Government of South Australia
Department for Infrastructure and Transport

Public Transport Standard: Electrical Infrastructure Engineering – Design

Asset Management

CS5-DOC-003511

DOCUMENT AMENDMENT RECORD

REV	CHANGE DESCRIPTION	DATE	COMMENTS
1	Initial Issue	08/09/11	
2	Changes in various sections	27/07/12	
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5	Update for PTSA. Changes to lighting level tables, luminaire tables and numerous enhancements. MOCs KDA2621525 and TC 096.	27/03/25	
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1. Introduction

This standard specifies the requirements for the design of Electrical Infrastructure and Lighting Systems for all Adelaide Public Transport Networks.

2. Purpose

The purpose of this Standard is to outline the design requirements for the Electrical Infrastructure, Lighting Systems and Pit & Conduit systems at all public transport assets on the train, tram and bus networks.

3. Scope

This Standard applies to all projects and to contractor organisations designing, constructing, or maintaining electrical infrastructure associated with rail passenger stations and tram or bus stops for all South Australian metropolitan public transport networks.

4. Related Documents and Drawings

DOCUMENT NAME	DOCUMENT NUMBER
Typical Single Line Diagram for an Electrified Railway Station	004-A2-12-115
Standard Drawing – Stations – Lighting Control Requirements – Functional Diagram	CS4-DRG-359802
Standard Drawing – Tram Stops – Isolated Power and Lighting – Typical Schematic Diagram	CS2-DRG-365211
Standard Drawing – Pedestrian Crossings – Lighting Control Requirements – Functional Diagram.	TC4-DRG-200014
Standard Drawing – System Electrical – Small Indoor Distribution Board with DALI Control – Layout and Equipment Details	CS5-DRG-365195
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Standard Drawing – Stations Electrical Services – Lighting Pole Internal Wiring – Equipment Arrangement	CS4-DRG-350285
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Standard Drawing – Pole-Top Adaptor, 60mm OD	CS5-DRG-362557
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System Electrical – Switchboard Cubicle – Outdoor, Weatherproof, Pad Mount	004-A1-80-524
Typical Electrical Arrangement for a Neighbourhood Rail Station	004-A2-11-033

DOCUMENT NAME	DOCUMENT NUMBER
Communications, General – Details of Enclosure for Shelter Power Outlet	624-A3-11-317
Standard Drawing – Stations, Electrical Services – Typical GPS Time Switch Arrangement for Neighbourhood Stations	CS1-DRG-360129
Seaford Line – Goodwood Underpass – Maintenance Lights Remote Control – Circuit Diagram	CS1-DRG-350295
Standard Drawing – Bicycle Enclosure – Card Reader Circuit Diagram	CS5-DRG-350182
Standard Platform Details – General Assembly of Cage & Mirror	735-A1-10-197
Standard Platform Details – Recessed Enclosure for Power Outlet in DTEI Mirror Pole	735-A2-11-029
Standard Platform Details – Typical Installation and Footing for Mirror Poles	735-A3-10-164
Electrical and Mechanical Clearances for the 25 kV Electrified Train Network	TP1-DOC-000389
Public Transport Standard: Earthing & Bonding (was AR-PW-PM-SPE-00129002, D Part 061)	TP4-DOC-003507
Public Transport Standard: Security Systems (was AR-PW-PM-SPE-00129015, D Part 075)	PI5-DOC-003512
Public Transport Standard: Passenger Information Systems for Rail (was AR-PW-PM-SPE-00129016, D Part 076)	PI1-DOC-003513
Public Transport Standard: Equipment Room – Engineering – Design (was AR-PW-PM-SPE-00129017, D Part 077)	CE5-DOC-003514
Technical Standard – Photovoltaic Power Supply Systems	CS5-DOC-003595
Public Transport Standard: Design – Stations – Toilet Facilities (was AR-PW-PM-SPE-00129008, D Part 067)	CS1-DOC-003510
Lifts for Public Transport Infrastructure	CS1-DOC-002336
Supply and Installation of Conduits and Pits	RD-EL-C3
Pit and Conduit Standard for Signalling and Communication Cables	PTS-MS-10-SG-STD-00000094
Railway Inspection, Testing and Commissioning	PC-RW50
Road Lighting Design	RD-EL-D1
Conduit Design for Road Lighting, Traffic Signals and ITS	RD-EL-D3
PTSA's Wayfinding Rulebook	–

5. References

- AS 1158 Lighting for Roads and Public Spaces (Set)
- AS 1680 Interior and Workspace Lighting
- AS 1735.2 Lifts, escalators and moving walks – Passenger and goods lifts – Electric
- AS 1742.3 Manual of uniform traffic control devices – Traffic control for works on roads
- AS 2053 Conduits and Fittings for Electrical Installations
- AS 2293.1 Emergency escape lighting and exit signs for buildings – system design, installation and operation
- AS 2648.1 Underground marking tape – Non-detectable tape
- AS 3000 Electrical Installations (Wiring Rules)
- AS 3008.1.1 Electrical Installations – Selection of Cables – Cables for Alternating Voltages up to and Including 0.6/1 kV – Typical Australian Installation Conditions
- AS 3013 Electrical Installations – Classification of the fire and mechanical performance of wiring system elements
- AS 3084 Telecommunications installations – Telecommunications pathways and spaces for commercial buildings
- AS 3100 General Requirements for Electrical Equipment
- AS 3996 Access Covers and Grates
- AS 4312 Atmospheric Corrosivity Zones in Australia
- AS 4282 Control of Obstructive Effects of Outdoor Lighting

- AS 60076.11 Power Transformers – Dry-type Power Transformers
- AS 61558.1 Safety of Power Transformers, Power Supplies, Reactors and Similar Products
- AS 61558.2.4 Safety of Power Transformers, Power Supplies, Reactors and Similar Products. Requirements and Tests for Isolation Transformers and Power Supply Units incorporating Transformers.
- AS/NZS CISPR15 Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment
- DSAPT Disability Standards for Accessible Public Transport
    - Digital Addressable Lighting Interface (DALI) (Set)
- TS 085 – 2006 Trenching and Conduit Standard for Underground Cable Networks – South Australian Power Networks (SAPN)
- TS 087 – 2005 Construction Standard (SAPN)
- TS 100 – 2006 Electrical Design Standard (SAPN)
- TS 102 – 2005 Easement Standard (SAPN)
- TS 105 – 2007 Testing Standard (SAPN)
- WEBB Lighting Report, 2004 Queensland Rail Network – Lighting of Station Environment to Comply with Disability

6. Application

Railways have ‘stations’, while tramways and buses have ‘stops’. Throughout this document the term ‘station’ is used for convenience, but all requirements herein, unless specifically noted, apply equally to:

- heavy rail stations on the Adelaide Metropolitan Rail Network (AMPRN);
- tram stops on the AMPRN’s tram network,
- bus Infrastructure (interchanges, car parks, the O’Bahn, etc.) and
- other public transport infrastructure as required (for example, underpasses, car parks, and Park ‘n’ Rides).

7. General

The design works for station projects must include, but are not limited to, the following items:

- new mains power supply connection or existing mains power supply upgrade;
- electrical infrastructure;
- lighting system;
- consideration of future works; and
- design works necessary to isolate the 25 kV or 600 V traction return from the incoming utility supply Multiple Earth Neutral (MEN) and to prevent circulating or traction fault current in the neutral of station supplies.

Note: *For additional requirements for isolation in electrified areas, refer to standard TP4-DOC-003507.*

8. Design Requirements – Reticulation

8.1. SAPN Supply Point

The Contractor must design the power loading for the station and organise any SAPN upgrade required to the electrical supply point and associated infrastructure to meet the power demands of the new or upgraded station, plus a 30% minimum factor for future increases.

Sites where there is a tenancy must have two separate supplies—one for the Department and one for the tenant.

Sites incorporating large pumping stations for corridor de-watering will require two separate supplies—refer to section 9.9.11 below.

8.2. Site, Platforms and Structures

The Department's standard pits and conduits must be utilised on site wherever practicable. Conduit routes must comply with the following:

- utility services required to traverse the rail corridor at a site with an overpass must use the overpass structure;
- utility services required to traverse the rail corridor at a site without an overpass must be via undertrack conduits in accordance with *PTS-MS-10-SG-STD-00000094 – Pit and Conduit Standard for Signalling and Communication Cables*.
- a minimum distance of 300mm must be maintained between structure footings and conduit trenches;
- conduit for shelter luminaires must be reticulated in the cavity of the Alucobond station sign—refer drawing *No. S7071*, sheet 22;
- With the exception of the fourth dot-point above, all electrical cables and conduits must be concealed within the shelter structural framework—fabrication and construction techniques must be co-ordinated to accommodate this requirement;
- Where conduits cannot be practically concealed within the structure, cabling may be fixed to the exterior of the structure within a galvanised metal conduit in a continuous run to a minimum height of 3 metres with the prior approval of the Department; and
- All shelter cable entries require access to the concealed cables. Access covers must comprise flush cover plates as shown on drawing *624-A3-11-315 Details of Conduit Entry into Shelter Columns or Poles*. Covers must be fixed with M6 anti-vandal metal-thread fixings (larger size bolts must not be used).

8.3. Enclosed Areas

Enclosed areas include the Common Equipment Room (CER), bicycle enclosure, toilet facilities and waiting rooms.

Conduits from a pit adjacent to the enclosed area must penetrate through the floor slab. Conduits must be installed within wall cavities and ceiling space (where available) to provide simple cable access to enclosed areas.

8.4. Co-ordination

- The Contractor must co-ordinate the electrical services design with the design requirements of:
  - *TP4-DOC-003507 – Public Transport Standard: Earthing and Bonding on Electrified Train or Tram Territory;*
  - *PI5-DOC-003512 – Security System; and*
  - *PI1-DOC-003513 – Passenger Information System for Rail; or*
  - *PI6-DOC-003515 – Passenger Information System for Trams and Buses.*
- Early investigation of existing power supply requirements must be undertaken to determine if the existing supply is satisfactory for new demands. The Contractor must allow for all requirements to connect new power demands to an existing power supply;
- Contractors must adhere to all relevant standards and regulations, with all required approvals and licences obtained from relevant third parties and stakeholders; and
- Where practical, lighting may share 'joint-use' (camera) poles with CCTV cameras, refer to *PI5-DOC-003512 – Security System* for camera pole requirements.

8.5. Labelling

All significant items of equipment must be labelled. The Contractor must allocate appropriate designations for transformers, switchboards, cables, circuits, light poles

and camera poles. Labels must correspond to the terminology and identifying number of the respective item. Labels must be in English, legible, permanent, and robust, and must comply with the requirements of *AS 3100: General Requirements for Electrical Equipment* as a minimum. Also refer to section 12.6 below.

9. Design Requirements – Electrical Infrastructure

9.1. Power Distribution Network

- The power distribution network must provide power supply to the station precinct as required.
- For new or large sites, the power supply must be a 400 V, 3 phase, 50 Hz system and the designed electrical network must be capable of supporting this system. For small, upgraded train or tram sites, it may be possible to retain (and upgrade) the existing single-phase supply.
- The maximum electrical power demand of the station must be calculated in accordance with *AS 3000: Electrical Installations (Wiring Rules).*
- A minimum of 30% spare capacity must be allowed for future or unknown loads/demands.
- The power distribution network will include all or part of the following components in quantities as required:
  - Power Transformer;
  - Main Switchboard (referred to as the MSB);
  - Isolation Transformer;
  - Main (isolated) Distribution Board (referred to as the MDB);
  - Sub-Distribution Boards (referred to as DB2 – DBn);
  - DALI lighting control system, cabling and wiring;
  - Cabling including consumer mains cables and sub-main cables;
  - Sub-circuits and associated cabling and wiring;
  - Cable pits, conduits, and ducts;
  - Power Monitoring System; and
  - Earthing System.
- All aspects of a train station or tram stop's electrical system must be designed and installed strictly in accordance with *TP4-DOC-003507 – Public Transport Standard: Earthing and Bonding* and with reference to either drawing *004-A2-12-115 Typical Single Line Diagram for an Electrified Railway Station* or *CS2-DRG-365211 Tram Stops – Isolated Power and Lighting – Typical Schematic Diagram.*

9.2. Power Transformer

- Large public transport sites may require their own supply transformer. Power transformers must be in accordance with the Electricity Supply Authority's specification.
- On rail sites, the power transformer must be placed outside the Over-Head Contact Line Zone and Pantograph Zone (OHCLZPZ) and at least 2.5 m away from any structure that is bonded to the Common Bonded Earth of the AMPRN.
- The transformer must be earthed such that the earthing system impedance (with the traction earth bond disconnected) must comply with *AS 3000*: *Electrical Installations (Wiring Rules)*, Clause 5.7.4.
- Refer to the Earthing and Bonding (E&B) Guidelines, noting that the sheaths of incoming HV supply cables are required to be gapped, in compliance with the Guidelines, if a 2.5 metre separation from structures to the Common Bonded Earth cannot be achieved.

9.3. Main Switchboard

- All of PTSA's public transport assets require a metered supply.

- The switchboard which houses the Retailer's metering device will be referred to as the Main Switchboard (MSB).
- The MSB must supply power to Distribution Boards (if any) and may also incorporate sub-circuits for lighting and power as suitable. On electrified traction territory, often the MSB's role is solely to feed the isolation transformer, however it may also feed non-isolated loads such as a carpark, as indicated on drawing *004-A2-12-115*.
- The MSB is usually outdoors and is usually made up of a minimum of two separate compartments:
  - A metering section for the Retailer's meter and Main Switch (Meter Isolator) and, possibly, the Service Fuses. The lock for this compartment must be keyed to PTSA's 'K9800CM'.
  - A distribution section to supply power to Distribution Boards (if any) along with any local sub-circuits for lighting and power as suitable. This compartment must be keyed to 'K9800'.
- The MSB must be able to cater for the maximum power demand plus a minimum of 30% additional capacity.
- All MSBs must be provided with a white Communications conduit—refer to Section 9.8 below.

