NSW GOVERNMENT

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T HR EL 20005 ST

Standard

Above Ground Installation Configurations for High Voltage AC and 1500 V DC Cables

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Document information

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Document history

Revision	Effective date	Summary of changes
1.0	23 May 2018	First issue as T HR EL 20005 ST
1.0	27 November 2024	First issue as TS 03752, superseding T HR EL 20005 ST, version numbering recommenced in line with new designation. Changes from previous version include extending the scope of the document to include metro.

Preface

This standard is a first issue as TS 03752 and supersedes T HR EL 20005 ST. This document sets out the technical requirements for above ground installation configurations for HV ac and 1500 V dc cables for the TfNSW heavy rail passenger network within the metropolitan rail area TfNSW heavy rail network.

The power supply to traction and other substations, railway stations, signalling systems and other elements of the TfNSW Transport Network is primarily provided by the Sydney Trains and Sydney Metro distribution systems. The Sydney Trains distribution system consists of both HV cables and aerial lines with nominal voltages that vary between 11 kV and 132 kV. The Sydney Metro distribution system consists of HV cables with nominal voltages of 11 kV, 33 kV and 132 kV.

The Sydney Trains distribution system 1500 V dc traction power supply system contains cables with a rated voltage of 3.8/6.6 kV.

The changes from the previous issue are:

- transfer onto the current template format
- updated referenced documents along with updated terms, definitions and abbreviations
- minor technical clarification for required use of solid trunking except where a design and risk analysis supports a slotted trunking alternative
- extending the scope of the document to include Metro.

Table of contents

1 Scope

This standard covers above ground installations of HV ac and 1500 V dc traction power supply cables for the TfNSW heavy rail passenger network within the metropolitan rail area and the Sydney Metro passenger network with the following configurations:

- cable trunking systems installed above ground and at ground level
- cable tray systems
- cable ladder systems
- cables supported by cable cleats mounted on structures.

These configurations include but are not limited to the cable installation configurations listed in this section that are located in the following structures:

- railway tunnels
- cable tunnels
- cable pits
- cable shafts
- UGOH poles
- OHW structures
- portal structures providing over-track crossing for cables.

This document sets out the interface requirements between above ground HV ac and 1500 V dc traction power supply cable installations and other services. However, it does not cover detailed requirements of combined services routes.

This document does not cover the following:

- transition arrangements between underground and above ground cable installations, which are covered in TS 03753
- requirements for cables with a nominal voltage higher than 66 kV; currently there is no approved 132 kV cable type
- cables and cable installations in rolling stock
- aerial bundled cables.

The requirements for the design and installation of HV aerial bundled cables in the Sydney Trains distribution system are covered in TS 03770.

Refer to TS 03751 for design and construction requirements of these cables.

Refer to TS 03748 for the approved cable types and sizes.

2 Application

This document applies to HV cables that form part of the Sydney Trains and Sydney Metro distribution systems and 1500 V dc traction power supply cables.

This document is applicable to all new above ground HV ac and 1500 V dc traction power supply cable infrastructure.

This document is also applicable to the modification of existing above ground HV ac and 1500 V dc traction power supply cable infrastructure in accordance with the requirements set out in Section 5.

Where a new HV ac and 1500 V dc traction power supply cable installation or modification is constructed and energised in stages, the requirements of this document are applicable to the configuration at each stage of construction.

In addition to the requirements of this document, asset decisions take into account the life cycle cost considerations specified in TS 01505.

25 kV ac traction power supply cable infrastructure requirements are covered in separate standards.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

EN 61537 *Cable management – Cable tray systems and cable ladder systems*

IEC 61914 *Cable cleats for electrical installations*

Australian standards

AS/CA S009 *Installation requirements for customer cabling (Wiring Rules)*

AS/NZS 1214 *Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)*

AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 4296 *Cable trunking systems*

AS/NZS 4680 *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

AS 2067 *Substations and high voltage installations exceeding 1 kV a.c.*

AS 60529 *Degrees of protection provided by enclosures (IP Code)*

Transport for NSW standards

TS 01505 (T MU AM 01001 ST) *Life Cycle Costing*

TS 01722 (ESC 340) *Tunnels*

TS 02390 (T HR CI 12190 ST) *Service Installations within the Rail Corridor*

TS 03500 (ESC 215) *Transit Space*

TS 03676 (T HR EL 12002 GU) *Electrolysis from Stray DC Current*

TS 03677 (T HR EL 12004 ST) *Low Voltage Distribution and Installations Earthing*

