Signalling equipment housings

Telecommunications

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Reviews and Amendments

This document should be reviewed every one (1) year by the Group Manager Engineering or amended as appropriate if the nature of operations changes significantly.

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1. Conventions

1) Words or phrases that appear capitalised out of context are defined within the Definitions section of this VRIOG Standard.
2) The word **"Shall"** is to be understood as mandatory.
3) The word **"Should"** is to be understood as non-mandatory i.e. advisory or recommended.
4) Uncontrolled Standards may not be referenced within the VRIOG Standards. These include former PTC Standards, Franchisee Standards, Franchisee Subcontractor Standards and Infrastructure Lessee Standards.
5) Controlled Standards, including Australian Standards and other VRIOG Standards, may be referenced but only if:
    i) The referenced item cannot be adequately explained with an amount of text that could not reasonably be inserted into the body of the Standard.
    ii) The reader is not referenced to another Controlled Standard necessary for the item to be adequately explained i.e. one document link only.
    iii) The referenced document is a Figure or table and could not reasonably be included in the appendices of the Standard.
6) The format employed in the VRIOG Standards is compatible with Australian Standards, and will be used from this point on.
7) The numbering system for the VRIOG Standards is chronologically sequential from the point of introduction, and is not based on any form of interpretive system.
8) The VRIOG Standards contain engineering information necessary to operate a safe Railway. VRIOG Standards will not contain any information that can be construed as a work instruction, procedure, process or protocol. This information forms the basis of each individual entity's Safety Accreditation Certification, and, as such, is outside the scope of VRIOG Standards.

2. Definitions

2.1 Acronyms

Terminology	Definition
AFFL	Above the Finished Floor Level
AIRAH	Australian Institute of Refrigeration, Air Conditioning and Heating
ARO	Accredited Rail Operator
AS	Australian Standard
CER	Communications Equipment Room
CBI	Computer Based Interlocking
CBR	California Bearing Ratio – a penetration test for evaluation of the mechanical strength of road subgrades and base courses.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DMS	Drawing Management System
DDA	Disability Discrimination Act
ELD	Earth Leakage Detector
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
HV	High Voltage
IP	Ingress Protection - protection provided by enclosures of electrical equipment as regards: Protection of persons against access to hazardous parts inside the enclosure; Protection of the equipment inside the enclosure against ingress of solid foreign objects; Protection of the equipment inside the enclosure against harmful effects due to the ingress of water.
LAN	Local Area Network
LED	Light Emitter Diode
MEBS	Main Equipotential Bonding Strip
MEN	Multiple Earth Neutral
MMDD	Modified Maximum Dry Density
OHS	Occupational Health and Safety
RAS	Remote Arming Station
RHS	Rectangular Hollow Sections
SER	Signalling Equipment Room
SPD	Surge Protection Device – a device that limits transient over voltages caused by power line disturbances and by natural events, such as lightning strikes to, or near to, exposed conductors.
SPT	Signal Post Telephone
UPS	Uninterruptible Power Supply

Terminology	Definition
VRIOG	Victorian Rail Industry Operators' Group (VRIOG) comprises the following members: • Australian Rail Track Corporation (ARTC) • Metro Trains Melbourne (MTM) • VicTrack • V/Line • Yarra Trams • Public Transport Division of the Department of Transport
WAN	Wide Area Network

Table 1 Acronyms

2.2 Signalling Equipment Housing Categories

Category	Definition
Signalling equipment buildings	These are equipment housing structures that may be periodically or permanently occupied by authorised personnel to perform works.
Signalling equipment huts	These are precast or prefabricated structures that are smaller than equipment buildings, and are limited in space and facilities.
Signalling equipment boxes	These are enclosures closely encompassing racks and their mounted equipment. This classification also includes junction boxes, point clip boxes, power supply boxes (e.g. high voltage, battery, Uninterruptible Power Supply (UPS), supply authority and changeover contactor generators) and signal post telephone boxes.

Table 2 Signalling Equipment Housing Categories

3. Scope and general

3.1 Scope

The purpose of this document is to provide specifications on signalling equipment housings for detailed design by architects and by signalling, civil, structural, and services engineers.

3.2 Application

This standard defines requirements which apply to various housings and enclosures for signalling equipment and their surrounding areas.