9.3.1. MSB Location and Construction

- The MSB is usually an outdoor, free-standing, pad-mounted cubicle. Alternatively, suitably small boards can be mounted onto the outside wall of an Equipment Room.
- It must be located such the Retailer's staff (agents) can access the metering compartment without needing to enter the rail corridor.
- Outdoor switchboards must be constructed of heavy-duty pre-galvanised sheet steel or aluminium. Powder-coated stainless steel must be used if the board is located in a coastal area that may be regarded as Category C4 to *AS 4312*: *Atmospheric Corrosivity Zones in Australia.*
- Outdoor switchboards must:
  - Be built to minimum ratings of IP56 and IK07;
  - Have 3-point locking on doors equal to or taller than 500mm;
  - Be fitted with heavy-duty 'swing handles' (Select Lock or equivalent) that can accept either a C4 pin tumbler lock or a padlock. Locks must be keyed to the Department's standards, as above;
  - Have their compliance/rating plates mounted inside;
  - Be labelled externally using aluminium or stainless-steel labels laser cut fully through;
  - Have their fixings located inside the galvanised plinth;
  - Be fitted with vents (passive cooling);
  - Be fitted with two-stage fans and 5-sided heat-shields of IK07 rating if the enclosure contains lighting control or other electronic equipment;
  - Have an internal switched light;
  - Have door stays fitted; and
  - Be finished in UV-stabilised powder-coat paint, coloured mid-grey or to the project's specification, subject to approval.
- Refer to section 13.2.1 below for information regarding earth-rod pits.
- A plastic cable pit must be cast into the concrete surround under the switchboard, generally as shown on drawing *S-4055, sheets 43 and 54*.
- A typical small MSB is shown on drawing *004-A1-80-524.*

Note: *This section forms the basis of a specification for any PTSA outdoor enclosure, whether for electrical or communication purposes.*

9.4. Isolation Transformer

- The purpose of an isolation transformer is to isolate the Electricity Supply Authority's power network from the rail Mains supply. The transformer is normally located within the rail corridor and must be no less than six metres from the MSB and the Authority's MEN earth stake.
- The isolation transformer(s) must comply with the manufacturing and installation requirements set out in Appendix 1. Drawing *TP4-DRG-004185* provides detail for the manufacture of small (15 kVA) transformers and guidance for larger units.
- All wiring associated with the transformer must be double insulated and primary and secondary cables/wiring must be physically segregated. By way of example, they must not share the same conduit or terminal box.
- Isolation transformer enclosures must have the same construction specifications as outdoor MSBs.

9.5. Main Distribution Board

- There will be a distribution switchboard 'downstream' from the MSB, which will be referred to as the Main Distribution Board (MDB). On electrified traction rail territory, the MDB will be fed from the isolation transformer.
- The MDB will contain the main lighting and power sub-circuits and also must have provision to house the DALI lighting control system.
- The MDB must be installed inside the equipment room so that the lighting control electronics benefit from the air-conditioned environment.
- The MDB must provide a minimum of 30% spare capacity.
- An indoor cabinet must:
    - Be of medium-duty pre-galvanised sheet steel construction, and;
    - Have side-by-side doors with one door housing distribution and the other containing only lighting control;
    - Have the control electronics mounted at an ergonomic height;
    - Have a socket outlet (GPO);
    - Have 3-point locking on doors taller than 600mm;
    - Have flush-mounted door handles (Kiroo A/HF8V Series or similar);
    - Be ventilated;
    - Be coloured orange; and
    - The lighting control equipment must have two colours of wiring duct installed with one colour being white (communications).
- A typical small MDB is shown on drawing *CS5-DRG-365195*.

9.6. Sub-Distribution Boards

- The station may have Sub-Distribution Boards (DB2 to DBn) as required, unless the MDB is relatively close to the loads.
- The number of sub-circuits crossing rail or tram tracks must be kept to a minimum; as such SDBs must be mounted on that side of the track that has the least number of consumers and loads.
- The SDB must be provided with a lighting 'Test' button and a DALI network port for the connection of a local laptop computer for maintenance purposes. It must not be necessary to open the board's internal escutcheon to access the port. A socket outlet (GPO) must be provided adjacent to the port. The port and power outlet may either be both external to the board or both internal.
- Note that a separate isolation transformer with an independent secondary connection to traction earth is required for SDB's in excess of 500m from the MSB. Refer to the E&B Guidelines.

9.7. Surge Protection

- All installations must be protected by a suitable surge protection device(s) in a suitable location.
- For large installations, both the MSB and the MDB must be provided with a surge arrestor device. For small installations, it may be sufficient to protect only the MDB or, in some cases, only the circuit feeding the control electronics.
- Units must be protected by a specialised circuit breaker designed for the task.
- Surge arrestors must be fitted with segregated, normally-closed alarm output terminals. The alarm output will be ELV and must be isolated from the mains circuits by a minimum of 4 kV. It must be fed to an input of the DALI lighting control and arranged to be remotely monitoring by the "MERLINS" application. ***Note**: Designers are reminded that, on electrified rail territory, the MSB's alarm signal will need to cross the 'isolation boundary' and so will need to be transmitted over optical fibre. (Relays or contactors are not considered to provide sufficient segregation.)*

9.8. Power Monitoring System

- At least one stand-alone 'Power Logic' Power Monitoring System (PMS) must be provided.
- The PMS must have the facility to be connected via Ethernet to a Central Monitoring System located in a remote location using Department approved software.
- All metering devices within the switchboards, except for the Retailer's supply meter, must be connected to the PMS. The PMS cables must be reticulated through communications conduits. Co-ordination with other communications system cables is required for conduit allocation.

9.9. Sub-Circuits

- The Contractor must specify each sub-circuit on the switchboard's single line diagram and allocate supply phases to each circuit to balance the load across the phases. In three-phase lighting sub-circuits, only one phase must enter the pole and be connected to the luminaire.
- Below is a list of sub-circuits (comprising of protective devices, conduit runs and cables) for stations.

9.9.1. Lighting

Lighting circuits include but are not limited to:

- Platforms;
- Shelters;
- Bus Interchanges;
- Lifts, Stairs and Overpasses;
- Primary access and access paths;
- Bicycle Enclosure;
- Equipment Room;
- Car Parks; and
- Subways.

9.9.2. Power outlets including Shelter and Bicycle Enclosure General Purpose Outlets

- IP 56 outdoor rated 15 A, 240 V switched power outlets must be provided every 40 m of sheltered platform, mounted with a height of 1900–2000 mm above the finished platform surface.
- The outlets must be recessed into a shelter column, flushed to the exterior, fitted with a padlock-able cover and locked with an "M" padlock

which must not be located on an access path to avoid injury. The general-purpose outlet must be installed with its face perpendicular to the track. Refer to drawing *624-A3-11-317– Details of Enclosure for Shelter Power Outlet* for details.

- One secured IP 56 outdoor rated 15 A 250 V switched power outlet must be provided on a structural column within the Bicycle Enclosure at a height of 1900–2000 mm above finished floor level and secured with an 'M" padlock.

9.9.3. Alucobond Sign-trough Lighting

- Aluminium composite troughs are incorporated into new station shelters. The station name is normally routed into the trough and back-lit. The LED drivers must be DALI compatible so that they can be controlled and remotely monitored (refer to section 11.11.1 below).
- Its portion of the trough should be covered to prevent light spill.
- This light(s) should be fed from one of the shelter's lighting circuits and programmed to remain on all night.

9.9.4. Commercial Advertising Signs and Vending Machines

- Third-party advertising signs or vending machines may be supplied from the Department's switchboards under commercial agreement. Both types of load must be fed from multiple, dedicated, RCD-protected circuits to ensure that a fault does not cause any of the Department's apparatus to lose power.
- A dedicated switched socket outlet should be provided for each vending machine. The socket must be auto-switched and of the type that accepts a threaded (locking) plug and the plug should be threaded to avoid inadvertent disconnection. To mitigate vandalism, the socket outlet and plug should be housed in a metal enclosure mounted above the machine.
- The wiring for lighting of signs must have a clear point of delineation so that the sign's maintenance staff can isolate its power without the need to gain access to the switchboard. The delineation is typically a weather-proof, double-pole isolator mounted on the back of the sign.
- Vending machines should be located:
  - with their back against a wall to deter vandalism;
  - with consideration of CPTED principles;
  - outside of pedestrian walkways;
  - as close as practicable to a mains power source; and
  - in an area monitored by CCTV.

9.9.5. Ticket Vending Machines

The requirements for the Department's ticketing machines are similar to those for commercial vending machines above.

9.9.6. Illuminated Station Name Signs

- Some public transport infrastructure has illuminated signs showing the destination's name. These are identified in PTSA's Wayfinding Rulebook as 'AMid710'.
- Each sign must be fed from a circuit breaker in the light pole nearest to it and be fitted with an internal isolator switch.
- The LED drivers must be DALI compatible so that they can be controlled and remotely monitored (refer to section 11.11.1 below).
- The signs should be programmed to remain on all night.

9.9.7. Heated Mirrors

- Heated mirrors must be installed wherever driver mirrors are required as per *CS1-DOC-003508 – Public Transport Standard: Design – Stations – Platforms* Clause 6.7, "Train Driver's Platform Sighting Mirrors".
- A socket output (GPO) must be provided on each mirror gantry. It must be mounted on the same side of the gantry pole as the mirror and be recessed into the pole as per drawing *735-A2-11-029*. It must be weatherproof to IP66 and incorporate double-pole automatic switching. The mirror outlets must be on a discrete circuit(s) controlled by the lighting control system to allow the mirror heaters to be controlled as follows:
  - A Humidity & Temperature Transducer, together with its associated Radiation Shield, must be provided and its sensor must be installed at the same height as the mirrors (or within 500mm lower). It must be interfaced to the lighting control system via RS-232 data communications (or equivalent).
  - Power to the mirrors must be controlled using an algorithm based on train services (as for the lighting control) and a measurement of when the ambient temperature is approaching the dew-point temperature. This difference must be user programmable (typically set to 2°C).
- Note that heated mirrors (or any light fittings) within the Overhead Contact Line Zone and Pantograph Zone (OHCLZPZ) are required to be bonded to traction earth and thus the protective earth conductor must not be terminated to prevent traction fault current flowing in this conductor to the SDB/MDB—refer to the E&B Guidelines.
- Mirrors must be manufactured to drawing *735-A1-10-197* and will be installed and aligned by the staff of PTSA's maintenance contractor.
- Drawing *735-A3-10-164* details the positioning of a typical mirror pole.

9.9.8. Facility Circuits

- **Equipment Room** – Where an equipment room is specified at a station, it must be air conditioned and include lighting, dedicated outlets and general-purpose outlets in accordance with CE5-DOC-003514 – *Public Transport Standard: Equipment Room*.
- **Stand Alone Toilet Facility** – A separate circuit (usually 32A) is required for those stations where a unisex self-contained toilet (Exeloo) is provided. Refer to document *CS1-DOC-003510 – Public Transport Standard – Toilet Facilities*.
- **Security System** – Refer to *PI5-DOC-003512 – Public Transport Standard: Security Systems*.
- **Passenger Information System for Rail** – Refer to *PI1-DOC-003513 – Public Transport Standard: Passenger Information Systems for Rail*.
- **Passenger Information System for Trams & Buses** – Refer to *PI1-DOC-003515 – Public Transport Standard: Passenger Information Systems for Tram & Bus*.
- **Bicycle Enclosure** – These require three circuits for: lights, a 15A GPO (refer to section 9.9.2 above) and power for a card reader ('validator'). This requires power and communications conduits – refer to drawing *CS5-DRG-350182 – Bicycle Enclosure – Card Reader Circuit Diagram*.

9.9.9. Lifts

A lift isolating switch must be installed at each lift controller. The current rating of the switch should be co-ordinated with the lifts' specialist sub-

contractor. Refer to specification *CS1-DOC-002336 – Lifts for Public Transport Infrastructure.*

9.9.10. Pedestrian Underpasses

- With reference to Tables 11.3.2 *Lighting Levels for an Open Station* and 11.4 *Luminaries for Public Transport Projects*, the luminaires in subways must be rated to IK10++ or higher. The lights in subways are exposed to extreme vandalism and graffiti.
- Some fittings must be of the battery-backed type and provide emergency illumination that complies with the level specified in section 11.7 below.
- Small sump pumps are located at stations with pedestrian subways. The pump must have its own circuit. All pumping faults are to be remotely monitored by PTSA's maintenance contractor and their specialist sub-contractor.

9.9.11. Large Pumping Stations

Large sump pumping systems are associated with 'lowered' stations and underpasses (for example, at Bowden and the Goodwood Dive).

Such pumping stations must:

- have redundant pumps;
- have redundant power transformers fed from separate SAPN feeders;
- have an Automatic Transfer Switch (ATS) feeding the pump switchboard;
- have a terminal enclosure for the connection of a generator set; and
- a pump control system that allows pumping faults to be remotely monitored by PTSA's maintenance contractor and their specialist sub-contractor.

It is preferable that the supply for an adjacent station is also fed from the output of the ATS (that is, the Pump MSB is also the station's MSB).

A communications conduit must be installed between the Pump MSB, the Pump Switchboard and the Equipment Room for monitoring of the ATS and pump status through the PMS System.

9.9.12. Track Maintenance or Incident Lighting

Critical areas of rail or track must have incident/maintenance lighting provided. Such areas include underpasses and viaducts.

