurisdictional-specific services search shall be undertaken as determined by the RIM.

The services search shall be undertaken to ensure:

(j) that no buried services are damaged; and

(k) the safety of the personnel involved.

3.5 Application of the track control or monument network

3.5.1 General

The track control mark or monument network is a further breakdown of the rail survey control network and shall be established using the same coordinate reference system.

These networks are installed to provide a reference to the design alignment of the track to which they relate.

The frequency and permanency of track control marks shall be determined by the RIM and aligned with the purpose of their installation.

3.5.2 Track control marks

Track control marks or monuments are permanent survey marks and shall be assigned a unique identifier.

All marks installed for the purpose of permanent track control shall be:

(a) made of high quality, durable and corrosion resistant materials; and

(b) installed in stable ground, solid rock, or solid structures such as posts or overhead wiring structures.

Examples of the types of marks that can be used for permanent track control include:

(c) stainless steel pins;

(d) brass or steel bars;

(e) spigots;

(f) star pickets;

(g) survey monuments;

(h) mast bolts;

(i) rail section, channel iron or post in concrete; and/or

(j) galvanized iron or black pipe.

Examples of these types of marks are illustrated in Appendix E.

3.5.3 Placement of track control marks

Track control marks or monuments shall be:

(a) located at regular intervals as determined by the RIM; and

(b) more frequently located on curved track as compared to tangent track.

Track control marks or monuments shall be positioned adjacent to the track, such that they are easily accessible and useable by all railway maintenance staff working in the operational corridor.

Track control marks or monuments shall be placed in a manner that is not hazardous to pedestrians, rail or road traffic.

In electrified areas as a minimum, track control marks or monuments shall be located at every overhead wiring structure.

At locations with restricted clearance such as platforms, tunnels and bridges, track control marks or monuments shall be placed at more frequent intervals in line with risk requirements and as agreed with the RIM.

In all cases where ground penetration is a requirement, a services search of the site utilizing BYDA and/or any state jurisdictional-specific services search shall be undertaken as determined by the RIM.

The services search is undertaken to ensure:

(c) that no buried services are damaged; and

(d) the safety of the personnel involved.

3.6 Survey mark identification requirements

3.6.1 Coordinated survey networks

In addition to the physical mark being installed in the ground or in a wall or cutting, an identifying plaque, marker, datum plate or tag shall be affixed to, or attached adjacent to the physical mark.

This identifier shall provide by embossing, marking, engraving or by electronic means the following information:

(a) Kilometrage of the mark (if applicable, preferably to the millimetre).

(b) Design superelevation/cant (in millimetres) of the track adjacent to the mark.

(c) Design offset (in millimetres) from the mark to the adjacent track/rail running face.

(d) Additional information as required.

Such additional information may include:

(e) height from the mark (up or down in millimetres) to the design low rail of the adjacent track;

(f) design radius of the circular curve to the millimetre if the mark is located adjacent to a circular curve;

(g) information relating to the track being referenced (e.g., track name, designation, code);

(h) design track centres between the track being referenced and an adjacent track;

(i) information relating to the mark attachment location (e.g., overhead wiring structure number, road over-line bridge name); and

(j) point number or unique identifier of the reference mark.

Different types of plaques, markers, datum plates or tags are illustrated in Appendix E.

Section 4 Deliverables

4.1 Coordinated survey networks

4.1.1 Reporting

A survey report shall be provided, and contain the following information:

(a) Job or project details;

(b) Surveyors' details;

(c) Equipment details, observation techniques, rail survey control network details, photographs and field notes/sketches;

(d) Data processing methods and software used;

(e) Least squares adjustment details, accuracies and software used, constraints, options, analysis and results; and

(f) Additional information as determined by the RIM.

Commentary *C4.1.1*

Projects can require relevant details as required by independent safety assessors (ISA) when Safety Integrity Level railway application are correlate (e.g. justification to indicate how the used method manages the risk of safety-related errors in the survey data SFAIRP).

4.1.2 Observational deliverables

Observed survey data for rail survey control and track control shall be provided in a format as determined by the RIM.

All data should be compatible with the requirements of the respective State or Territory surveying and mapping agencies for integration into their geodetic control networks.

The datasets shall be provided to the RIM with sufficient information to ensure traceability, and in such a format that they will be available for future readjustment of the rail survey control network.