It is intended to be read in conjunction with site- or project-specific documents such as briefing specifications and drawings that will state the location, design and construction options to be adopted (if applicable) and indicate any departures required as a result of the project specifics. It shall be read in conjunction with other relevant standards and particular project specifications.

3.3 Background

Signalling equipment housings vary according to size and purpose. They are categorised into the following three classifications:

a) Signalling equipment buildings (also called large signalling equipment rooms (SERs), relay rooms, etc.) – these are housing structures that may be periodically or permanently occupied by authorised personnel to perform works.

b) Signalling equipment huts (also called small SERs, equipment bungalows, etc.) – these are precast or prefabricated structures that are smaller than equipment buildings, and are limited in space and facilities.

c) Signalling equipment boxes (also called boxes, signalling boxes, zone boxes, module boxes, cluster boxes, location cases, etc.) – these are enclosures with equipment racks and their mounted equipment. This classification also includes junction boxes, point clip boxes, power supply boxes (e.g. high voltage, battery, UPS, supply authority, changeover contactor or generators), signal post telephone boxes (SPT), relay boxes, level crossing boxes, etc.

This document is structured to cover the general requirements for the signalling equipment housings, followed by specific requirements for types of housings.

4. Common Requirements

4.1 Selection of Housings

The type, size and facilities of a housing shall be determined by the designer in consultation with the respective ARO, and are predominantly based on the types, physical dimensions and amount of equipment that needs to be housed at a particular location and providing some capacity for future requirements.

Where the combined floor area requirements at a location exceeds 10 m2, an SER shall be provided instead of many individual equipment boxes.

4.2 Environmental Requirements

Design and location of housings shall take into account local environmental conditions including, but not restricted to, potential for flooding, exposure to fires, solar exposure and restricted air circulation.

Where flooding occurs, the floor level (or foundation) shall be set at least 250 mm above the calculated 1:100 year flood level or 500 mm above highest recorded flood level at the site.

Where an enclosure houses environmentally hazardous liquids, the design shall make provision for the containment of spills.

Housings shall have ingress protection (IP) that meets the requirements and ratings set out in TS-ST 040 “Environmental Conditions” in accordance with AS 60529 “Degrees of protection provided by enclosures (IP Code)”.

Further details of environmental requirements for housings are described in TS-ST 040.

4.3 Temperature Control

The temperature controls of a housing shall be sufficient to maintain its internal temperature within the manufacturer-specified operational temperature ranges of all equipment in the housing.

Housings shall be provided with temperature control measures appropriate to the amount of heat generated by the equipment that it will house. The heat removal capacity to be provided shall be based on the calculated equipment generated heat load.

The hierarchy of temperature controls for housings are (in descending order):

a) Ventilation[1]
b) Shade Structure
c) Air-conditioning

[1] Extensive trials have shown that improved ventilation provides the most significant improvement to internal ambient temperatures, compared to double skinning or tropical roofs. However improved ventilation also increases dust in housings. Improved thermal insulation can reduce the amount of ventilation required.

4.3.1 Ventilation

At least 2% of the total air moved shall be fresh air.

Unrestricted low-level inlet air vents shall be provided by a combination of wall and door vents.

High-level outlet air vents shall be provided through wall, door or roof vents.

Vents shall be designed to prevent water (rain) entry and minimise the entry of air borne dust, and be fitted with effective insect barriers which provide minimal restriction to the air flow. They shall have vandal-proof covers fitted.

4.3.2 Shade Structures

In some locations or installations, where local conditions mean that ventilation alone would not provide the necessary temperature control, a shade structure comprising roof- and (possibly) wall-screening shall be provided to limit solar energy gain within the housing.

Provision of shade structures is secondary to the provision of proper ventilation.

The shade roof- and wall-screening may be attached directly to the housing, or may be a standalone structure spanning over the housing.

Wall screening shall only be required:

a) On northern and western walls where the housing will be fully exposed to afternoon sun; and

b) Where roof shading does not extend beyond the housing eaves.

Shade roofs shall be designed to reduce the entrapment of heated air underneath the structure. Open metal louvre mesh should be used in preference to solid metal roofing. Mesh should be oriented to present the maximum opaque surface to midday and afternoon sun.

The roof slope can be reduced if the roof material is not solid and permits heated air to rise through the roof.