- Rail Underpasses
  - (i) Lights must be provided on both sides of the tunnel and must be spaced to provide a minimum value of average horizontal illuminance ($E_{H\,AV}$) at floor level (rail fastenings) of 160 lux (with a target of 200 lux) and a Uniformity (= $E_{H\,MIN}/E_{H\,AV}$) of 0.5.
  - (ii) Similar levels of lighting must be provided over the storm-water sump(s) if this is located in the underpass.
  - (iii) The lights must be remotely controlled using a system providing on/off control from a (mobile) phone. The controller must be a 'Remote Lighting Controller' using an approved voice interface. (The Department's drawing *CS1-DRG-350295* refers.) The unit must be located adjacent to the lighting supply's switchboard and a 'Manual Override' (Test) switch must be provided as per the drawing.

- Viaducts
  (i) Where no other lighting is present, it must be provided over the walkways to permit safe egress by passengers in the event of an incident. The illumination must meet the horizontal requirements of Category PE1 to *AS 1158.3.1*.
  (ii) Local controls for the lighting must be provided along the length of each walkway and spaced 100–150 m apart. Each control point must provide on/off control of all the lights.
  (iii) The lights must be remotely controlled using a system providing on/off control from a (mobile) phone, as above.

10. Design Requirements – Various

10.1. Equipment Rooms – General

1. Refer to *CE5-DOC-003514 – Public Transport Standard: Equipment Room*.
2. Cables entering the equipment room via conduits must be routed to their final destinations via a system of cable trays or ladders. (Refer to section 10.4 below.)

10.2. Equipment Rooms – Below Ground Level

Where a station's Equipment Room is below natural ground level, it will be necessary to protect some cable pits against flooding by:

1. The incorporation of a pit drainage system, with a sump pump if necessary.
2. The installation of electronic (capacitive) proximity water sensors. The pit sensors must be wired to a Water Sensor Monitoring Unit in the equipment room. This facility must transmit these 'water detection' alarms to the pump's controller for transmission via its telemetry system.
3. The 'water detection' alarm must be remotely monitored through the DALI or PMS system.
4. Relevant pits must have an 80mm silt trap.

10.3. Photovoltaic Supply Systems

These systems must be designed and installed in accordance with *CS5-DOC-003595 – Standard – Photovoltaic Power Supply Systems*.

10.4. Cable Trays and Ladders

1. Cable trays must be installed as per the manufacturer's specifications.
2. All trays must be properly earthed as per *AS 3000* and be provided with proper segregation if required.
3. Cable trays must be powder coated to reduce sharp edges and identify services:
   a) Electrical cable trays must be powder-coated Orange.
   b) Comms cable trays must be powder-coated White.
   c) Special purpose trays must be Yellow.
4. All cable trays in accessible areas must be fitted with covers and be of the fully enclosed type.

10.5. Cable Trunking

Metal cable trunking must contain earthed segregated compartments if required to house more than one service.

10.6. General Design Principles

***Note**: The term "L1" is used herein to denote a lighting circuit that remains on all night, while "L2" denotes a lighting circuit that turns off (or dims) at night between the last evening service and the first morning service ('ALBF').*

1. Other then as described in section 9.9.11 above, there must be only one Mains supply point for a site. It is preferred to have long cable runs than to have multiple MSBs and retailer meters.

2. The Department's usual lighting control is to provide L2 circuits so that approximately half the site lighting dims down to 30–50%, or turns off, after hours (where practicable).
3. On new installations, this L2 function is supplemented by movement detectors which temporarily restore the lighting to full brightness and also send an alarm to the Department's security monitoring centre.
4. There are 'exception days' where L2 lighting circuits must stay on all night (L1) at train stations and tram stops. Currently, there are two exception days: New Year's Eve and Anzac Day.
5. Open car parks are usually arranged to be an L2 area and programmed to be dimmed after hours.
6. Enclosed/multi-storey car parks must have lighting control systems including movement detection, capable of being programmed for after-hours as well as day-time requirements.
7. All new public transport infrastructure must have emergency/exit lighting to comply with AS2293.1.
8. In general, different types of loads must not share a circuit (for example, a platform's ticket machine must not share a breaker with a Passenger Information Display, and, where there's two ticket machines, each must have its own circuit). This is necessary to ensure that a fault causes the minimum number of devices to lose power.

10.7. Other Design Elements for Existing Installations

- Where a time clock function is required at an installation without DALI control, and this cannot be provided, the time clock must be a GPS unit, complete with GPS antenna and of a type approved by the Department. It must be installed as per drawing *CS1-DRG-360129*. It must be programmed to handle daylight saving changeovers and, if appropriate, to have 'exception days' as described in section 10.6 above.
- Most basic 'neighbourhood' train stations and tram stops have electrical systems based on drawing *004-A2-11-033*.
  ***Note**: As shown on the drawing, the Department's usual arrangement is to have lighting controlled by a photo-electric sensor ('PE Cell') and to have the L2 function performed by a time clock 'in series with' the PE Cell. Control circuit arrangements with a PE Cell and time switch 'in parallel' are not appropriate.*
- Where a timer function is required at an installation without DALI control (for example, an Emergency Lighting test timer), the timer must be a mains digital type and of a type approved by the Department.
  ***Note**: The unit's LED indicator should be configured to be 'on' during the timing period.*

11. Design Requirements – Lighting System

11.1. General

The lighting system must include all of the following elements as required:

- Light poles;
- Luminaires complete with mounting and wiring; and
- Lighting control system.

On electrified railways and tramways, design must be in accordance with standard *TP4-DOC-003507 – Earthing and Bonding Guidelines*.

The following areas must be illuminated in accordance with Tables 11.3.1, 11.3.2 and 11.3.3 (Required Lighting Levels) below:

- Primary access and other paths;

- Platforms – both open and under cover;
- Passenger Information (PI) System displays and static timetabling;
- Ramps;
- Equipment room (where provided);
- Emergency Help Phones;
- Information Displays;
- Toilet facilities;
- Lifts, stairs, and overpasses;
- Bus interchanges and Kiss and Ride zones;
- Car parking;
- Bicycle facilities;
- Undercover (multi-storey) car parks;
- Bus shelters;
- Vending machines; and
- Pedestrian subways.

The Contractor must provide a complete and functional lighting system for the operational requirements of the site and the safety of customers at all hours of the day. It must be co-ordinated with the Security System design to ensure appropriate lighting levels are provided in the necessary locations to meet the system's functional requirements.

The lighting system must be designed to:

- Provide a minimal number of luminaires while meeting the light level requirements indicated in Tables 11.3.1, 11.3.2 and 11.3.3 (Required Lighting Levels) below;
- Ensure light spill to neighbouring properties is minimised and does not exceed the levels prescribed in the standards and in accordance with *AS4282: Control of obstructive effects of outdoor lighting;*
- Minimise glare to both customers and to train and tram drivers;
  Note: *Batten ('linear') luminaires must be mounted facing downwards. The use of batten fittings facing outwards on walls should be avoided and care should be taken with the use of up-tilt for pole-mounted luminaires. (Refer to section 11.12 below. Also, drawing CS4-DRG-350377 shows an example of the type of mounting bracket expected.)*
- Include a maintenance factor dependent on the type of luminaire as follows:
  (i) LED with regulated ('constant') output: 0.90;
  (ii) LED: 0.85;
  (iii) T5: 0.8.
- In a rail or tram environment, consider maintainability in an electrified traction environment by avoiding placing elements that require maintenance within the electrification clearance zone as described in the Department's specification *TP1-DOC-000389 – Electrical and Mechanical Clearances for the 25 kV Electrified Train Network;*
- Ensure light fitting locations are co-ordinated with CCTV cameras and selected to optimise CCTV images for the target light level whilst avoiding glare caused by light fittings appearing in the close in field of view of cameras;
- Ensure all side platforms have light poles located at the back of the platform;
- Ensure adequate light levels around Emergency Telephone locations; and
- Ensure that any structure does not impact signal sighting.

11.2. Lighting Design

- The lighting/electrical design must divide the station precinct into logical areas and each such area must be serviced by multiple single-phase circuits with luminaires

spread/spaced evenly between the circuits. The failure of one RCBO/circuit breaker should cause an even reduction in illumination across an area, and it must not be possible for the tripping of one RCBO to put an entire area into complete darkness. Three-phase lighting circuits/breakers must not be used.

- It is expected that lighting levels will be "over-designed" such that they can be dimmed down to the required values during commissioning.
- The lighting design should make use of the PTSA's lighting assets only—the contribution of any adjacent 'third-party' lights (for example, council) must not be relied upon.
  Exception*: tram stops in the Central Business District.*
- The design must avoid shadows and/or complex ground patterns which can be created on paths, stairs or ramps from the effects of fences and solid walls. This can be especially problematic for stations built below the natural ground level. The use of accurate 3D modelling is essential.
- The lighting calculations must be carried out to the appropriate standard.
- Daylight harvesting must be utilised where the building topology permits.
- Prior to commencement of design the designer must investigate the area surrounding the site to determine if any lighting or electrical elements that fall outside the scope of work are impacted by the new works. The Department must be informed should any of these elements be found to be non-compliant to current regulations and standards.
- Solar-powered lighting may be considered, provided that it meets the required lighting levels below and the battery backup provides sufficient days of operation without sun.

At each Design Stage Review the designer must submit a lighting design report incorporating the following data as a minimum:

- Design parameters and assumptions including limitations;
- Luminaire and light pole arrangement, co-ordinated with CCTV camera locations, including the use of joint use poles;
- Isolux contours for lighting levels across the Station Precinct and extending to the nearest residential boundary; and
- A tabulated summary table, with headings as per Tables 11.3.1, 11.3.2 and 11.3.3 of the designed light levels for all the station elements.

11.3. Required Lighting Levels

It is essential that light levels in various areas of the station precinct meet the DSAPT or Departmental requirements in Tables 11.3.1, 11.3.2 and 11.3.3 below.

11.3.1. Enclosed Stations and Tram Stops

An enclosed station is one that is fully surrounded with roof and walls, such as Adelaide Railway Station.

STATION ELEMENT	AVERAGE HORIZONTAL ILLUMINANCE	MINIMUM HORIZONTAL ILLUMINANCE	MINIMUM VERTICAL ILLUMINANCE (NOTE 1)	UNIFORMITY	UNIFORMITY
	$\overline{E}_H\ (lux)$	$E_{Ph}\ (lux)$	$E_{Pv}\ (lux)$	$U_1 = \frac{E_{min}}{\overline{E}_H}$	$U_{E2} = \frac{E_{max}}{\overline{E}_H}$
General areas	160			0.5	

STATION ELEMENT	AVERAGE HORIZONTAL ILLUMINANCE	MINIMUM HORIZONTAL ILLUMINANCE	MINIMUM VERTICAL ILLUMINANCE (NOTE 1)	UNIFORMITY	UNIFORMITY
	$\overline{E}_H\ (lux)$	$E_{Ph}\ (lux)$	$E_{Pv}\ (lux)$	$U_1 = \frac{E_{min}}{\overline{E}_H}$	$U_{E2} = \frac{E_{max}}{\overline{E}_H}$
Passenger Information Displays (excluding monitors), static signage and Emergency Help phones	200	–		0.5	–
Sheltered entrances, primary access paths, stairs, escalators, ramps and overpasses	150	–		0.5	–
Sheltered platforms	160	–		0.5	–
Yellow line at platform edge – sheltered platform	–	150		–	–

Table 11.3.1 – Required Lighting Levels for an Enclosed Station

11.3.2. Open Stations and Tram Stops

An open station means a station—or those portions of a station—which are essentially open to the sky. The platform may contain ticket offices, covered canopies (shelters), etc.

STATION ELEMENT	AVERAGE HORIZONTAL ILLUMINANCE	MINIMUM HORIZONTAL ILLUMINANCE	MINIMUM VERTICAL ILLUMINANCE (NOTE 1)	UNIFORMITY	UNIFORMITY
	$\overline{E}_H\ (lux)$	$E_{Ph}\ (lux)$	$E_{Pv}\ (lux)$	$U_1 = \frac{E_{min}}{\overline{E}_H}$	$U_{E2} = \frac{E_{max}}{\overline{E}_H}$
General areas	42	21	14	–	7
Under shelter and covered areas (on open platforms)	160			0.5	–
Yellow line at platform edge – open areas of platform	–	30	–	–	–
Yellow line at platform edge – adjacent to shelters	–	150 (Note 2)	–	–	–
Emergency Help Phones	200	–	–	–	–
Enclosed areas, including but not limited to Toilet Facilities, equipment rooms and bicycle enclosures	200	–	–	0.5	–
Access paths, ramps, stairs and overpasses	42	21	14	–	–
Pedestrian Subways	200 (Note 3)			0.5	
Any other area	As per AS 1158 and AS 1680				

Table 11.3.2 – Required Lighting Levels for an Open Station

11.3.3. Other Areas

STATION ELEMENTS	AVERAGE HORIZONTAL ILLUMINANCE	MINIMUM HORIZONTAL ILLUMINANCE	MINIMUM VERTICAL ILLUMINANCE (NOTE 1)	UNIFORMITY	UNIFORMITY
	$\overline{E}_H\ (lux)$	$E_{Ph}\ (lux)$	$E_{Pv}\ (lux)$	$U_1 = \frac{E_{min}}{\overline{E}_H}$	$U_{E2} = \frac{E_{max}}{\overline{E}_H}$
OUTDOOR CAR PARKS					
Accessible (Cat PCD in accordance with AS 1158)	35	14	7	–	10
Standard (Cat PC1 in accordance with AS 1158)	14	3	3	–	1
COVERED CAR PARKS					
	As per the requirements of AS 1680.2.1 and PC1 for the roof				
BUS INTERCHANGES					
Bus or integrated Bus and Rail Interchanges — sheltered areas	160	–	–	0.5	–
Separate Bus Shelters within the Station Precinct	160	–	–	0.5	–
Bus lane roadways	As per AS 1158 Category 'V' requirements				
PEDESTRIAN RAIL CROSSINGS					
Immediately adjacent to a station or tram stop	42	21	14	–	7
Intermediate (mid-block) rail crossings for pedestrians	20	10 (Note 4)	5	–	5
OTHER					
Bicycle, and shared bicycle and other access paths within the boundary of the Station Precinct that access the station from the public road network	In accordance with AS 1158 PP1(h) and PP2(v) levels, except where a higher luminance is required under DSAPT for accessibility				
Bicycle, and shared bicycle and other access paths adjacent to the boundary of the Station Precinct	In accordance with AS 1158 PP1(h) and PP2(v) levels				