TS 03741 (T HR EL 00006 ST) *Electrical Power System Signage*

TS 03743 (T HR EL 12005 ST) *Bonding for 1500 V DC Traction Systems*

TS 03744 (EP 00 00 00 13 SP) *Electrical Power Equipment – Design Ranges of Ambient Conditions*

TS 03746 (T HR EL 20004 GU) *High Voltage AC and 1500 V DC Traction Power Supply Cables – Design and Construction Guide*

TS 03748 (T HR EL 20001 ST) *High Voltage AC and 1500 V DC Traction Power Supply Cable Requirements*

TS 03751 (T HR EL 20004 ST) *High Voltage AC and 1500 V DC Traction Power Supply Cable Infrastructure – Standards for Design and Construction*

TS 03753 (T HR EL 20006 ST) *High Voltage ac and 1500 V dc Cables – Transitions Between Underground and Above Ground Installation Configurations*

TS 03757 (T HR EL 20010 ST) *HV and 1500 V dc Cables – Joints and Terminations*

TS 03770 (T HR EL 10001 ST) *HV Aerial Line Standards for Design and Construction*

TS 03794 (T HR EL 08001 ST) *Safety Screens and Barriers for 1500 V OHW Equipment*

TS 03799 (T HR EL 08006 ST) *Services Erected Above Overhead Wiring*

TS 03885 (T HR EL 99006 ST) *Substation Fire Protection and Detection*

TS 05164 *Construction of Cable Routes and Signalling Civil Works*

TS 06197.1 *TAO Authorisation Requirements*

TS 06210 (T MU TE 01001 ST) *Campus Backbone Telecommunication Routes and Cabling*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document:

ac alternating current

AMB Asset Management Branch

cable ducting system assembly comprising a ducting length and possibly other system components to provide an enclosure for the accommodation and drawing in of insulated conductors and cables and possibly the accommodation of other electrical equipment

cable tray system or cable ladder system assembly of cable supports consisting of cable tray lengths or cable ladder lengths and other system components (Source: EN 61537)

cable trunking system a system of trunking lengths and components, used for the accommodation and protection of cables

> Note: Also widely known as ‘troughing’, with common variants including galvanised steel troughing (GST), ground-line troughing (GLT), stainless steel for use in tunnels, polymeric and composite material troughing.

dc direct current

HV high voltage; a voltage exceeding 1000 V ac or 1500 V dc

metropolitan rail area area bounded by Newcastle Interchange (in the north), Richmond (in the northwest), Bowenfels (in the west), Macarthur (in the southwest) and Bomaderry (in the south), and all connection lines and sidings within these areas, but excluding private sidings

OHW overhead wiring

rail corridor the land on which railway is built; comprising all property between property fences, or if f there are no fences, everywhere within 15m of the outermost rails (RailSafe)

Sydney Metro distribution system distribution system as defined in the *Electricity Supply Act 1995* (NSW); this includes high voltage ac distribution system, 1500 V dc metro line service equipment or 25 kV ac metro line service equipment and low voltage installations

Sydney Trains distribution system distribution system as defined in the *Electricity Supply Act 1995* (NSW); this includes high voltage distribution system, 1500 V heavy rail service equipment and low voltage installations

TAO Technically Assured Organisation

TfNSW Transport for New South Wales

trunking length the main component of a cable trunking system, consisting of a base and a removable cover

UGOH underground to overhead

5 General requirements

5.1 Overview

Above ground cable installation configurations shall comply with TS 03751.

Above ground cable installation within the rail corridor shall comply with TS 02390. The location of above ground cable installations shall comply with TS 03500.

Above ground installation of HV ac cables in the open route shall comply with AS 2067.

Where existing above ground HV ac and 1500 V dc traction power supply cable installations are modified, the design and construction of the modification shall be such that the resultant configuration shall comply with this document, unless it is not practicable to do so. Where it is not practicable to do so, the designer shall list all non-compliances and identify the associated hazards in a hazard log. The designer shall propose a design approach to mitigate the operational and maintenance risks, and other risks associated with the non-compliances. The mitigation shall be subject to review and acceptance by the relevant TAO before commencing the detailed design and be in accordance with the TAO's judgement of significance processes. Refer to TS 06197.1 for more information.

5.2 External third-party high voltage cables

Above ground cable installation configurations shall not be used within the heavy rail and Sydney Metro corridors for HV cables that are not part of the TfNSW heavy rail and Sydney Metro networks.

5.3 Cable security

Above ground cable installation configurations shall be selected in accordance with the hierarchy of risk exposure set out in TS 03746 and TS 03751.