With solid metal roofing, the slope should be between 10 and 18 degrees to allow the heated air to escape. The low side should be on the North or West side depending on the available natural shade. The low side should be toward the North if no other shade is available. These guidelines are based on studies published by the CSIRO on shade structures.[2]

4.3.3 Air-Conditioning

Refer to Section 5.9

4.4 Power Supplies

The standard voltages used within the Victorian railway signalling infrastructure are nominally 240V 50Hz AC, 110V 50Hz AC, 50V DC, 24V DC and 12V DC.

For standards related to signalling power supplies, refer to VRIOGS 012.2 “Specification for Signalling Supply, Construction and Installation” section 8 “Power Supplies” and VRIOGS 012.7.11 “Power Supply Units for Signalling Equipment – General Requirements”.

[2] Refer to the CSIRO books titled “Sunshine and Shade in Australasia” and “Design of Sunshading Devices”. They can be purchased online at www.publish.csiro.au/books/

4.5 Earthing

4.5.1 General Requirements

a) Earthing for CBI signalling equipment shall be installed as per this standard and in accordance with the CBI equipment manufacturer's specifications.

b) Earthing of equipment within SERs shall be of the prime earth concept; constructed so that all equipment in the SER needing to be earthed is earthed via a main central terminal block wired to earth spikes, in accordance with AS 3000 "Wiring Rules".

c) A separate earth shall be provided for each housing (unless they are in close proximity – refer to section 4.5.2 below)

d) Housings shall be earthed using earth spikes connected to the main central earthing terminal block.

e) All conductive parts of enclosures shall be earthed.

f) Earth wiring shall not be run in the same conduits or cable enclosures as wiring and cabling for signalling, power, or communications.

g) All cables constructed with metallic earthing conductors shall be connected to earth in accordance with AS 3000 and VRIOGS standards.

h) All shielded cables to trackside signalling equipment shall have the earth drain wires of the cables connected only to the prime earth connection at the housing end point. The opposite end of the earth drain wire shall be insulated and covered by an approved means such as a heat shrinkable tube.

Drawings STD_G0009 and STD_G0010 provide a visual representation of the earthing arrangement (see SECTION 10.0 for the table of drawings)

For additional information, refer to PTV Infrastructure Drafting Standards.

4.5.2 Earthing Principles

The earthing system connects all artificial and natural earth electrodes. Its function consists of directing the lightning current diverted from the equipment into the ground in order for it to dissipate there. Housings that, for various reasons, require earthing are to be provided with an overall earthing system complying with all requirements.

In housings accommodating signalling and safety equipment, the potential rise of the housing has to be kept low by means of a low earth electrode resistance, as the high number of links to the interlocking outdoor equipment creates a connection to a distant potential. During a lightning strike the building's potential rises, thereby stressing the isolation points to the outdoor equipment on the electronic interface module boards.

A low-impedance earthing system shall be provided to mitigate the potential rise. It is implemented using a low-resistance earth electrode with a minimum of inductive components (i.e. using short connections) and the main equipotential bonding strip (MEBS) being connected to all surrounding parts that are conductive or in contact with earth.

In addition, the earthing systems of surrounding buildings are to be integrated if distances between these systems are below 20 m. Where distances exceed 20m, earth electrodes of high steeples or other buildings endangered by lightning should not be integrated in the earthing system if there are no electric connections to these buildings.

Foundation earth electrodes are an especially low-cost earthing system. Zinc-plated iron (preferably iron strap) is enclosed in the foundation of the building. The concrete protects it against corrosion, thus giving it a nearly infinite lifetime. Connection lugs brought out in the appropriate positions are used to connect the earth electrode to the MEBS. The lugs have to be protected carefully against corrosion by using stainless steel, zinc-plating, anti-corrosive sheath, etc. The performance of the earth conductor is further improved by integrating all reinforcement mats, thus turning it into a planar earthing electrode. If the reinforcement mats are integrated via lashings, it has to be noted that on average only a third of the lashings can be assumed to be conductive. For this reason, the number of lashings must be increased correspondingly or clamps have to be used instead.