Table 11.3.3 – Required Lighting Levels for Other Areas of the Station Precinct

Note 1: *Vertical illuminance is measured in a vertical plane at a height of 1.5m above finished floor level as required by AS 1158: Lighting for Roads and Public Spaces set. Refer to Appendix 2 for clarification regarding the calculation of vertical lighting levels on train and tram platforms.*

Note 2: *The DSAPT requirement is for 150 lux, but an allowance of 30 lux may be made for the contribution of spill light from the open doors of trains or trams while stationary—that is, 120 lux is required at other times.*

Note 3: *With regard to clauses 9.9.10 and 11.1 above, because of the extreme vandalism and grime experienced in subways, a very low maintenance factor should be assumed.*

Note 4: *Applies at the corridor boundaries and the centre of the tracks.*

11.4. Luminaires

Luminaire selection must meet the following criteria:

- Meet Australian Standards including without limitation *AS 3000:* Electrical Installations (Wiring Rules) and *AS/NZS CISPR 15*: Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment (EMC compliance).
  Note: *Documentary evidence of compliance to AS/NZS CISPR 15 is required.*
- Be of the Solid-State Lighting (SSL or LED) type.
- Fit for purpose and robust in construction;
- Minimum IP rating of IP55 for exterior locations (including covered spaces);
- Very good horizontal cut-off (*AS 1158.3.1*, type 5 or better);
- Very good rear cut-off;
- Constant light output (where available);
- Minimise life cycle cost;
- Be readily available, easily maintained and replaced;
- An expected design life of 15 years minimum;
- Energy efficient (low wattage and high output);
- 4000°K nominal Correlated Colour Temperature;
- A CRI > 70;
- High power factor > 0.9;
- Availability of a NATA (or equivalent) LM-63 tested and approved report with electronic photometric data in IESNA format. (Luminaires for *AS 1158*: *Lighting for Roads and Public Spaces Set,* Category 'V' designs should include electronic photometric data in CIE format.);
- Minimum 5-year warranty;
- The diffuser of batten ('linear') luminaires must not be fastened by clips;
- The body of external batten luminaires must be metal (for UV and vandal resistance;
- A minimum of IK10 impact rating, with higher values (for example, IK10+) for specific locations (for example, lower than 3 m mounting height);
- Additional requirements (IK10++ minimum) are needed for subway lighting;
- Minimum LED life of 90,000 hours to L90B10 with operation to > 40°C;
- Pole-mounted luminaires that are available with different characteristics (optical system and/or wattage) but which appear identical from ground level must be indelibly marked on the bottom of their body with the value of their particular characteristic(s) (for example, "S2 75W") in a lettering size readable from the ground; and
- Units with internal surge protection and a pressure compensation filter are preferred.

All luminaires must be safely accessible for maintenance purposes by ladder or mobile work platform. The mass of the luminaire must not exceed that which can be safely handled whilst working on a ladder or mobile work platform.

Luminaires on platform shelters must be integrated with the structure ensuring the following:

- Provide good quality and uniformity of light;
- Be concealed, protected or mounted to avoid vandalism;
- Be easily accessible for maintenance;
- Meet the architectural intent; and
- Limit light spill to adjacent precincts or residences.

The Department maintains a register of luminaires which have received approval for use under various categories (KNet document # 22854539), as shown in Table 11.4 below. Any proposed alternatives must:

- Be approved by Rail Asset Management and have a Product Technical File (PTF) provided in accordance with master specification PC-RW50; and
- Be tested by the Department to ensure full compatibility of their control gear with the requirements of the Department's control system.

Table 11.4 below indicates the luminaire selection for various public transport applications:

TYPE	SPECIFICATION	STATION ELEMENT
A	Compliant with Australian road lighting standards; LED luminaire (with Constant Light Output over life); Fitted with DALI dimmable driver; IK09 minimum rating and a UV-resistant body; Available with optional NEMA or ZHAGA socket; LEDs and reflectors shielded from angles above 90° elevation; IP 65 minimum; Simple access with control gear cavity secured by screws.	Open Car Parks. Open Areas other than Platforms and Car Parks.
B	LED luminaire (with Constant Light Output over life); Fitted with DALI dimmable driver; IK10 minimum rating and a UV-resistant body; Available with optional NEMA or ZHAGA socket; LEDs and reflectors shielded from angles above 90° elevation; IP 65 minimum; Simple access with control gear cavity secured by screws.	Open Platforms.
C	Surface-mount LED 'linear' luminaire with integral DALI dimmable driver; Highly vandal resistant — certified to IK10++ minimum impact rating; UV-stabilised, polycarbonate lens; IP65 minimum with metal body; Stainless-steel security fasteners or bar locking system; Option for integral maintained DALI emergency function.	Covered Areas, Enclosed Areas, Indoor Areas. Subways.
D	Surface-mount LED 'linear' luminaire with integral DALI dimmable driver; Vandal resistant — certified to IK10 minimum impact rating; IP65 minimum with metal body; Stainless-steel security fasteners; Option for integral maintained DALI emergency function.	Covered Areas, Enclosed Areas, Indoor Areas.
E	Optional recessed or surface-mount LED 'linear' luminaire with integral DALI dimmable ballast and various length options; Polarised electrical connectors between sections; Vandal resistant — certified to IK10+ impact rating; IP65 minimum; Option for integral maintained emergency function.	Tram stop shelters.
F	Surface-mount LED luminaire with integral DALI dimmable ballast and diffused refractor optics; Vandal resistant — certified to IK10+ impact rating; Option for maintained DALI emergency function and security locking screw; IP65 minimum; Suitable for low to medium mounting heights.	Covered car parks.
G	DALI LED Batten	Equipment Rooms.
H	LED Batten	Cleaners' Rooms, etc.

Table 11.4 – Luminaries for Public Transport Projects

Note: *Type C luminaires are recommended for low-height applications while Type D is recommended for mounting situations higher than 3 metres.*

11.5. Lighting Amenity

The lighting design should take a 'whole of journey' approach, considering the paths that people will take to access the public transport facility in all weather and at all times of day.

The addition of architectural lighting in the public transport precinct should be considered.

11.6. Control Gear

All lighting must be fitted with Digital Addressable Lighting Interface (DALI) dimmable drivers, offered with a warranty no less than five years.

This requirement includes any non-standard or architectural lighting that may be incorporated into the station precinct.

11.7. Battery-backed (Emergency) Lighting

Emergency luminaires must be provided throughout the installation on platforms and indoor areas. The provision and installation of emergency lighting must be in accordance with *AS 2293.1*: *Emergency Escape Lighting and Exit Signs for Buildings – System Design, Installation and Operation*.

Under loss-of-power conditions, an average lighting level of 1–2 lux must be provided under train and tram shelters, in station overpasses and subways, over stairs, etc. Lighting levels according to *AS 2293.1* must be provided in premises.

Permanently illuminated DALI-compatible 'EXIT' signs must be provided where required for safe evacuation of the precinct in accordance with the National Construction Code.

The battery packs must be of best contemporary, long-life technology Lithium-Ion or better type, taking into account the effects of temperature.

The lighting control system must provide for routine, automated testing and remote fault reporting for all battery-backed lights. For non-DALI sites, a local manual emergency lighting test facility in accordance with *AS 2293.1* and clause 10.7 above must be provided.

All battery-backed fittings must be:

- Wired in the 'maintained' mode (that is, luminaires must be switched normally as required, forming part of the illumination calculation for their respective area and, in the event of mains failure, the required light source must remain energised by the internal battery pack);
- Generally located in the row of fittings closest to the yellow line edge of the platform;
- Spaced as evenly as practicable; and
- Be suitable for automated DALI testing—that is, they must have two DALI addresses.

11.8. UPS System for Battery-Backed Lighting

With the Department's prior approval, an Uninterruptable Power Supply (UPS) system may be used to provide the emergency lighting function, as an alternative to individual batteries.

The UPS must have a network card and be compatible with the Department's approved interface software.

The Automatic Transfer Switch must be interlocked with the DALI control system.

11.9. Light Poles

11.9.1. Type of Light Poles for Roads, Interchanges or Open Carparks

These light poles may be medium-duty, octagonal, fixed, base-plate mounted poles with a maximum outreach of 4.5 m. Standard poles are 7 m (9 m with outreach), 8.5 m (10.5 m with outreach) and 10 m (12m with outreach) high galvanised 'impact absorbing' poles. However, the tilt-down poles in section 11.9.2 are preferred for use in open car parks.

Light fixtures for this application must be provided with a suitable adaptor to fit the pole tenon if not already compatible.

These poles must not be used for joint VSS (CCTV) and lighting purposes unless they meet the rigidity criteria stated in *PI5-DOC-003517 – Security Specification*, Appendix 1 and are approved by the Department.

Footing details are available from the Department's website (refer to the "lighting" subsection).

11.9.2. Type of Light Poles for Station or Tram Stop Precincts

Poles for use within the station precinct (for example, platforms, access paths, ramps and pedestrian crossings) are usually 6 m tall. Lighting poles must be of the tilt-down ('see-saw') type and comply with the requirements of drawing CS4-DRG-362572.

Likewise, camera or joint-use (that is, lights and cameras) poles must comply with the requirements of drawing CS4-DRG-362573.

Tilt-down lighting or camera poles of 7 m or 8.5m height may be used in open car parks and must comply with drawing *CS4-DRG-362574* (light poles) or *CS4-DRG-362575* (camera poles).

Care must be taken in the installation of tilt down poles to make sure that correct clearances are observed from all structures and live equipment.

Outreach arms must generally be in accordance with standard drawing *CS4-DRG-350286*. Standard spigots and adaptors may be used with a minimum arm length of 300 mm. All luminaires must be installed with zero up-tilt (with the possible exception of open car parks).

Where lighting poles for pedestrian ramps are not located on the ramp itself, they must have their base-plates at the same height as the ramp surface by being mounted on up-stands that are engineered for the purpose and are cosmetically attractive. The preferred solution is to use square polymer-concrete pit risers.

Poles for pedestrian mazes must not tilt into the corridor and, at active crossings, must not interfere with the RX-12 ‘red man’ sign’s pole.

On train and tram platforms and paths, light and camera poles must be mounted on square plinths encompassing the pole’s base-plate. The plinth must provide 30 % luminance contrast with the surroundings (for example, by being painted yellow). Light poles in the rail corridor or elsewhere need not be mounted on plinths.

Pole rag-bolts must be neatly and correctly installed—all four bolts shall protrude above their nuts by 4–6 threads length. Damaging the galvanising by cutting the bolts must be avoided.

Poles must not have their base-plates or fixings covered.

***Note**: The Department’s public transport poles have an internal stud for the attachment of a bonding cable in electrified traction territory. This stud must be used in preference to an eternal connection which may be vandalised. The bonding cable will require an extra conduit to enter the pole (refer to section 12.7.1 below).*

11.9.3. Signs Attached to Poles

Signage must be fixed to tilt-down poles in such a way as to not prevent the pole from tilting.

11.10. Lighting Control

11.10.1. Test Facility for Non-DALI Stations

‘Legacy’ stations that are not fitted with DALI controls must have a lighting ‘Test’ circuit installed.

A user must be able to over-ride the PE cell and time clock (if fitted) in order to test the lights. This circuit must incorporate a timer so that it automatically reverts to normal operation after a period of two hours. Refer to wiring diagram *004-A2-11-033*.

11.10.2. Lighting Control Strategy

Dimming must be incorporated in the lighting design for the site. Dimming levels must be determined during the commissioning phase to ensure that the lux levels required for all station elements as indicated in Tables 11.3.1, 11.3.2 and 11.3.3 above are achieved.

Lighting in the station precinct must be split over staggered multiple circuits to ensure that tripping of circuit breakers will not cause total black-out in any area.

Each pole-mounted luminaire must be individually protected by a 4–6A circuit breaker in the pole. Each sub-circuit of lighting must be protected by a 30 mA RCBO/RCD in the switchboard.

Daylight harvesting must be utilised where the building topology permits. The control must be of the ‘closed loop’ type using multiple PE Cells.

The control system must include a push-button control at stations with T5 fluorescent lighting to activate a 100-hour timer to cause the tubes to ‘burn in’ without any dimming following a relamping exercise.

A single DALI line is capable of operating 64 devices; however all lines must be limited to 50 devices to allow for future expansion.

In general, lights should dim down (or turn off) around 20 minutes (rounded to the nearest 5 minutes) after the station's last evening train and return to full brightness around 30 minutes before the morning's first train.

11.10.3. Photo Electric Cell

At DALI sites, switching of the lighting circuits must be controlled by means of a photo-electric light sensor ('PE Cell'). This PE Cell must be:

- Mounted outdoors, either on a structure, or an adjacent light pole;
- Mounted at height on the (tilt-down) pole closest to the lighting switchboard if no building is available,
- Mounted away from direct sun light and protected from other light sources including oncoming vehicles and train lights;
- An analogue unit connected to the lighting control system;
- Installed in a location close to the lighting control system interface to minimise wiring;
- A DALI type; and
- Activated when the ambient lighting level drops below a programmed threshold (typically 42 lux).

The (main) PE Cell must be used as the basis of lighting control, however the DALI system must be able to detect a faulty PE Cell. It must then signal this fault on the remote monitoring computer and change over to the DALI control's almanac function for lighting control.

Multiple PE Cells will be required if daylight harvesting is implemented.

For non-DALI sites, it is preferred to have only one PE Cell controlling the entire precinct's lighting—multiple PE Cells must be avoided. Various systems are in use by the Department to transmit the PE Cell's signal over optical fibre on electrified traction territory—refer to drawing *CS1-DRG-350145* as an example.