Specific requirements for particular installation configurations are given in Section 8 to Section 11.

5.4 Mechanical properties

Above ground cable installation configurations shall have adequate strength for the following requirements:

- supporting the static weight of the cables
- withstanding the loads from construction and maintenance of the cables
- withstanding the electromagnetic forces under electrical fault conditions
- withstanding loads due to climatic conditions applicable to the site of installation.

The sag of the cable between support points shall not exceed the maximum value specified by the cable manufacturer.

All components of the cable installation shall be free from sharp edges and burrs. Where the cable route changes direction, the cable installation system shall allow the cables to be installed in compliance with the following requirements from the cable manufacturer:

- minimum bending radius
- maximum sidewall bearing pressure.

If there is a risk of vehicle impact damage, additional mechanical protection shall be provided for the cable installation.

The design documentation shall clearly demonstrate that the above requirements have been considered and are satisfied by the design configuration.

5.5 Materials

Above ground cable installations shall consist of materials that are compatible with the site environmental conditions and the design life of the installation. Metallic components used in railway tunnels shall consist of stainless steel, with a resistance to corrosion property equivalent to grade 316 or higher.

Mild steel components shall be hot-dip galvanised to AS/NZS 4680. Mild steel threaded fasteners shall be galvanised to AS/NZS 1214.

See Section 7 for fire life safety requirements for installations in railway tunnels and underground railway stations.

5.6 Environment

The minimum design life as specified in TS 03751 shall be achieved in the environment of the cable installation. The following factors shall be considered by the designer as a minimum:

- vibration from rail traffic or other sources
- solar radiation
- ambient conditions in accordance with TS 03744
- conditions that accelerate corrosion.

The design of the cable installation configuration shall include mitigation measures for hazards from project specific environments. Examples of such hazards include the following:

- falling rocks where the cable route is located at the bottom of a cutting or embankment
- strong winds
- bush and grass fire
- vermin.

The visual impact of above ground cable installations on the environment shall be considered by the designer. Attachment to heritage-listed structures shall require approval by the relevant environmental authorities.

5.7 Thermal expansion

Above ground cable installation configurations shall allow for thermal expansion of the cables and components of the cable support assembly.

At locations where the cable or other components of the cable installation are rigidly restrained, the arrangement shall be capable of withstanding thrust due to thermal expansion at the maximum design temperature.

Where the cable route is located on a structure and traverses an expansion joint of the structure, the design of the cable installation configuration across the expansion joint shall allow for the movement of the structure components associated with thermal expansion and contraction. The design shall be assured for all the following aspects for the entire design temperature range:

- clearance between the cables and the structure, and other components attached to the structure
- radii of bends in the cable are greater than the minimum specified by the cable manufacturer
- maximum sidewall pressure on the cable specified by the cable manufacturer is not exceeded.

Sufficient slack in the cable shall be provided between cable support points to allow for the thermal expansion and contraction of the cable. The cable support arrangement shall have adequate strength to withstand stress resulting from the thermal expansion and contraction of the cable.

Details of expansion joints of the cable support system and the cable support arrangement at or near structure expansion joints shall be documented on design drawings.

5.8 Cable cleats

Cable cleats and intermediate restraints shall comply with IEC 61914. Cable cleats and intermediate restraints shall be AMB type approved. Cable cleats and intermediate restraints shall be resistant to electromechanical forces, withstanding more than one short circuit in accordance with IEC 61914. Cable cleats shall also have other classifications in accordance with IEC 61914 as appropriate to the design application requirements.

For installation in railway tunnels, cable cleats and intermediate restraints shall comply with the following requirements:

- be of metallic or composite material and in accordance with the requirements of Section 5.5
- have a high resistance to corrosion.

Single-core HV ac cables shall be arranged in close trefoil as far as practicable. Single-core HV ac cables shall be secured with cable cleats, and intermediate restraints where used, at appropriate intervals to withstand the electromagnetic forces under electrical fault conditions.

The structure supporting the cable cleats shall be capable of withstanding the loads transferred from the cleats. The maximum load supported by cable cleats, and the spacing between the cleats, shall be provided to the civil designer.

Where cable cleats are installed within a cable support system, adequate clearance shall be provided between the cable cleats and other components of the cable support system, such as trunking length covers.

5.9 Earthing and bonding

Metallic cable support assemblies shall have provisions for earthing and bonding complying with the requirements in TS 03677 and TS 03743 and the recommendations of TS 03676.

Insulation breaks shall be aligned with those of other services as far as practicable.