Section 5 Data management and quality assurance

5.1 Survey data management system

Each RIM shall maintain all survey data in an appropriate data management system, enabling safe and secure storage, searching and management of 3D coordinate and other information relating to established ground marks within their rail survey control network and track control network.

In relation to survey data management, the RIM shall specify the following:

(a) Data formats; and

(b) The method required for recording the location of all permanent rail survey control and track control marks or monuments.

The data management system shall be accessible to all authorized parties as required.

Survey control and track control marks and data are assets that are essential for the support of engineering activities on the rail network. The RIM shall maintain a system that ensures the availability of both the physical railway survey control marks and track control marks and the survey mark data.

With regards to the maintenance and upkeep of the rail survey control and track control networks, some of the issues that the RIM needs to factor in can include:

(c) the availability of the mark;

(d) identified movement of the mark; and/or

(e) adverse reports received from, or issues identified by users of the mark.

Where it is identified that there is a risk that rail survey control or track control marks can possibly be destroyed, the RIM should be informed at the earliest opportunity.

Where rail survey control and/or track control marks have been destroyed, removed, damaged or displaced, the affected marks shall be replaced unless otherwise advised by the RIM.

In the case of track control marks, a new or revised plaque or datum plate shall be installed. Any rectification work shall be undertaken in consultation with the RIM.

5.2 Records management requirements – Coordinated networks

The RIM shall ensure that on completion of all surveys:

(a) all relevant railway databases are updated, including track design alignment and clearance data; and

(b) other relevant authorities are notified.

Appendix A Hazard Register (Informative)

The following hazards are addressed by this document:

Hazard No.	Hazard Description
6.5.1.18	Incorrect equipment use
6.6.1.3	Hitting a wayside structure
6.6.1.16	Wayside structures infringing the rolling stock kinematic envelope
6.8.1.26	Poor QA
6.9.1.24	Survey error
6.9.1.25	Equipment calibration error
8.4.1.1	Being struck by rail traffic

Appendix B Typical Railway Surveying Tasks (Informative)

Examples of different types of railway surveying projects undertaken in accordance with Clause 2.2.

The following list contains specific examples of survey tasks undertaken by surveyors within the railway corridor and danger zone:

(a) Survey control in the rail environment.

(b) Track control, monumentation, installation and maintenance.

(c) Detailed surveys for specific requirements, by various techniques such as conventional total station, scanning, LiDAR and aerial photo.

(d) Track design (alignment and grading), track realignment, duplication, and bifurcation.

(e) Track lifts and pulls.

(f) Track work on ballasted track, track slabs, transition slabs, direct fixation.

(g) Precise monitoring for deformation, settlement movement and erosion.

(h) Track reconditioning, track renewal, track maintenance.

(i) Turnout, crossover and special track work installation or renewal.

(j) Kinematic structure clearance surveys.

(k) Half-block replacement.

(l) Retaining walls.

(m) Track drainage, culverts, stormwater, open drain, effective waterway.

(n) Underline track crossing installations, under track bores and associated monitoring.

(o) Location of rail and external buried services infrastructure.

(p) Platform interface issues such as:

    (i) rebuilds;

    (ii) awnings;

    (iii) coping location;

    (iv) platform heights;

    (v) cutbacks;

    (vi) platform gap reduction; and

    (vii) level and standard access.

(q) Under bridges; ballast top, transom top, direct fix, deck renewal or replacement.

(r) Overbridges; road, pedestrian, deck replacement, clearance requirements.

(s) Level crossing surveys.

(t) Tunnels, deflection walls, overbridges.

(u) Line side equipment, kilometre posts, speed boards regarding location and kinematic clearance.

(v) Signals, dwarf signals, gantries.

(w) Overhead wiring structures, including precast footings, portal and planted post positioning.

(x) Overhead wiring structure drop verticals, contact wires, catenary wires, other attached infrastructure, and cantilever calculation requirements.

(y) Stabling yard infrastructure.

(z) Creep measurements.

This list is not exhaustive, and some tasks may be undertaken by alternative techniques as approved by the RIM. As an example, monitoring of large bridge and viaduct structures may be undertaken by terrestrial photogrammetry.

It may not be necessary to conduct these tasks on a national geospatial reference system.

The following list provides examples of survey work undertaken within the rail corridor, but external to the Danger Zone, where specific railway surveying competencies are NOT required:

(aa) Access roads.