Where no building is available, the PE Cell must be mounted at height on the (tilt-down) pole closest to the lighting switchboard.

11.10.4. Motion Detectors

Motion detectors must be placed in order to cover the entire platform and main access points to the station. Such detectors may be:

1. DALI long-range movement, or movement plus light level, sensors (outdoors rated where required);
2. Long distance, outdoor rated, robust 'curtain' motion sensors can be used for long-distance detection on platforms;
3. The movement sensing and 'boundary' analytic functions of one or more VSS cameras at the site; or
4. A combination of the above.

Note: *Such movement detectors are specialised items, and the electrical sub-contractor should allow for them to be mounted and calibrated by the security sub-contractor and integrated into the alarm system. It is essential that the adjustments do not allow the sensors to be triggered by after-hours*

movements on the rail or tram track. The fabrication of special shields may be necessary, particularly for the type 1 sensors above.

Dimming of the luminaires must be triggered by the lighting controller's time clock function for certain hours of the day and full light levels must be restored instantly for a programmed period (normally 15 minutes) as soon as a movement is detected by motion detectors.

11.11. Lighting Control System – Details

11.11.1. General

The programmable lighting control system for the precinct must be DALI and be compatible with the Department's approved remote monitoring software. It must incorporate at least one Zone Controller unit and a DALI Power Supply unit is required for each DALI line.

All personnel who are working on lighting control system must be suitably competent in the use of DALI Systems and the Department's approved monitoring software.

The DALI system is to be integrated by a suitably qualified specialist in order to install, program and commission the system.

The lighting control system's ELV power supply(s) shall be fed from a separate correctly sized (low value) circuit breaker.

11.11.2. Introduction

The scope of work for the lighting control system is based upon maximum flexibility and maximum control. It provides an individually addressable DALI digital lighting system that can typically be reconfigured without the need to rewire, while providing control and status down to an individual ballast, transformer or emergency inverter.

The lighting control system is to be a multi-master DALI (Digital Addressable Lighting Interface) system with DALI Control Gear in all light fittings, emergency lights and exit signs. These are to be controlled by multi-master DALI Control Devices. The lighting ballasts, transformers, drivers, emergency inverters and other electronic control gear and electronic control devices are to fully comply with the DALI Standard (IEC 62386).
All electronic control gear must comply with the latest version of the DALI Standard IEC 62386 in order to provide manufacturer, serial number and other related data held in DALI memory.

When equipment reaches its end of life or is being upgraded, it must be replaced in line with above.

DALI Lines are to be linked on an Ethernet network to provide computer control, configuration, monitoring, alarming and analysis.

The lighting system must provide a manual test facility and an emergency override capability. Reference must be made to standard drawings *CS4-DRG-359802* and *TC4-DRG-200014* and their dimming times noted.

The lighting controls are to utilise rail or tramway timetable schedules, occupancy/movement sensors, light sensor, switches and temperature sensors to control the lighting.

The Zone Controller(s) is to automatically monitor the status of all ballasts and emergency fittings on the DALI Lines and provide the tools to identify and replace ballast and lamp failures.

11.11.3. System Description

The lighting control system must consist of multiple DALI Lines linked to form an arrangement using intelligent control units connected by an Ethernet network. Parts of the station's local network may need to be isolated using optical fibre when crossing an isolation boundary or if long distances are involved.

All DALI Control Devices must be multi-master devices with data collision detection and must not interfere with each other on the DALI line.

A highly resilient DALI system is required to ensure operation in the case of failures of either Zone Controllers or the Ethernet infrastructure. Each DALI Control Device must include and have operating an integral DALI Application Controller. These local Application Controllers must co-operate with each other and with the Zone Controllers so that failure of a Zone Controller will result in switches and sensors having a control ability on their local DALI line.

Single master control devices are not acceptable as they do not provide the flexibility required for the system.

11.11.4. Wiring and Installation

All light fittings are to be wired in compliance with the DALI Standard and local electrical regulations.

A single DALI Line has the following constraints:

- The maximum number of addressable DALI Control Devices is 64 (devices that take a DALI short address, such as ballasts, transformers, emergency lighting units, etc.), although the Department's limit is 50 to allow for future expansion.
- The DALI voltage range at the DALI Power Supply must be between 11.5 V and 22.5 V; with a typical value of 16 V.
- All personnel installing or maintaining DALI Lines and equipment must be fully qualified to the level required for LV Work because the DALI voltage has the capability of going to 240 V in the case of a fault.
- The voltage-drop over the length of the DALI control wires is not to exceed 2V.
- The maximum permitted line current is 250mA.
- The sum of the current consumptions of all the DALI units from the DALI Line must not exceed the nominal current of the DALI power supply used.

Note: *The DALI standard recommends a maximum length and size of 300 m of 1.5 mm^2 cable for each DALI Line, however the Department requires that larger cross-section cable (double-insulated, mains-rated twin) be used for long runs.*

Emergency luminaires and Exit signs must be connected to the nearest DALI Line and be powered by the DALI active conductor to minimise cabling and installation costs.

11.11.5. DALI Zone Controllers

The Zone Controllers are required to link the distributed DALI Lines onto an Ethernet network to provide a site-wide DALI system. The Zone Controllers provide configuration, monitoring, control, reporting and maintenance functions.

Where multiple Zone Controllers are used, they must use secure communication with each other based on modern cyber-security encryption techniques. The security and encryption processes must be disclosed and based on at least AES-128.

In the event of an Ethernet infrastructure failure, the Zone Controllers are to operate independently and must continue to process DALI operations and schedules when disconnected from the Ethernet network. The Zone Controllers must not be reliant on a server, a cloud service, or other control system in order to operate. When the Ethernet infrastructure fault is repaired, the Zone Controllers must seamlessly join together again and resume normal operation.

The Zone Controllers must provide local intelligence and features including:

- Integrated real time clock with automatic daylight savings adjustment and leap-year correction.
- Integrated sunrise/sunset support based on site location (latitude and longitude).
- Automatic Time Schedules to control groups for scheduled occupancy with support for active periods and holiday exceptions.
- Multiple operating modes or profiles to provide differing operating configurations for either different conditions, or for different periods of the day including office hours and after-hours.
- Support direct connection to four DALI Lines (up to 200 devices).
- Zone control, whereby groups on different DALI Lines are controlled together as one entity.
- DALI Emergency testing and reporting.
- Local processing. In the event of network failure or disconnection from the Ethernet network the Zone Controller is to continue to run automatic time schedules and sequences and process inputs independently.
- Remote computer monitoring and configuration. The Zone Controller must allow configuration, monitoring and analysis from computers on the Ethernet network.
- Local computer control. The Zone Controller must allow configuration, monitoring and analysis using local laptop access.
- The Zone Controller must allow schedules and scenes to be modified without recourse to a Systems Integrator to perform re-programming.
- The Zone Controller must allow its real time clock to be set either from a programming computer or by using Network Time Protocol (NTP).
- The Zone Controller must cooperate with local Application Controllers in sensors, switches and input units to allow a seamless and resilient operation.

- The Zone Controller must accept, process, and action event messages from certified DALI-2 compliant switches and sensors.

In order to separate mains voltage from extra-low voltage and Ethernet cabling, Zone Controllers and similar devices are to be located in the switchboard separate from their associated DALI line power supplies.

The specialist DALI sub-contractor must set up each Zone Controller's IP address from the Department's master list.

Details of Zone Controller functions include:

1. **Distributed Control Functions**
   The DALI Control Devices (input units) such as switches and sensors must include and have operating an integral DALI Application Controller. These local application controllers must co-operate with each other and with the Zone Controller(s) so that failure of a Zone Controller will result in switches and sensors having a control ability on their local DALI line.

   The Systems Integrator must commission the system in a manner where the DALI Application Controller functions of switches and sensors is used as the normal operating behaviour.

2. **Zone Controller Operating Profiles**
   The Zone Controller must include functions to allow the enabling and disabling of system functions and the change of system properties.

   The Enable/Disable function must include the ability to determine from a computer control signal, a schedule, or a switch or sensor, that selected switches or sensors or other input types are to be enabled or disabled.

   The system property change function must include the ability to determine from a computer control signal, a schedule, or a switch or sensor, that selected switches or sensors or other input types or other system behaviours are to change their behaviour. Changes of behaviour must include being enabled or disabled, changes of timeouts (for example, sensor hold times), changes of fading speeds and so on.

   System property changes may typically be used for normal-hours and after-hours operation, but may also include other changes such as emergency mode, special days or public holidays.

   The Zone Controller's property change functions may be used for integration with lift controllers, fire panels, security panels, access control systems and Building Management Systems (BMSs).

   An example of uses for this functionality is:
   - After Hours Occupancy Sensor
     Daylight Hours: disabled
     After Hours: 15-minute Override Sequence

3. **Automatic Time Schedules**
   In order to cater for scheduled occupancy of the station, the Zone Controller(s) must include an integrated real-time clock and automatic schedule control.

The Zone Controller must provide:

(i) An integrated real-time clock to allow automatic time schedules to be run independently of the Ethernet network.

(ii) The real-time clock is to provide automatic daylight savings adjustment and leap year correction.

(iii) Sunrise and sunset support based on site location. Schedules are to be provided with a configurable offset to allow lighting to be controlled relative to dusk and dawn.

For example, sunrise + 20 minutes;
sunset - 30 minutes.

(iv) Active Periods where a timer can be configured to fire only within a defined date range.

For example, from 1st June to 31st August 2024;
from 1st June to 31st August every year.

(v) Custom time schedules are to be configured for an absolute time.

For example, Office open, Monday to Friday at 8:30am;
Cleaners' lights, Thursdays at 8:00pm and for Special Services.

(vi) Repeat timers.

For example, Run façade lighting sequence every 30 minutes from 7pm until 11pm.

(vii) Time schedules must be able to be configured to include or exclude holiday periods. Holiday periods are to be configurable for one or more days and are to be able to be selected as perpetual.

For example, 31st December, every year.

(viii) Scheduled actions are to include the ability to set DALI lighting levels, activate scenes or run logic code.

(ix) Configuration of the time schedules is to be completed from a computer over the Ethernet network.

(x) Modification of schedules must be possible using Facilities Management Software by a user without recourse to a qualified Systems Integrator.

4. Sequences

Control sequences are required to provide multi-step lighting functions. Examples of uses for sequences include:

(i) Cycling between possible levels and timeouts: 30 mins 75%, 5 mins 50%, 5 mins 25%, 5 mins OFF.

(ii) Delayed exit button: Goto 50%, 5 mins MINIMUM, 5 mins OFF.

(iii) Façade colour mixing: variations in red, green and blue over time.

(iv) Mood lighting: SCENE1, 20 sec SCENE2, 30 sec SCENE3, 40 sec SCENE4.

The Zone Controllers or sensors or switches must be able to operate such sequences of any definition or complexity.

Sequences may be activated by a Time Schedule, from an Input or by computer via the Ethernet network.

Configuration of the sequences is to be completed from a computer over the Ethernet network. If suitable sequences are not included in standard behaviour, the equipment manufacturer must have the capability to provide new sequences as a downloadable item without recourse to the supply of new system software or firmware.

5. Computer Control

The Zone Controller must accept commands from computers, touchscreens, apps and similar software connected to the Ethernet network.

This provision may be provided by a desktop app, touchscreen or similar that provides the user with full control of their lighting.

Any such apps must include at least a slider with full dimming capabilities plus buttons with the following functions: Maximum, Minimum, Off, Setting of at least 16 scenes.

The selection of the DALI lighting loads to be controlled must be configurable.

6. Configuration and Special Customisation

The Zone Controller must allow a qualified Systems Integrator to write and insert their own custom code ("Logic Code") into the controller to perform specialised functions not normally included in the controller.

The Logic Code must allow at least:

(i) networked communication by TCP/IP sockets;
(ii) access to and communication using a serial RS-232 port for integration to other systems;
(iii) high level language block structured programming, including constructs such as, but not limited to, conditionals ("if statements"), loops, use of variables and similar; and
(iv) Operation of logic code at scheduled times.

Configuration of the logic code is to be completed from a computer over the Ethernet network.

7. Status and Error Information

The Zone Controller(s) is to monitor the connected DALI Lines and is to provide status and error information for DALI Lines, ballasts and lamps.

The status and error information is to be available using an Application Programming Interface (API) to the Zone Controller.

The Zone Controller, or other software that works with the Zone Controller, is to monitor and track lamp hours for connected luminaires and emergency fittings. If the DALI ballast does not support lamp hours, then the Zone Controller or other software must provide the tracking.

8. Occupancy Sensor Interface

The DALI occupancy sensor interface is used to control a group of lamps (ballasts) depending on the occupancy of an area as determined by occupancy sensors.

The interface is to operate with one or more sensors that provide a contact-closure output.

The group of ballasts to be controlled is to be configurable allowing the space to be reconfigured or modified without changing the fixture wiring.

The lighting level activated when the sensor detects a change in occupancy is to be configurable to match the use of the space.

9. Light Sensor Interface

The DALI light sensor interface is used to control the level of a group of ballasts depending on the light level of an area as determined by a light sensor. The light sensor interface is typically used to control a group of ballasts adjacent to a row of windows.

The group of ballasts to be controlled is to be configurable, allowing the space to be reconfigured or modified without changing the fixture wiring.

When the group is in the ON state, the light level is to be raised or lowered depending on whether the light level determined by the light sensor is above or below a setpoint.

The system is to monitor the light sensor's output and produce an alarm at the remote system monitor if the sensor fails—refer to section 11.11.8 below).

10. DALI Relay and Output Modules

DALI Relay or Output Modules are required to provide ON/OFF control for non-dimmable loads such as fixed output electronic ballasts, incandescent lamps, fans and motors. The modules are to accept DALI commands over the DALI Line allowing modules to be placed adjacent to the load to be controlled.