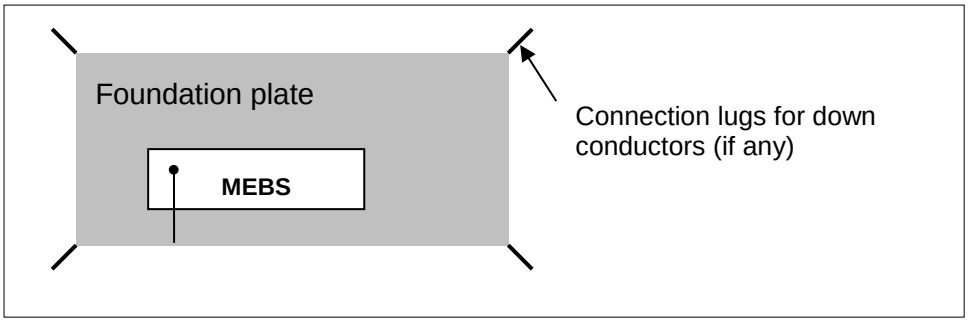

Figure 1 Copper meshed network underneath double floor

If no foundation earth electrode can be implemented (e.g. for existing buildings), a ring earth electrode, preferably made of non-corrosive steel or zinc-coated steel, will have to be laid around the building. It should be laid at a distance of 1 metre from the building walls and a depth of 1 metre.

Another option is buried earth electrodes which are to be interconnected (e.g. within the building).

4.5.3 Earth Resistance

An earth resistance not exceeding 5 Ω (ideally 2 Ω for all locations where CBI and similar electronic equipment is housed) in all environmental conditions shall be provided for SERs. There are several ways to reduce the earth resistance to the desired level:

a) Lengthen the earth electrode in the earth;

b) Use multiple rods; or

c) Treat the soil with chemical compounds.

In the extreme situation where an acceptable connection to earth cannot be achieved, it would be necessary to rely entirely on equipotential bonding to protect persons and equipment against hazardous potential differences caused by lightning.

For detailed standards on earthing resistance, refer to AS 1768 “Lightning Protection”.

Where locations are encountered that exhibit poor site conditions and where the above methods may not meet the requirements, it will be necessary to seek expert advice from industry specialists for “earthing, lightning and surge protection”.

4.6 Equipotential Bonding

4.6.1 Principles of Equipotential Bonding

In interlocking rooms, equipotential bonding is necessary. Its primary purpose is to:

- optimise protection against the effects of lightning;
- ensure personnel protection; and
- ensure electromagnetic compatibility (EMC).

Since lightning protection is a part of EMC, the measures are divided up into:

- suppressing high frequency interference sources;
- balancing short-time potential differences during lightning interferences; and
- reducing possible influences of lightning flashes and surges.

4.6.2 Methods of Equipotential Bonding

Two methods are available for this:

- star-connected equipotential bonding; and
- meshed equipotential bonding (preferred)