(bb) Power poles and conductors clear of the danger zone.

(cc) Earthworks, sound mounds, noise walls.

(dd) Embankments, cuttings, retaining walls.

(ee) Buried infrastructure, BYDA clear of the danger zone.

(ff) Fencing, railway land boundary determination.

(gg) Platform works behind the yellow safety line.

(hh) Substation works, feeders, general electrical set out work.

(ii) Car parks, road works, kerb and gutter.

(jj) Stations, buildings.

(kk) Drainage (non-track).

This list is not exhaustive and approval by the RIM should be sought before commencing activities. Due to safety concerns for survey personnel and equipment, it may be necessary to plan for a track possession to undertake some of these survey projects.

Appendix C Specialized Tools and Equipment used for Railway Surveying Purposes (Informative)

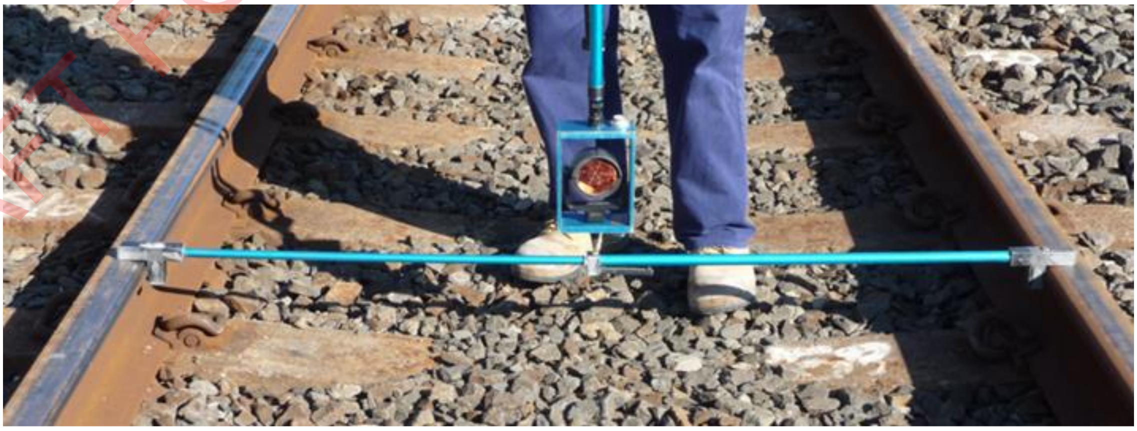
Reference Clause: 2.5.1 Specialized Tools and Equipment - Source TfNSW TS 03553