Where it is necessary to control lighting with relay outputs (and optional associated contactors), preference should be given to operating them in the 'normally-closed' mode—that is, a fail-safe arrangement where the control system turns ON the contactors in order to hold off the lights.

11.11.6. Documentation

The specialist DALI sub-contractor must produce a Technical Maintenance Plan and the Department's standard schematic diagram in AutoCAD® format.

11.11.7. System Safety

The control system must be wired with full and obvious segregation between its ELV and LV sections. The ELV portion must form a Compliant Telecommunications System and a telecommunications Certificate of Compliance (form TCA1) must be delivered. By way of example, ducting of different widths must be used for LV and ELV wiring and the ELV (communication) ducts must be white.

11.11.8. Remote System Monitoring

The system must be fully integrated with the Department's existing remote lighting monitoring and control software application ("MERLINS"). The specialist sub-contractor must allow to make all changes necessary to the monitoring software system in order to add an additional station and to facilitate the remote testing and monitoring of the lighting including the battery-backed lighting.

The Zone Controller is to monitor the connected DALI Lines and is to provide status and error information for DALI Lines, control gear, ballasts and lamps. All error information must be communicated to maintenance personnel via SMS and/or email.

Additional alarms (such as the PE Cell failure alarm) must be supported and displayed. The application must be able to show diagrammatic views of each site, including luminaire location, to a level of detail that permits each individual luminaire's information to be viewed.

Time synchronisation of all the Zone Controllers using their NTP protocol (or otherwise) must be supported.

The communications network must comply with the latest cyber-security requirements. Cloud-based systems must not be used without the specific approval of the Department.

11.11.9. Maintenance and Ballast Replacement

The maintenance software (MERLINS) is to identify a faulty ballast and the address of that ballast and support configuration of a replacement ballast with a simple point and click operation.

All group, scene and configuration settings are to be restored to the new DALI ballast.

11.12. Luminaire Installation

Luminaires must be installed to their manufacturers' instructions and their mounting must ensure that their IP rating is not compromised from the rear or otherwise.

Water or insect ingress from behind or otherwise must be prevented and will be regarded as a defect. Circular cable and glands must be used where necessary to ensure that the sealing of luminaires is not compromised by the inappropriate use of flat TPS cables. Fixings must be fitted with sealing washers.

All luminaires must be installed behind the platform's white line.

Every luminaire must be identified with the circuit breaker from which it is supplied and the relevant DALI address. This labelling must be provided immediately adjacent to the light fitting and lettering height must be selected so that it can be read by a person standing underneath. It may be stencilled or be engraved labels with externally rated high-performance adhesive. Pole mounted lights must be labelled at the gear tray. Long rows of batten luminaires may be labelled at every tenth unit. This information is required on the as-built drawings.
Note: *the labelling must not be fixed directly to the light fittings.*

12. 230/400 V and 110 V Electrical Power Cabling and Conduits

12.1. Cabling – General

1. All cables used throughout the installation must be of Australian manufacture and comply with AS 1125, *AS 3808, AS 5000* and all relevant Standards stated in Appendix A of *AS 3000*.
2. All cables must be double insulated, including those entering the isolation transformer and light poles.
3. For consumer mains and sub-main cables, single-core or multi-core cables with copper conductor and Cross-linked Polyethylene (XLPE) X-90 insulation and PVC sheath must be used.
4. Cable must use multi-stranded soft drawn copper conductors.
5. All PVC insulated and PVC sheathed cables must use a minimum of V-75 insulation, unless otherwise specified.

6. Where required to have a fire resistance level, mains cabling in lift shafts must comply with Category WS52 of *AS 3013: Electrical Installations – Classification of the fire and mechanical performance of wiring system elements*, as required in *AS 1735.2: Lifts, escalators and moving walks – Passenger and goods lifts – Electric.*
7. Cables must be selected in accordance with *AS 3008.1.1*: *Electrical Installations – Selection of Cables – Cables for Alternating Voltages up to and including 0.6/1 kV – Typical Australian Installation Conditions*. The following must be considered in cable selection:
   a) Circuit nominal current as per *AS 3008.1.1*;
   b) Permissible voltage drop as per *AS 3000*;
   c) Fault loop impedance as per *AS 3000*; and
   d) Short circuit current as per *AS 3008.1.1*.

12.2. Cabling in Tunnels and Underground Buildings

The cable used in tunnels and underground building areas must be of the LSZH type and comply with all relevant Australian Standards.

12.3. Cables Encased in Concrete

LV cables that are encased in concrete to a depth of less than 300 mm, such as bridges, walkways and suspended platforms must have flush identification markers set into the top surface of the concrete to indicate services below. The markers must display:

- Type of service;
- Approximate depth; and
- Direction of service

and must not create a slipping or tripping hazard.

12.4. Cable types and Sizes

All cables and wiring associated with any new electrical circuits must comply with the following:

12.4.1. Underground wiring

- 2-core plus earth insulated conductors, not less than 4 mm^2 (7/0.84), 0.6/1 kV, PVC insulated, PVC sheathed; and
- Installed in heavy duty conduit of minimum size 32 mm for lighting and power circuits.

12.4.2. Above ground wiring

- 2-core plus earth insulated conductors, not less than 2.5 mm^2 (7/0.67), 0.6/1 kV, PVC insulated, PVC sheathed; and
- Installed in heavy duty conduit of minimum size 32 mm for lighting and power circuits.

12.4.3. Inside poles and elsewhere directly to luminaires

- Circular 5-core DALI power cable only. The requirements of Section 11.12 above must be noted.
- Pole-mounted luminaires must be individually protected at the base of the pole and wired generally in accordance with drawing CS4-DRG-350285 *Stations Electrical Services – Lighting Pole Internal Wiring – Equipment Arrangement*.
- The DALI power cable must have the following characteristics:

MARKING	CONDUCTOR TO SIZE	WIRE COLOUR	DESCRIPTION
L	2.5 mm^2	Brown	20A Active Conductor
N	2.5 mm^2	Blue	20A Neutral Conductor
Earth symbol	2.5 mm^2	Green/Yellow	Protective Earth
DA-	1.5 mm^2	Grey (typical)	DALI Control Wire
DA+	1.5 mm^2	White (typical)	DALI Control Wire

12.5. Cable Installation

1. All electrical cables must be installed to AS 3000 and the manufacturer's recommendations.
2. All Telecommunications ELV & LV cables must be installed to *AS/ACIF S009* and the manufacturer's recommendations.
3. Unless otherwise specified or unavoidable due to route length or site conditions, cables must be run for their entire route length without intermediate joints. Joints must only be made at equipment terminals.
4. No cable joints must be made below ground level, nor in concealed or inaccessible locations, without prior application to the Department, as follows:
   - the Contractor must provide full details of the exact joining method proposed and must not install the joint until approval is granted by the Department; and
   - at each end of any cable that is joined, the Contractor must provide labels stating that the cable is jointed and the approximate location of the joint.
5. All cable joints required due to cable damage during installation, route length or difficult installation conditions must be installed in accordance with manufacturer's recommendations unless otherwise specified. Any enclosures containing joints must be installed at accessible locations and labelled.
6. Cables must be installed so as to avoid damage to insulation or sheathing. Damage to cables must be reported and replaced or repaired as directed by the Department.
7. Where cable access holes pass through metal structures, the holes must be burr free, treated against rust, bushed and sealed to prevent the ingress of moisture and vermin.
8. Cabling extending to the top of poles must be installed with the appropriate cable support at top and bottom.
9. Flexible stranded copper conductors with a nominal area less than 0.75 mm^2 must be terminated by means of a compression-type ferrule of the correct size for the conductor and compressed only by the correct tool.
10. All wiring, cabling and terminations, both within and outside of switchboards and other enclosures, must be performed in a neat and professional manner in accordance with the best current industrial electrical work standards. By way of example, all wiring must be installed in ducting or neatly loomed and supported; cables, terminals, and other elements must be labelled. Adhesive products such as self-adhesive cable-tie mounts must not be used.

12.6. Cable Marking, Protection and Labelling

1. The Contractor must ensure that underground conduits are protected by:
   - Telecommunications — white marking tape in accordance with Australian Standards *AS/ACIF S009 & S008*.
   - Electrical — orange cable marking tape complying with *AS 2648.1: Underground marking tape – Non-detectable tape* and installed in compliance with *AS 3000*.
2. Concrete covering or polymetric cover strips may be used where necessary.
3. Each end of all cables must be labelled. In addition, all cables must be fitted with a third label immediately adjacent to the point where they enter the equipment room

and cables which run underground must be identified in every cable pit by means of stamped, non-ferrous tags or engraved plastic tags tied around each cable.

4. Cables must be identified in a manner that is permanent and indelible and consistent with the as-built drawing nomenclature. Self-adhesive labels are not acceptable.

12.7. Conduits

12.7.1. General Requirements

- The rail signalling's pit and conduit system must not be used for mains electrical power.
- On electrified traction territory, E&B cables must have their own conduits and must not share conduits with any other services.
- **No corrugated conduit is to be installed underground** except for the purpose of providing additional sheathing (segregation) in pits. Where awkward or unusual bends are required in order to direct a conduit into a pole or small opening, the Contractor must use "setting" (gentle heating and bending of a PVC conduit while using a metal bending spring to prevent conduit wall collapse).
- Conduits must be laid out in straight lines to avoid unnecessary bends. The maximum permissible bend count for any one conduit run is 180° (for example, 2 × 45° sweeps and 1 × 90° sweep = 180°).
- Sweeps must be used in preference to bends.
- Conduits must be cleaned and must be free of dirt and debris.
- For conduits in filled platforms, each platform's pits and conduits must consist of a main 'back-bone' and a number of 'daisy-chained' spurs, such that an arrangement of 'redundant loops' is formed along the platform for each of the Power, Communications and Speaker systems.
- Conduit diameters may be chosen by the Contractor, subject to a minimum of 32mm. For an initial installation, conduits must achieve a fill factor of less than 25% as the ratio of the sum of cable cross sectional areas to the inner cross-sectional area of the conduit. This equates to 50% spare useable capacity.
- In accordance with master specification RD-EL-D3, spare conduits must be provided in every trench or under-bore. The electrical spare must be the same size as the largest occupied electrical conduit. The communications spare must be the same size as the largest occupied communications conduit. Where close to a station or other infrastructure, consideration must be given to the installation of a second, smaller conduit (50 mm minimum) for LV communications (PA speakers).
- Notwithstanding AS 3000, in order to avoid confusion with white communications conduits, power conduits must be orange and must not be grey unless more than 3 m above surface level.

12.7.2. Conduits Entering Poles

All conduits entering poles must:

- be spaced from each other so that conduit caps or couplings can be easily fitted to all conduits at the same level.
- extend up from the finished floor level by 100mm (drawing *624-A3-11-315* refers).
- be rigid wall conduit.

If more than one type of service enters a pole, all services with the exception of electrical must be fully segregated from all other services.

12.7.3. Joining Conduits

All underground conduit joints must be prepared with PVC red priming fluid and glued together with PVC solvent cement. Refer to *AS/NZS 2032: Installation of PVC pipe systems*. The conduit to be joined (not bell end) must be cut square to create the strongest join. After glue is applied, the conduits must be pushed firmly together ensuring maximum bell penetration.

Where the conduit enters a pit, the conduit end must be fitted with an End Collar ("bell end").

12.7.4. Conduit Compliance

- All conduit and pit installations, without exception, must require the Contractor to supply a compliance certificate stating that the installation meets all relevant Australian Standards, is fit for purpose and is safe to use.
- For electrical conduits, a Certificate of Compliance (CoC) is required and, for communications conduits, a Form TCA1 certificate must be submitted. This must be considered as a **HOLD POINT**.
- Conduit and pit installation work involving communications conduits must be performed by, or supervised by, persons who are appropriately registered in accordance with the ACMA Cabling Provider Rules.
- If the pit and conduit installation is done by persons under supervision of a Registered Cabler, the Contractor must demonstrate that those persons have received training on the essentials of communications conduit work.
- The certificates must be delivered to the Department as soon as possible after the work is completed.
- It must be noted that a Project must deliver a total of 4 CoCs, as listed in Section 17 below.

12.7.5. Underground Electrical Conduit Cover

Notwithstanding *AS3000*, the cover for electrical conduits (without additional protection) must be a minimum of 600mm and a maximum of 800mm below finished floor/ground level. The conduit must be orange to comply with *AS3000* and have a minimum diameter of 32mm.

12.7.6. Underground Communications Conduit Cover

Notwithstanding *AS/CA S009*, the cover for communications conduits (without additional protection) must be a minimum of 450mm and a maximum of 600mm below finished floor/ground level. The conduit must be white (marked "Communications") to comply with *AS/CA S008* and have a minimum diameter of 32mm.
Note: *Platforms and walkways are regarded as 'public footways'.*

Marking tape must be installed, complying with the requirements of *AS/CA S008.*

12.7.7. Above Ground or Exposed Conduits

- All wiring in exposed situations (including under suspended-slab platforms without any other protection) must be enclosed in metal conduit up to a minimum height of 3 m above finished floor or ground level. Solid wall galvanised metal conduit must be used, incorporating short lengths of flexible metal conduit ("Anaconda") where necessary.

(Metal Anaconda conduit must not be used in straight lines as a replacement for solid-wall conduit.)

- Fixings must be of stainless-steel material and be provided with two fixing points (not “P-clips”). They must be fitted at a maximum spacing of 600 mm to secure the conduit to the structure. The usual minimum diameter of metal conduit to be used is 32 mm, although 25 mm is preferred.
- Sections of metal conduit can be replaced by a “top-hat section” being a mechanical protection in the form of 1.6 mm hot dipped galvanised section, screw fixed in place at intervals not exceeding 1000 mm and painted to match the surroundings.
- PVC conduits more than 3 m above finished floor or ground level must be UV-resistant.