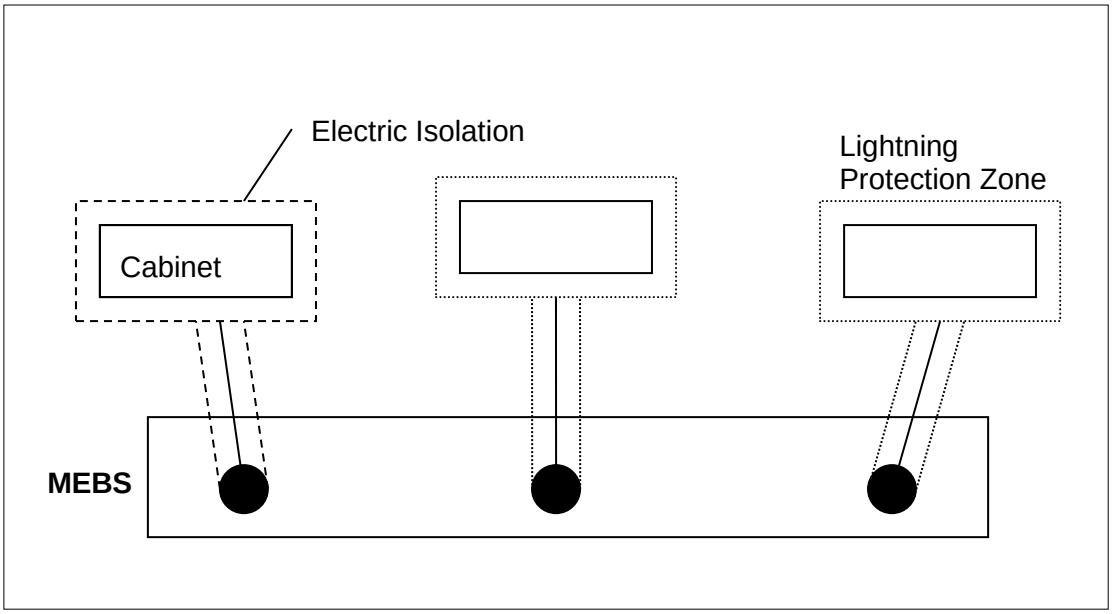

Figure 2 Star Connected equipotential bonding within a lightning protection zone

Where star-connected equipotential bonding is employed (see Figure 2), all racks within a lightning protection zone (e.g. an SER) are connected to the MEBS of this lightning protection zone, and the racks are insulated from one another and against their environment. The radial design eliminates low-frequency resistive loop currents. This system must be checked at regular intervals, since unintended random connections destroy the star-connected system. Likewise, it is not allowed to bring shields of connecting cables between devices into contact more than once. In separate SERs without electric installations (e.g. cable termination rooms), the meshed network is not required.

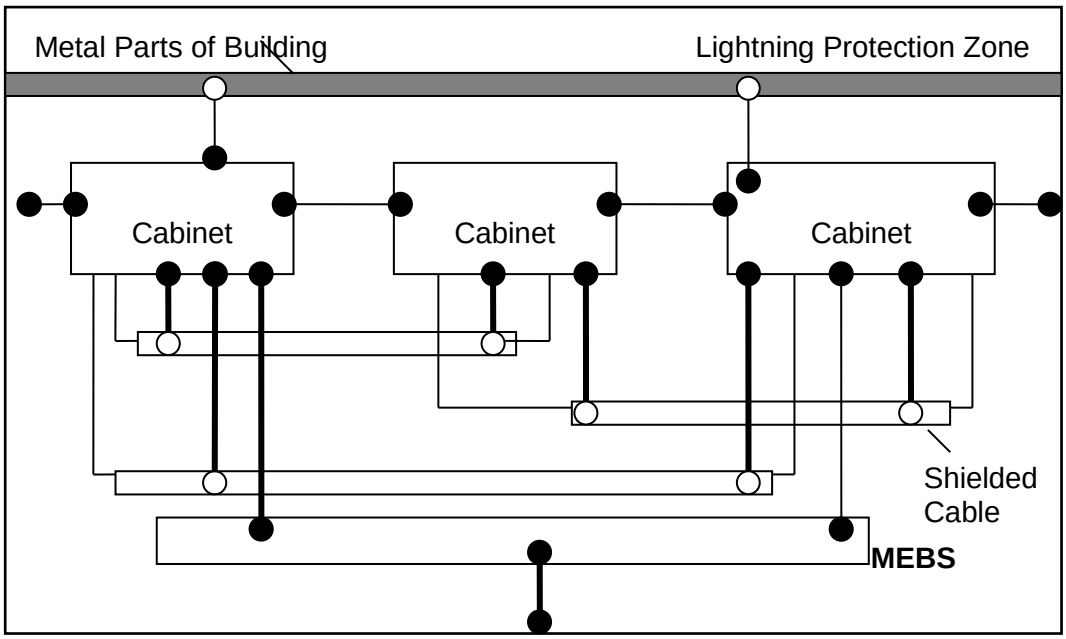

Figure 3 Meshed equipotential bonding within a lightning protection zone

Where meshed equipotential bonding is employed (see Figure 3), the racks are connected to the MEBS and to one another by means of many short connections, screwed or bolted joints of conductive installations, shields, random connections, etc.

In electronic interlocking rooms, many meshed connections occur between the control racks, especially since the cable shields of signal and data cables are connected at both ends. Via these low-impedance connections, the resistive and induced equalising currents are dispersed to many cable connections. The short-circuit loops set up by the equipotential bonding act as magnetically reducing loops: they counteract the permeating field and reduce its strength. Voltages induced in conductor loops formed by cables are also reduced effectively.

The conductive paths of this meshed equipotential bonding form a meshed network of conductors. Magnetic fields caused by lightning currents induce voltages into this network. The equalising currents of these voltages produce an opposing field and thus attenuate the invading magnetic fields.

The meshed network consists primarily of the steel reinforcements of the building. It is implemented by bonding the reinforcing rods with one another and with the equipotential bonding system.