Appendix Figure C-1 Offset prism and associated attachment arms

Appendix Figure C-2 Right-angled offset prism being used to measure an SSP

Appendix Figure C-3 Platform coping tool

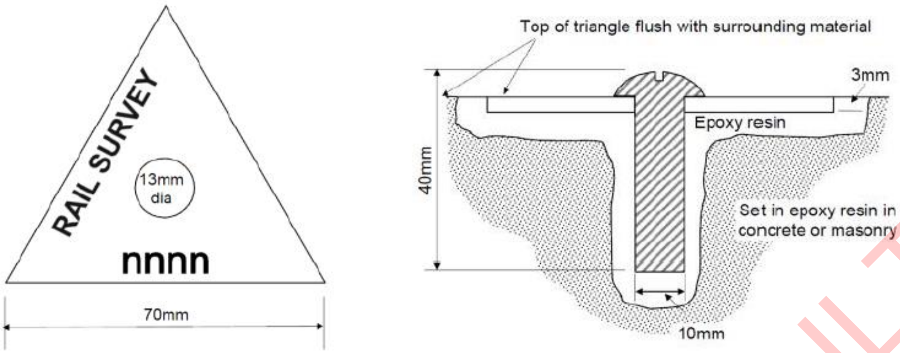
Appendix Figure C-4 Magnetic rail prism



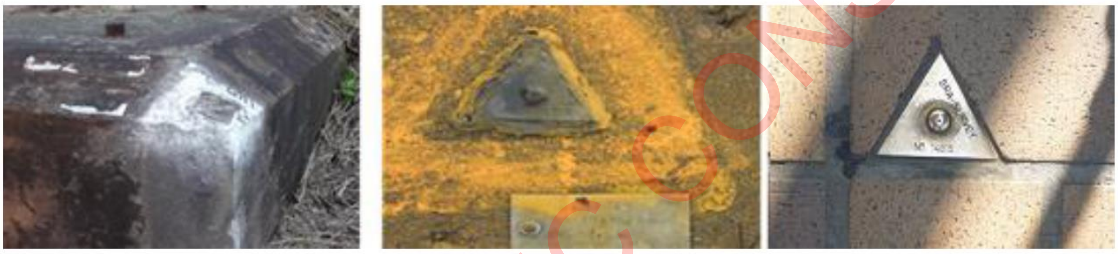
Appendix Figure C-5 Track bar used to measure track centreline

Appendix D Different Types of Rail Survey Control Marks – Typical Examples (Informative)

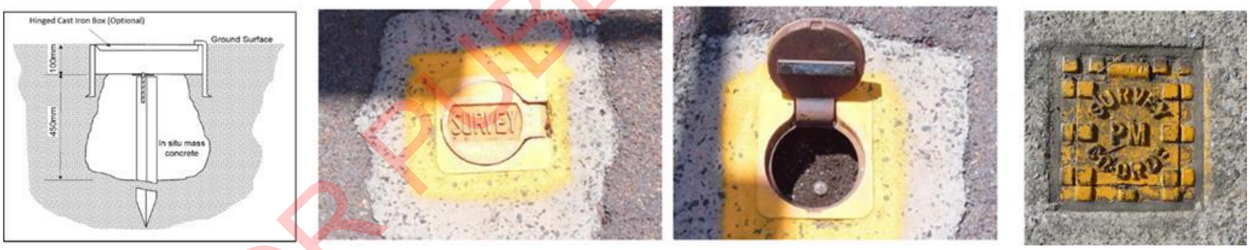
Reference Clause: 3.1.1 Rail Survey Control Marks



Appendix Figure D-1 Brass triangle type mark, details



Appendix Figure D-2 Rail survey control marks



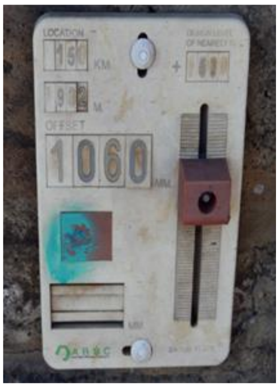
Appendix Figure D-3 Survey marks in cast iron cover boxes

Appendix Figure D-4 Other types of permanent survey control marks

Appendix E Examples of Track Control Marks, Monuments, Plaques, and Data Plates (Informative)

Reference Clause: 3.2.1 Track Control Marks

Appendix Figure E-1 Brass bar and survey plaque

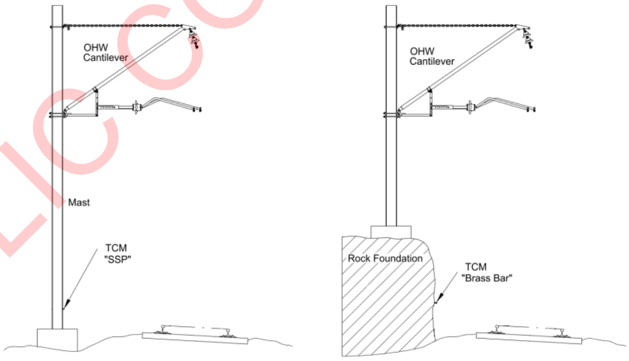


Appendix Figure E-2 Datum plate

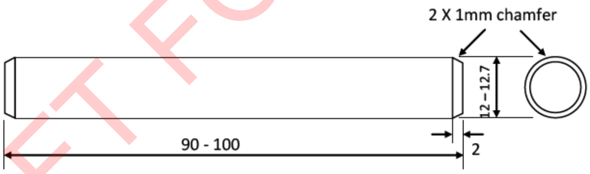
Appendix Figure E-3 Track data plate

Appendix Figure E-4 SSP and survey plaque

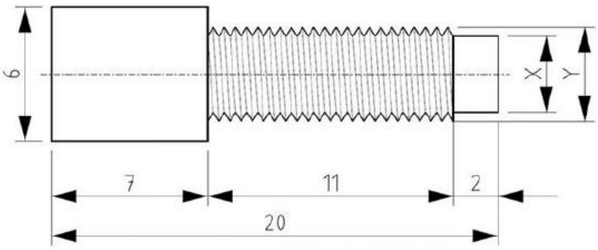
Appendix Figure E-5 Brass bar TCM in platform



Appendix Figure E-6 Typical locations for TCMs



Appendix Figure E-7 Brass bar type survey mark



Appendix Figure E-8 Stainless steel pin type survey mark

Appendix F Survey Class (informative)

The following definitions offer guidance on how to classify instrumentation and survey accuracy appropriate to tasks and what those tasks might entail.