12.7.8. On Front of Station Platforms

- Reticulation along the front of a platform must be regarded as a ‘last resort’.
- 230 V mains power must never be run on the front wall of a platform—110 V AC is the maximum voltage permitted. Usually only communications conduits are considered for use in this way.
  Note: *DALI data cables must be treated as mains and so cannot be attached to the front of a platform*.
- The conduits must be metal and as small as practicable to prevent them being used as a foothold by trespassers—32 mm is the maximum allowed.
- Fixings must be spaced at a maximum of 500 mm apart.

12.7.9. Draw-Cords

- Draw-cords must be provided in all conduits. Polypropylene yellow/blue draw rope with a minimum diameter of 4mm must be used. Existing ropes that are used to pull cables may have become brittle over time and must not be re-used.
- Any cables pulled though conduits (regardless of whether these are new or existing conduits) must have another draw-wire pulled through with them, so that a draw-wire remains in every conduit at the completion of the works. Ropes must be tied off at both ends.
- All empty conduits must be capped at both ends.

13. Cable Pits

13.1. Existing Pits

- Existing Departmental standard conduits and pits may be re-used unless otherwise specified in the Project’s CSTR.
- Before re-using the pit and conduit system, it must be inspected and made compliant to all relevant standards. If compliance is not possible, the pit and conduit system must not be used.
- Electrical and communications conduits must not terminate in the same pit unless it is fitted with a segregation wall.
- All existing pits must be permanently labelled identifying the service contained within.

13.2. New Pits

Conduits and pits must be installed in accordance with:

- Standard Pit Drawings *CS5-DRG-367219* and *CS5-DRG-367220*.
- *AS/AC S009 & 008* Telecommunications Standards.

- *AS 3084: Telecommunications installations – Telecommunications pathways and spaces for commercial buildings*.
- *AS3000*: *Electrical Standards*.
- The Department's Master Specification *RD-EL-C3 Supply and Installation of Conduits and Pits*.

All pits must have drain holes installed. Where no suitable drainage point is located near the pit(s), it must be provided with an engineered soakage facility.

Segregation between services must be strictly observed when installing pits.

All pits must be provided with a concrete surround, as detailed on *CS5-DRG-367219.*

Care must be taken to ensure that plastic pits are not distorted by the actions of installing the pit surrounds, backfilling or compaction and that their lids fit correctly.

13.2.1. Pit Location and Security

- In locations subject to pedestrian traffic (platforms, pathways, etc.), the Contractor must employ an arrangement that incorporates the use of an in-filled cover. The filling must match the surrounding surface (concrete, grouted pavers, etc.). The cover must:
  (i) be a minimum 'Class B' type to *AS 3996*.
  (ii) be installed within the frame and finished to the surrounding platform level in order to minimise tripping hazards.
  (iii) have minimal gap between the lid and the frame.
  (iv) be easy to open with use of the correct lifting equipment by two people.
  (v) in most circumstances, be large enough to comfortably cover three pits, being Electrical, Comms ELV and Comms LV (refer to drawing *004-A3-11-336* for details.).
- The pits located underneath Gatic covers must be fitted with labelled lids and gaskets and they do not need to be locked.
- In locations not subject to pedestrian or other traffic (for example, in the rail corridor or garden areas), the Contractor must install a lockable pit, fitted with a D-bolt and with provision for a padlock, in accordance with standard drawing *CS5-DRG-367219 Lockable plastic pits – Assembly and installation details*.
- All pits with metal covers must be permanently labelled with the SA Government roundel, identification of the pit as PTSA's and the service that it contains.
- The contractor shall provide the padlocks, which must be keyed to each pit's service.
- Pits must not be installed:
  (i) next to waterways
  (ii) on roadways
  (iii) in natural depressions or on sloping surfaces (allowing water to run into the pit)
  (iv) in areas that are difficult to access (including under platform furniture)
  (v) so that they are, or will become over time, buried
  (vi) within Earth Potential Rise (EPR) zones.
- Small pits for earth stakes must be able to be secured with a fastener.

14. Earthworks, Trenching, Boring and Concrete Works

The Contractor must undertake all trenching (or boring) and other earthworks in such a manner that:

- The work complies with the requirements of the *PTS-MS-10-SG-STD-00000094 – PTSA Pits and Conduits Standard*;
- The work complies with the requirements of drawing *CS5-DRG-367219 Lockable plastic pits – Assembly and installation details*;
- The work complies with the requirements of *AS 3000, AS 4799* and *AS/CA S008* and *S009*;
- All trenches dug in the rail corridor must employ a vacuum excavation method only.
- All open trenches, uneven surfaces, holes or other hazards must be isolated by the erection of temporary barriers, fencing or other means, supplied by the Contractor and compliant with *AS 1742.3: Manual of uniform traffic control devices – Traffic control for works on roads*;
- No trench or other excavation on pedestrian walkways or platforms must be left uncovered overnight.

14.1. Vandal Resistance

- All fittings, mounting brackets and arrangements must be designed to be vandal resistant.
- Exposed plastic must be avoided up to a minimum height of 3 m above finished floor or ground level.

14.2. Mechanical Protection

- All housings, fittings, mounting brackets and arrangements must be dust and weather resistant to at least IP55 rating level.
- All equipment installed must be suitable to withstand the prevailing environmental conditions. For example, boxes, etc. should be stainless steel at stations near the sea.
- All steel brackets, pipes, tubes, etc., together with their associated fixings, supplied as part of the works and intended for use out of doors must be hot dip galvanised or made from stainless steel, unless otherwise approved.
- The exposed thread of all metal conduits must be treated with zinc-rich paint.

14.3. Commissioning and Interruption of Services

The Contractor must ensure that the works undertaken by or under supervision of the Contractor are conducted so that electrical supply to the Station Precinct must be maintained at all times except by prior arrangement with the Department. Prior to any interruption of supply a minimum of 48 hours' notice is required.

Electrical supply to lighting on site may only be interrupted during daylight hours.

15. Drawings

New design drawings must be prepared in colour and showing conduits, cable trays, etc. as follows:

- Electrical: Orange;
- ELV Communications: Purple or similar;
- LV Communications: Light blue or similar.

Shop drawings for switchboards must be submitted to the Department for approval prior to fabrication beginning.

16. Test Plan

The Contractor's Inspection and Test Plan must be prepared in accordance with Master Specification PC-RW50. The Contractor's test plan must include tests to demonstrate the correct installation and/or function of each element of the system, including tests associated with the following:

- Earthing and Bonding requirements for electrified railways or tramways, as per Standard *TP4-DOC-003507 – Earthing and Bonding*.
- Inspection of quality of workmanship for physical installation works.
- Demonstration that the approved IFC documentation matches the installation.
- Validation of the lighting control software program.

17. Records

Records must be prepared in accordance with Master Specification PC-RW50. The following records in particular must be provided to the Department:

- Any changes to the original design;
- Layout arrangement of transformers, switchboards and distribution boards;
- Shop drawings of light poles and their mounting bases;
- Shop drawing of isolation transformers indicating details of mounting dimensions, connection points, earthing arrangement, mass and enclosure construction and finish;
- Shop drawings of switchboards showing the following:
    - Types, model numbers and ratings of assemblies;
    - Component details, functional units and transient protection;
    - Detailed dimensions;
    - Shipping sections, general arrangement, plan view, front elevations and cross-section of each compartment;
    - Projections from the assembly that may affect clearances or inadvertent operation, such as handles, knobs, arcing-fault venting flaps and withdrawable components;
    - Fault level and rated short circuit capacity characteristics;
    - IP rating;
    - IK rating;
    - Fixing details for floor or wall mounting;
    - Front and back equipment connections and top and bottom cable entries;
    - Door swings;
    - External and internal paint colours and paint systems;
    - Quantity, brand name, type and rating of control and protection equipment;
    - Construction materials and plinth details, ventilation openings, internal arcing-fault venting and gland plate details;
    - Terminal block layouts and control circuit identification;
    - Single line power and circuit diagrams;
    - Details of cables routes within assemblies;
    - Busbar arrangements, links and supports, spacing between busbar phases and spacing between assemblies, the enclosure and other equipment and clearances to earthed metals;
    - Dimensions of busbars and interconnecting cables in sufficient detail for calculations to be performed;
    - Form of separation and details of shrouding of terminals;
    - Labels and engraving schedules;
    - Type of locking system;
    - Shop drawings of concrete plinths;
- Report for any alternative design solution. The report must incorporate reasons, calculations, risk assessment, assumptions (if any), sketches and shop drawings for the alternative solution;
- Samples of equipment, where possible, along with the manufacturer's technical literature;

- Operation and Maintenance Manuals of all installed systems. The manuals must be supplied in native and PDF formats. The manuals must include the following:
  - General description of the installation;
  - Technical description of the systems installed, written to ensure that the Department's staff fully understand the scope and facilities provided. It must identify function, normal operating characteristics, limiting conditions and emergency operation;
  - Technical description of operation mode of the systems installed;
  - Manufacturers' technical literature for equipment installed or assembled specifically for the project, excluding irrelevant matter. Each product data sheet must be marked to clearly identify specific products and component parts used in the installation, and data applicable to the installation;
  - Supplements to product data to illustrate relations of component parts;
  - Safe starting up, running in, operating and shutting down procedures for systems installed; It must include logical step-by-step sequence of instructions for each procedure;
  - Control sequences and flow diagrams for systems installed;
  - Legend for colour-coded services;
  - Schedules of fixed and variable equipment settings established during commissioning and maintenance, including a list of all metering devices connected to the Central Monitoring System and their settings;
  - Schedule of normal consumable items, local sources of supply, and expected replacement intervals. It must include lubricant and lubrication schedules for equipment;
  - Instructions for use of tools and testing equipment;
  - Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding;
  - Material safety data sheets (MSDS);
  - Copies of test certificates for the installation and equipment used in the installation;
  - Test reports;
  - Operational and Training Manuals.
  - Switchgear and control-gear assembly circuit schedules including electrical service characteristics, controls and communications;
  - Maintenance procedures and program, relating to installed systems and equipment. It must indicate dates of service visits, state contact telephone numbers of service operators and describe arrangements for emergency calls;
  - 'As Installed' drawings showing dimensions, types and location of the services in relation to permanent site features and other underground services. Drawings must also show the spatial relationship to building structure and other services. All changes made during commissioning and the maintenance period must be included. Drawings must be supplied in native AutoCAD® and PDF formats (other drawing formats are not acceptable);
  - Certificates of Compliance. A minimum of four certificates are required:
    - An electrical CoC covering the (empty) pit and conduit work;
    - A Telecommunications CoC (Form TCA1); covering the (empty) pit and conduit work (unless communications work was not involved);
    - An electrical CoC covering all the electrical work undertaken (installation or modification);
    - A Telecommunications CoC (Form TCA1) covering all the communications work undertaken (installation or modification) if applicable.
  - Site commissioning software configuration files, and source files for all as-built site documentation of the Programmable Lighting Control System—hard-copy to be installed and issued on a USB flash drive.
- Circuit breakers settings along with final connected loads;

- Evidence of discrimination between Electricity Supply Authority service protection device and main incoming switch;
- Schematic diagram of power monitoring system along with relevant information and equipment technical literature;
- Remote access configuration for power monitoring and lighting control systems.
- Test results for Ohmic resistance of installed earth electrodes;
- Calculations showing earth fault-loop impedance conforms to the requirements of *AS3000*, Clause 5.7.4.
- Technical data sheets for luminaires, lamps and control gear (including power factor correction equipment if not integral);
- Lighting control system schematic and configuration settings; and
- Site verification results demonstrating compliance with the luminance levels in Section 11.3 above in accordance with clause 3.6.2 of *AS 1158.3.1*, including details of any light level dimming that was possible.

APPENDIX 1 – ISOLATION TRANSFORMER REQUIREMENTS

A1.1 General Requirements

The isolation transformer must be provided to isolate the railway traction supply earthing system from the local Electricity Supply Authority earthing Multiple-Earthed-Neutral system where low voltage supplies are required. The transformer must be located on the rail corridor property unless specified otherwise in the Project CSTR. The minimum separation required between SAPN's Network earthing point and isolation transformer earthing grids is 6 m, however a greater separation may be required if the SAPN earthing grid is extensive. Computer modelling of EPR may be required in such instances. Similar requirements must be adhered to in the case of Railway Signalling earthing systems.

Refer to the E&B Guidelines AR-EL-STD-0102 (train) or TP2-DOC-002020 (tram) for transformers installed within the railway corridor and also for cases in which the transformer has to be installed outside the railway environment.

The transformer must be earthed such that the earthing system impedance (with the traction earth bond disconnected) must comply with AS 3000, Clause 5.7.4.

Note that a railway-owned HV supply transformer can provide the functionality of an isolation transformer. In this case, the traction earthed railway supply may then result in simultaneous contact between traction earthed objects such as station lighting masts on the boundary of the railway alignment and MEN earthed objects which are closer than 2.5 m, for example, street lighting masts. In this case an isolation transformer is required to isolate this supply from traction earth. The secondary of the isolation transformer must be connected to an independent earthing system.

A second isolation transformer is required for all sub circuits in excess of 500 m to contain the touch potential between the local traction earth and that extended from the traction earth connection at the main transformer—refer to the E&B Guidelines.

A1.2 Specifications

The isolation transformer must comply with the requirements of:

- *AS 61558.2.4: Safety of Power Transformers, Power Supplies, Reactors & Similar Products – Particular requirements and tests for isolation transformers and power supply units incorporating transformers;*
- *AS 60076.11: Power Transformers – Dry-type Transformers;*
- Document *TP4-DOC-003507 – Earthing & Bonding;*

and the additional specific requirements of this document.