Sometimes, due to the design and construction of the building, the steel reinforcements cannot be used for a meshed equipotential bonding network, because instead of reinforced concrete a different material is used, or the reinforcements are not bonded continuously, or there are no connections. In these cases, as an additional measure, the supporting conductive framework of the false floors shall be set up as a meshed network, thus producing a similar effect. In order to achieve this, the vertical supports of the false floor framework must be connected with profiles in a highly conductive way (with frictional connections by screws, wedges, etc.). The framework must be connected to the equipotential bonding strip of the SER in the shortest possible way.

Another alternative for setting up a meshed network is installing a network made up of copper wire or copper tape (area ≥10 mm2) underneath the double floor with connections at all intersections (see Figure 4). This can be done by soldering or clamping. If necessary, it must be connected to the floor supports for electrostatic discharge (ESD) purposes.

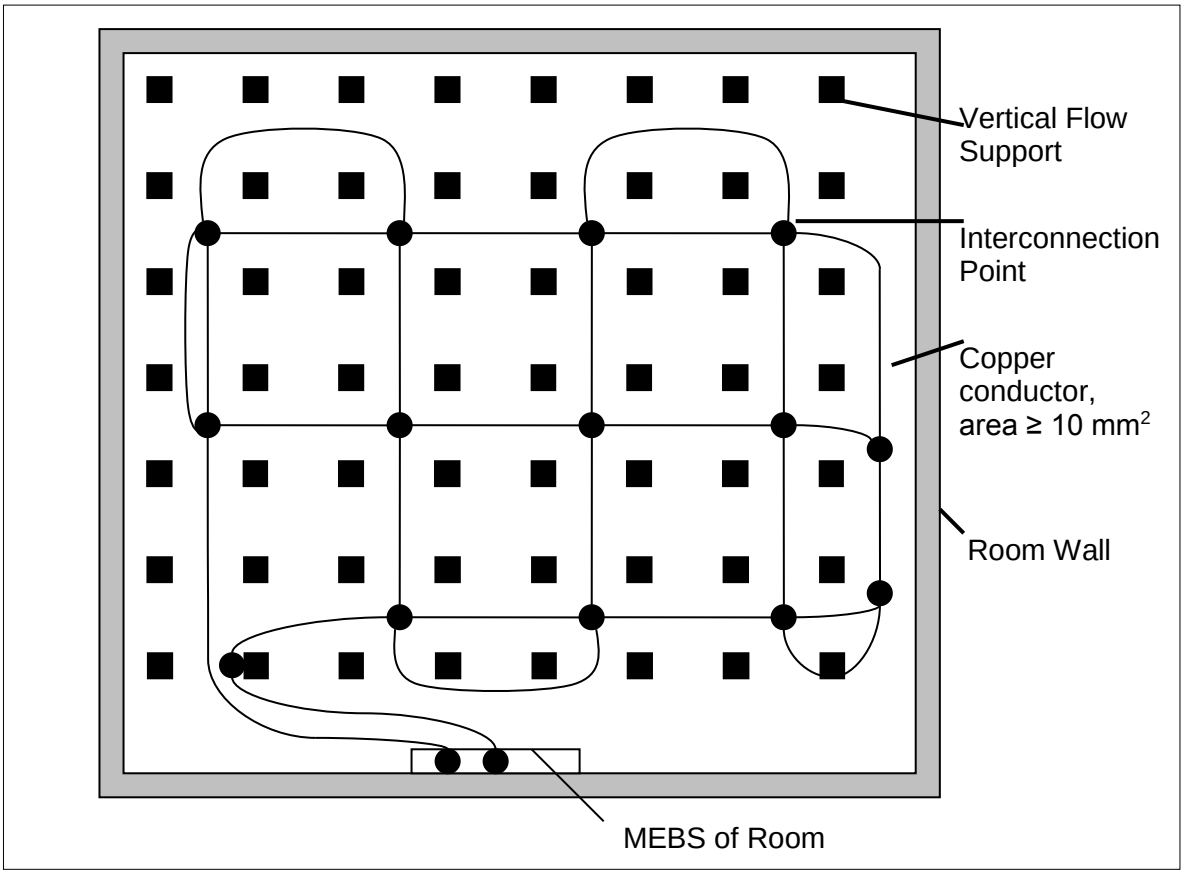

Figure 4 Copper meshed network underneath double floor

Where the meshed equipotential bonding is employed, the control cabinets and equipotential bonding connections are not subject to insulation requirements. Therefore, checks of the meshed equipotential bonding are not necessary. For certain tasks, parts of the equipotential bonding system are set up permanently (e.g. for personnel protection).