Survey Class Definitions:

Class to be used to provide Identification for RIM to request Engineering Survey Works to meet expectations aligned to the respective Rail Standards.

(a) Class A: Highest Order of Survey. Requires full validation and reporting to confirm that Survey processes conform to the stated Positional Accuracies. Typically aligned to Survey activities that support IFC and Construction requirements.

(b) Class B: Survey class typically aligned to Detailed Design requirements, where a high level of confidence in survey positional uncertainties is required to confirm Design standards.

(c) Class C: Survey information supporting works such as Concept phase design, As Built and Asset Class surveys where high orders of positional uncertainty are not strictly necessary.

(d) Class D: Survey aligned to information only purposes, supports decision making by providing context to site conditions and locality and existence of key rail feature.

Note: All table values are in meters.

Appendix Table F-1 – Survey Class (Relative Accuracy)

Survey Class	A		B		C		D		Examples of Instrumentation	Survey Tasks
Survey Class	Pos.	Height	Pos.	Height	Pos.	Height	Pos.	Height		

Survey Class	A		B		C		D		Examples of Instrumentation	Survey Tasks
Rail Geometry	±0.001	±0.002	±0.025	±0.005	±0.050	±0.025	±0.100	±0.050	• Track Trolleys • High Precision Total Stations (1" or better) • Purpose Built Track Geometry Survey systems • Use of Specific Track geometry specialized tools and equipment such as Magnetic Rail Prisms / Track Bar	• Track design (alignment and grading) • Track Realignments, duplication, and bifurcation • Precise monitoring for deformation, settlement, and movement • Specialist Track renewal
Structures	±0.015	±0.005	±0.025	±0.010	±0.050	±0.025	±0.100	±0.050	• Terrestrial Laser Scanners • Total Stations supported by specific Target • Use of Specific Track geometry specialized tools and equipment such as Offset Prisms with associated attachment arms, affixed targets, right angled offset prisms, and platform coping tools.	• Kinematic Structure Clearance • Station Structures • Overheads • Under Bridges / Overbridges • Tunnels, deflection walls

Survey Class	A		B		C		D		Examples of Instrumentation	Survey Tasks
Engineering Survey	±0.015	±0.010	±0.025	±0.010	±0.050	±0.030	±0.100	±0.050	• Terrestrial Laser Scanners • Total Stations • Mobile Laser Scanners • GNSS	• Detail surveys for specific requirements • Track Drainage, culverts, Stormwater, Open drain • Location of Rail and External Buried services infrastructure • Platform Interface Surveys • Grade Separations • Utility Investigations (as guided by positional standards within ASX5488:2021)
Natural Ground Features	±0.100	±0.100	±0.100	±0.100	±0.100	±0.100	±0.200	±0.200	• Airborne LiDAR • Terrestrial Laser Scanners • Total Stations • Mobile Laser Scanners • GNSS • Photogrammetry • Remotely Piloted Aircraft (RPAs)	• Asset Surveys, inclusive of identification of Assets both within and out of Rail Corridor • Terrain Models

Survey Class	A		B		C		D		Examples of Instrumentation	Survey Tasks
Trees / Vegetation	±0.100	N/A	±0.100	N/A	±0.100	N/A	±0.200	N/A	• LiDAR • Aerial Photography (Photogrammetry) • Reality Capture technologies • Remotely Piloted Aircraft (RPAs)	• Asset Surveys • Terrain Models

Bibliography (Informative)

The following referenced documents are used by this Standard for information only:

- Transport for NSW - *Railway Surveying TS 03553*
- ARTC - *Control Surveys ETD – 00 – 04:2010*
- CRN - *Survey Manual CM 212:2022*
- CRN - *Survey Manual CP 211:2021*
- CRN - *Contract Survey Manual CP 212:2021*