Above ground cable installation consisting of continuous metallic structures shall have a minimum clearance of 2 m from 1500 V overhead wiring structures where practicable. Where it is not practicable to provide this minimum clearance, the risks of transfer potential and dc stray current may be mitigated by one of the following provisions:

- an insulation break shall be installed on each side of the overhead wiring structure at a distance of between 2 m and 2.5 m from the edge of the overhead wiring structure
- other mitigation measures approved by the earthing and bonding designer, and documented on design drawings.

Above ground installation of HV ac cables in the open route shall comply with the earthing requirements of AS 2067.

5.10 Accommodation of cable joints and terminations

Where a cable joint or termination is located in an above ground cable installation, the design of the cable support arrangement shall comply with TS 03757.

The location of the cable joint or termination shall allow for ready access, repair and replacement of the cable and cable accessories.

5.11 Ground clearance

Cables and components providing direct support to the cables, such as trunking lengths, shall have a minimum vertical clearance of 500 mm to the ground level.

This requirement does not apply to locations where cables transition from an underground to an above ground configuration.

5.12 Separation from other services

5.12.1 General

Network reliability, maintainability and other requirements as set out in TS 03751, and the recommendations of TS 03746, shall be satisfied in determining the separation of cable installations from other services.

The separation from other services shall be adequate to allow for the access, repair and replacement of the cable.

Additional separation requirements are provided in Sections 5.12.2, 5.12.3, 5.12.4 and 5.12.5.

5.12.2 Separation from low voltage cables

Separation from low voltage cables shall comply with the requirements of AS/NZS 3000.

5.12.3 Separation from signalling cables

Separation from signalling cables shall comply with the requirements of TS 05164.

5.12.4 Separation from communication cables

Separation from communication cables shall comply with the requirements of TS 06210 and AS/CA S009.

5.12.5 Separation from other cables and services

HV and 1500 V dc cables shall not share the same enclosure or the same cable tray with other services or cables of another feeder.

Dedicated communication cables associated with HV protection schemes and distribution temperature sensing cables associated with HV cables may be installed in the same enclosure or on a common support component for the HV cables.

Where there is a risk that a single event may cause the failure of more than one feeder, the following conditions shall be satisfied:

- arrangement and details are documented in a design drawing
- the risk to network reliability is assessed and documented by the designer
- the arrangement is endorsed by the maintainer.

In addition, a design configuration with an over-track crossing on an OHW structure, or other portal structure, that carries multiple feeders of HV ac or 1500 V dc cables shall be approved by AMB.

5.13 Combined services route

Cable installations for HV and 1500 V cables and other services may be supported by common structures in a combined services route. For example, the trunking for an HV cable and another trunking for signalling cables may be supported by a common post.

5.14 Signs

The following permanent signs shall be installed on or next to the cable route in a conspicuous manner, and at an interval of 20 m or less:

- ’Danger – High Voltage’ warning sign
- feeder identification showing the nominal voltage and feeder number.

Refer to TS 03741 for details of the ’Danger – High Voltage’ warning sign.

Feeder identification signs shall also be provided at locations where the above ground cable installation transitions to the following configurations:

- underground installation
- mounting on OHW structures
- over-track crossing.

Cable trunking systems shall be marked in accordance with AS/NZS 4296.

Cable tray systems and cable ladder systems shall be marked in accordance with EN 61537.

Cable cleats and intermediate restraints shall be marked in accordance with IEC 61914.

6 Installation above overhead wiring

Installations above 1500 V overhead wiring shall comply with TS 03799.

7 Fire life safety

Above ground cable installation in railway tunnels and underground railway stations shall comply with TS 01722.

Unless otherwise specified, cables and cable support components of above ground cable installation in cable tunnels and cable shafts shall comply with TS 01722.

Arrangements to control propagation of fire at cable penetrations through system substation walls or floors shall comply with TS 03885. Cable penetrations at other walls and openings shall be determined by the designer in accordance with project requirements and as determined by risk analysis. Details of the arrangement shall be documented in design drawings.

An AMB type approved coating may be applied to the cables to achieve the specified fire resistance requirements at a location. The effect of the coating on the current-carrying capacity of the cable shall be assessed by the designer.

8 Cable trunking systems

8.1 General

Cable trunking systems shall comply with AS/NZS 4296.

Cable trunking systems shall also comply with the requirements set out in Sections 8.2, 8.3, 8.4, 8.5, 8.6 and 8.7.