The transformer must be suitable for continuous operation at nameplate rating under the environmental conditions specified in Table A1 (a) below:

CONDITION	REQUIREMENT
Minimum degree of protection	IP 55
Maximum ambient temperature	50°C
Minimum ambient temperature	-5°C
Maximum altitude	1000 m above sea level
Maximum relative humidity	95%
Maximum solar radiation intensity	1.1 kW/m²

Table A1 (a) – Environmental Conditions

The isolation transformer electrical characteristics must conform to Table A1 (b) below:

CHARACTERISTIC	REQUIREMENT
Rated power	As required. Standard sizes (kVA): 3.6, 10, 15, 25, 40, 63, 80, 100, 125, 160, 200, 315 & 400
Primary-to-Secondary ratio	1 : 1
Tapping	Transformers must be provided with tapping 5% above and below the nominal input voltage in 2.5% steps. Tappings must be arranged so as to be suitable to be altered by off-circuit bolted links.
Vector group	Dyn11
Windings	Separate primary and secondary windings with earthed screen interposed between the windings.

Table A1 (b) – Electrical Characteristics of Isolation Transformers

The isolation transformer must be designed with Class H insulation and natural air (NA) cooling. Transformers must have a maximum winding temperature rise of 115°C above a 50°C ambient temperature when mounted in their enclosure. The entire transformer core and coil assembly must be impregnated with Class H varnish and baked in accordance with the varnish manufacturer's specifications.

The isolation transformers must be of double wound isolation type and must incorporate an electrostatic earth screen of a minimum 0.5 mm thickness. The earth screen must be terminated to a separate terminal marked "Screen".

The transformer windings must be constructed of copper and mounted on a core of high-grade grain-oriented silicon electrical steel. The windings must be securely fixed to the core to prevent movement. Winding end turns must be positively secured.

The transformer core and coil assembly must be mounted in the enclosure on insulators suitable for the insulation levels specified in Table A1(c) below. The entire core and coil assembly must be insulated from the enclosure and must be mounted using high tensile fasteners.

The transformer must be constructed to *AS 61558.2.4* using uniform insulation. Short duration power frequency testing to be performed on the isolation transformer must be in accordance with the table below:

TEST	VOLTAGE	MINIMUM INSULATION RESISTANCE AT **500** V DC
Primary to earthed secondary and enclosure, with core and screen floating	5 kV AC RMS for 60 seconds	100 MΩ
Secondary to earthed primary and enclosure, with core and screen floating	5 kV AC RMS for 60 seconds	100 MΩ
Screen to earthed primary, secondary, and enclosure with core floating	2.5 kV AC RMS for 60 seconds	10 MΩ
Core to earthed primary, secondary, with enclosure and screen floating	5 kV AC RMS for 60 seconds	10 MΩ
Core to earthed enclosure with primary, secondary and screen floating	5 kV AC RMS for 60 seconds	10 MΩ
Screen to earthed core and enclosure with primary and secondary floating	5 kV AC RMS for 60 seconds	100 MΩ

Table A1 (c) – Insulation Requirements

The transformer must be subjected to a separate source induced over-potential test at twice rated voltage and two times rated frequency for a minimum of 5 minutes in

accordance with *AS 61558.1*. Note that the frequency can be increased and the duration reduced in accordance with Clause 18.4 of *AS 61558.1.*

A1.3 Enclosure and Terminations

The transformer must be mounted in a weatherproof enclosure with IP 55 rating constructed of metal incorporating mounting holes and provision for lifting by forklift or similar.

The enclosure must be designed to minimize external dimensions, according to the size of the transformer, whilst providing maximum surface area for cooling purposes. Ventilation by means of filtered grills at the top and bottom must be provided for air flow within the enclosure. Transformers must be rated for operation without fan cooling.

All external surfaces of the enclosure must be designed to withstand the impact of a test to IK07 without exposing live parts.

All primary, secondary and screen termination must be made of nickel-plated brass or stainless-steel studs, or pre-drilled copper flags. All winding terminations must be brought out to terminals or studs mounted in IP 56 termination enclosures mounted on the outside of the main transformer enclosure. Tappings may be located in these termination boxes or inside the transformer main enclosure. An earth stud must be provided within the transformer's main enclosure.

The enclosure must be of heavy-duty construction (IK07 minimum) in accordance with the requirements of section 9.3.1 above. The colour must be "Transformer Grey" or to the project's specification, subject to the Department's approval.

All removable covers must be securely fixed in place with internal hex tamper-proof vandal-resistant stainless-steel fasteners.

Primary, secondary and screen terminals must be located in separate termination enclosures or shrouded and separated such that it is not possible to bridge the primary and secondary windings unless disconnected from the primary supply. Cabling from the terminals to the transformer core and coil assembly must be double insulated and primary and secondary cables must be physically segregated.

Each termination enclosure must be fitted with two engraved labels with red letters on a white background and must read "DANGER nnn VOLTS" where nnn is the line voltage of the winding. The primary and secondary termination enclosures must be fitted with an additional label which must read: "WARNING – ISOLATE POWER BEFORE REMOVING THIS COVER" and "DO NOT INTERCONNECT THE EARTH SYSTEMS". The Department's standard label drawing *TP4-DRG-005124* must be followed. All labels must comply with *AS3100*.

The position of the termination enclosures must be such as to ensure that primary and secondary conductors are segregated. The terminals must be shrouded or made inaccessible by barriers such that primary and secondary terminals cannot be bridged.

Rating plates must comply with *AS60076 Power Transformers* and *AS3100* and must be of corrosion resistant metal. Rating plates must be engraved and mounted on the outside of the transformer enclosure. Tapping labels must be located adjacent to the tapping links.

The transformers must be routinely tested in accordance with *AS 61558.1, AS 60076.11* and Table A1(c) “Insulation Requirements”.

The first of each new design must also be temperature rise type tested. Test reports must be provided with the transformer supplied and submitted to the Department.

Drawing *TP4-DRG-004185 Isolation Transformer, 230V : 230V 15kVA, Typical Arrangement* details the requirements for a small isolating transformer (as used for neighbourhood stations). It also must be followed as a guideline for the manufacture of larger units.

APPENDIX 2 – EXPLANATORY NOTES ON THE CALCULATION OF VERTICAL ILLUMINATION LEVELS

When Vertical Illumination calculations are requested, numerous questions can arise in the mind of the lighting designer as to locations of calculation points and the direction(s) of the illuminance to be calculated. Horizontal Illumination calculations are typically less confusing, as they are usually performed either at ground or 'task' level on a grid of points. *AS 1680*: *Interior and Workspace Lighting* guides towards horizontal planes with uniform grid spacing of either 200 mm or 500 mm (depending on room size and shape), whereas *AS 1158* states that calculation points can be up to five metres apart in many instances.

Of *AS 1680* and *AS 1158*, *AS 1158* is the only standard which explicitly describes and illustrates the placement of vertical calculation points (including spacing, extremities and directions), ensuring that designers can provide results that can be meaningfully compared from one system to another without 'interpretation' of the Standard clouding the situation.

With reference to Figure A2, vertical illumination on open platform areas should be calculated as follows:

- For the purposes of this section, the term 'platform' means the structure designed to allow travellers to enter or exit a train on a single rail line. If the structure is an 'island platform' servicing two rail lines (one either side), a set of vertical calculations must be made for each half of the platform area;
- Vertical Illumination calculations must be performed at a height of 1.5 m above each platform floor level;
- For both straight and curved platforms, vertical illuminance calculations must be performed along two lines for each platform. The first line must be above the platform edge. The second line must be set halfway between the platform edge and the back of the platform area;
- The first and last set of calculation points must be set 7.5 m in from the respective platform ends;
- For open stations, vertical illumination calculation points must not be required underneath covered platform areas;
- The spacing between calculation points on each line must be no more than 5 m;
- Vertical Illuminance calculations must be performed in two opposing directions, aiming towards the platform ends. Where the platform is curved, the direction of the calculation point 'light meters' must be at a tangent to the curve at the centre of the platform.

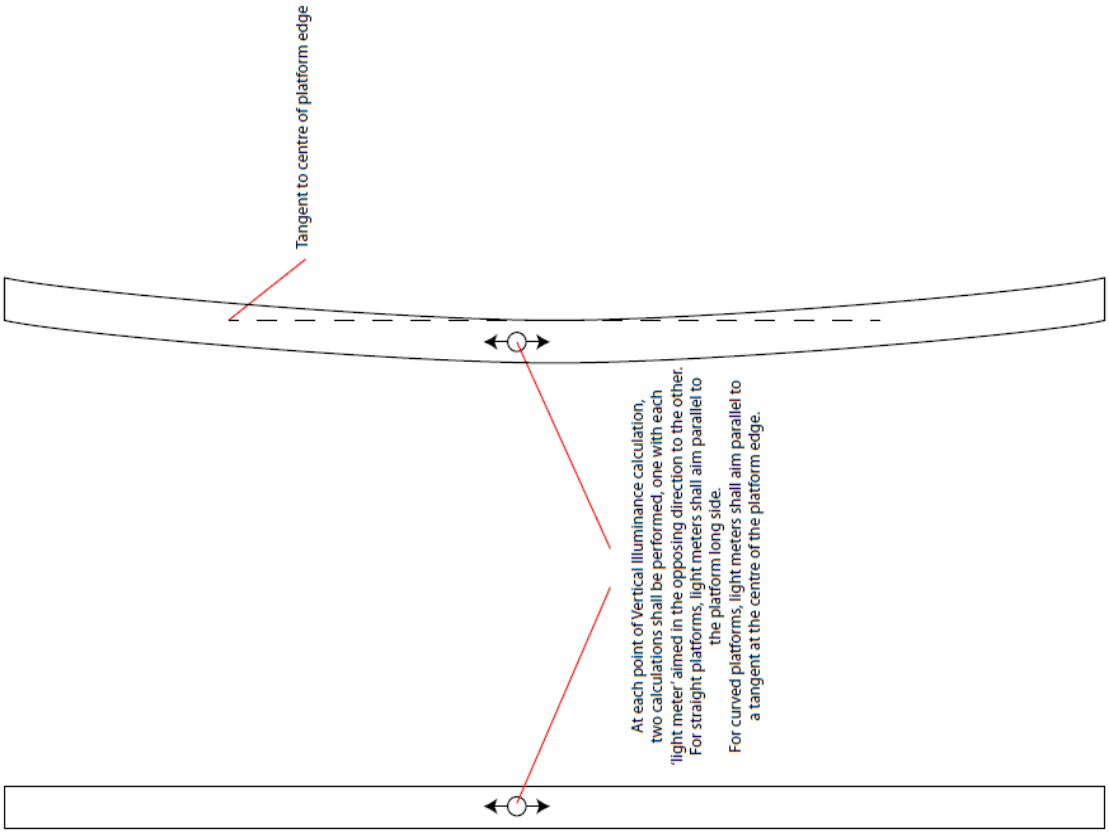

Fig 2

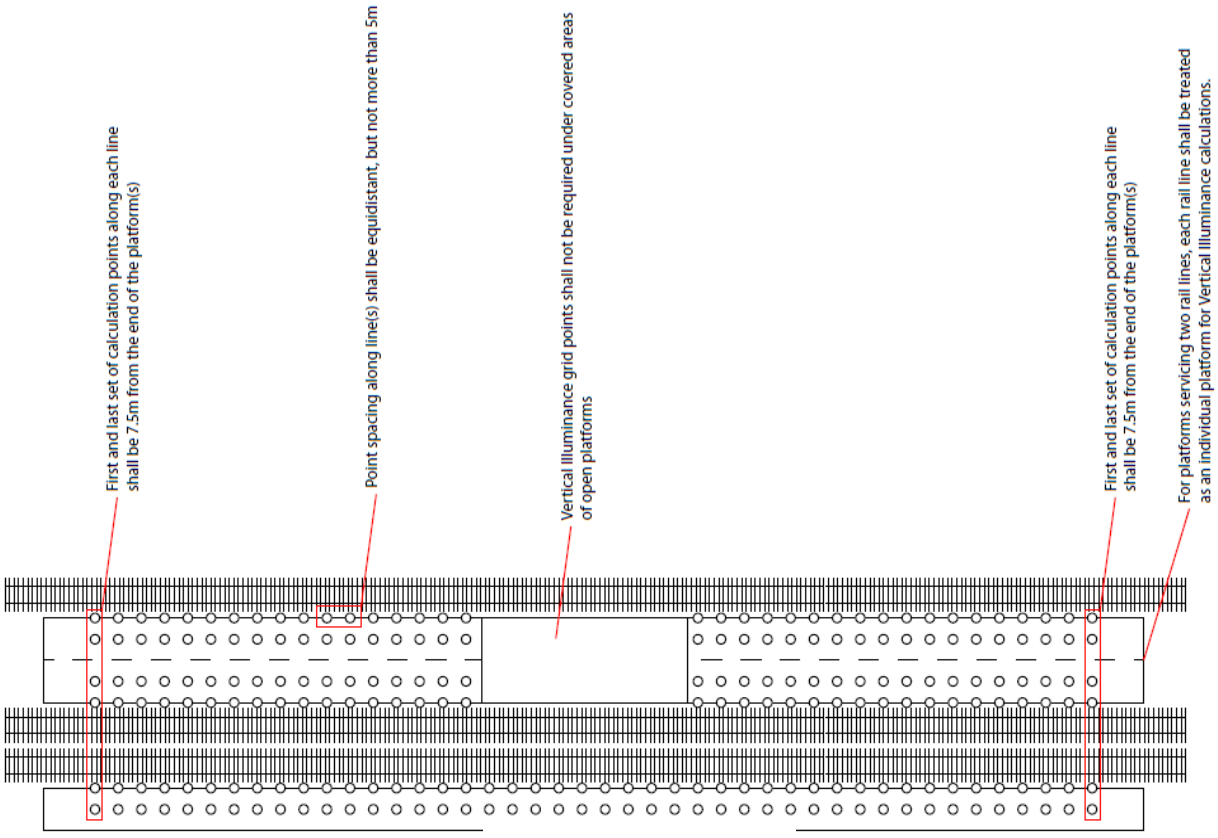

Fig 1

Figure A2