8.2 Properties

Cable trunking systems shall have the following requirements in accordance with AS/NZS 4296:

- metal
- solid
- suitable for heavy mechanical stresses
- do not propagate flame
- with electrical continuity
- IP22 or higher degree of protection in accordance with AS 60529
- medium protection against corrosive or polluting substances on the outside and inside
- high protection against solar radiation
- with covers that cannot be removed without the use of tools.

Open slotted and closed slotted trunking lengths may only be used in accordance with an approved design, and supported by a documented risk analysis.

The properties shall be maintained in the cable trunking system through joints and couplings of the system. Materials used in expansion and insulation joints shall comply with the requirements for protection against corrosion and solar radiation, but these joints do not need to satisfy the other requirements.

Cable trunking systems shall not allow water to accumulate inside trunkings.

Cable trunking systems used in railway tunnels, cable tunnels and cable shafts shall have halogen-free classification.

8.3 Cover retention

Covers shall not be fixed by screws, unless barriers are provided to protect the cables from damage by the screws.

The cover retention arrangement shall allow for ready access to the cables for maintenance purposes. The length of a cover shall not be more than 3 m. The cable trunking arrangement shall allow for the removal of the cover by one person.

8.4 Eddy current loss

Single-core HV ac cables shall be arranged in close trefoil formation as far as practicable.

Cables installed within an enclosure that can form a magnetic circuit around the cable shall be dimensioned to allow for loss due to eddy currents.

8.5 Thermal insulation

Where thermal insulation material is installed within or on the cable trunking system to mitigate the risk of cable damage from fires, the designer shall assess the effect of the thermal insulation on the current-carrying capacity of the cables.

8.6 Transition from underground to overhead poles

Where cables transition from an above ground cable trunking system to a UGOH pole, the cables shall be mechanically protected to a height of 2.4 m from any surface on which a person can stand.

The arrangement shall prevent climbing of the UGOH pole from any standing surface without the use of greater than normal agility, tools or climbing aids.

To facilitate pole base maintenance for wood poles, the ground around the pole and within 300 mm from the edge of the pole shall be able to be readily excavated to a depth of 450 mm with hand tools.

An insulated joint shall be provided in the cable trunking system at a distance of 2 m from the edge of the pole, or as nominated by the project earthing design.

8.7 Transition to 1500 V dc overhead wiring structures and over-track portal structures

An insulated joint shall be provided in the cable trunking system at a distance of 2 m from the structure, or as nominated by the project earthing and bonding design.

The requirements for the provision of safety screens and barriers shall be determined in accordance with TS 03794.

9 Cable ducting systems

Cable ducting systems shall not be used for above ground installation of HV ac and 1500 V dc traction power supply cables.

This requirement does not apply to locations where cables transition from an underground duct system to an above ground configuration.

10 Cable tray systems and cable ladder systems

Cable tray systems and cable ladder systems shall only be used in secure environments, and where there is no risk of vehicle impact damage. Examples of such environments include the following:

- inside a building and not accessible to members of the public
- within a railway tunnel
- within a cable tunnel or cable shaft, with access restricted to maintenance staff
- within a cable pit.

Cable tray systems and cable ladder systems shall not be used in the open route, and in areas that are normally accessible to the public.

Cable tray systems and cable ladder systems shall have the following classifications in accordance with EN 61537:

- metallic
- non-flame propagating
- with electrical continuity
- electrically conductive
- class 9B resistance to corrosion for systems used in railway tunnels; class 7 minimum for use in other environments
- impact resistance up to 5 J.

These properties shall be maintained in the cable tray system or cable ladder system through joints and couplings of the system. Materials used in expansion and insulation joints shall comply with the requirements for protection against corrosion, but the joints do not need to satisfy the other requirements.

Cable tray systems shall not allow water to accumulate on cable trays.

Where covers are provided, they shall be secured so that they cannot be removed without the use of tools. Covers shall also comply with the requirements of Section 8.3.

Cable tray systems and cable ladder systems used in railway tunnels, cable tunnels and cable shafts shall be halogen-free.

11 Cables with no enclosure and supported by cable cleats only

Configurations with no enclosure for HV ac and 1500 V dc traction power supply cables shall only be used in the following environments and conditions:

- within a substation
- within a railway tunnel
- within a cable tunnel or cable shaft, with access restricted to maintenance staff
- within a cable pit
- on a UGOH pole at a height of more than 2.4 m above any surface that a person can stand on
- on an OHW structure or over-track crossing portal structure in accordance with an approved design and the requirements of TS 03799.

Cable cleats and intermediate restraints shall comply with the requirements of Section 5.8.