For a number of reasons, the more economical and fault-tolerant meshed equipotential bonding system is preferred for signalling systems. In this system, all the other requirements, such as personnel protection, EMC, and functional earthing, can be integrated without causing major problems. Furthermore, there are no additional requirements for the design and set-up of the SERs for the signalling equipment. Integrating commercially available devices is also facilitated.

4.7 Surge Protection

Appropriate surge protection zones shall be defined for equipment installed in the housing, such that appropriate category of surge protection devices (SPDs) are fitted on the zone boundaries. For detailed requirements, refer to TS-ST 038 “Lightning and Surge Protection – General Requirements” and AS 1768 section 5.6 “Protection of Equipment”.

All wiring between the field and the housing is to be known as “dirty wiring”. “Clean wiring” includes all internal wiring electrically isolated from “dirty wiring”, as well as all internal wiring electrically interfaced to “dirty wiring” via appropriate surge protection. “Dirty wiring” shall be adequately separated from all “clean wiring” to limit electromagnetic interference (EMI) of “clean wiring” due to potential surges in “dirty wiring”. A separation distance of 300 mm is required where the “clean wiring” interfaces with CBI

equipment. Where it is impractical for “dirty wiring” not to cross “clean wiring”, the crossing shall be at 90° to minimise EMI.

4.8 Lighting

Lighting shall comprise fluorescent batten fittings, which shall be double insulated and not earthed.

Diffusers shall be provided to even illumination around equipment racks, walls and inside cabinets when the doors are opened.

Ceiling mounted light fittings shall be provided in front and rear of racks and cabinets. Light fittings shall not encroach upon the space above racks and cabinets, which shall be reserved for cable tray, power distribution and fire detection sensors.

Lighting shall ensure an average illuminance of 500 lux on a horizontal plane 1 m above the finished floor level (AFFL) at equipment termination spaces (including on walls) and at the front and rear of cabinets and racks. The spot illuminance may be up to 30% lower than the average at any point between the rack front or rear and the wall opposite.

4.9 Installation of Equipment in Housings

The equipment in SERs shall be installed to enable the most efficient use to be made of the available floor space. For details, refer to section 5.4.

Overhead trunking and cable racking shall be installed to have not less than 2100 mm clearance between floor level and the trunking or racking.

Communications equipment, power supply equipment, vital signalling equipment, and non-vital signalling equipment shall be grouped and mounted separately. This equipment shall be labelled according to VRIOGS 12.2 section 21.8 “Labelling of Equipment”.

Adequate ventilation shall be provided around heat producing equipment.

All racks shall be constructed and installed to have an overall height such that the uppermost piece of installed signalling equipment within is maintainable without the aid of steps or ladders (by 5 to 95 percentile height of personnel). Equipment shall not be mounted lower than 450 mm or higher than 1800 mm from floor level. Equipment racks shall not exceed 2000 mm in height.

All equipment shall be mounted in positions that facilitate ease of access for regular maintenance, inspection, testing or replacement.

Equipment that is heavy (i.e. over 15 kg) shall be mounted in the lower section of relay racks.

Equipment shall not be directly mounted to the floor of boxes, huts or rooms.

4.10 Cable Entry

At least one cable pit or turning chamber shall be provided at the periphery of the housing, for the termination of external buried or surface cable ducts, before the cables enter the housing. The size and depth of pits and chambers shall be calculated to accommodate the particular cable route requirements, access requirements for cable installation and cable jointing activities.

All spare conduits shall be cleaned, fitted with a draw wire of 6 mm polypropylene blue/yellow rope suitably anchored at each end of the pipe and then sealed with end caps to prevent the ingress of dirt, etc.

All used conduits shall be sealed after the completion of works at all ends of the conduits to prevent pit gases, dust, moisture, rodents and insects entering the housing via the conduits.

For detailed requirements, refer to VRIOGS 12.2 and VRIOGS 12.2.1 “Standard for Construction of Cable Route and Signalling Civil Works”.

4.11 Name Plates

Nameplates shall be provided on all housings.

Nameplates shall be provided on all doors. Nameplates shall also be provided for SERs on the wall facing the entry path.

Nameplates shall be secured to metal walls using metal tacks. Nameplates shall be secured to masonry walls using rust-proof screws and wall plugs.

The nameplate material shall be weather-proof and maintenance-free. It shall preferably be Architectural Bronze alloy plate stock, satin finished with engraved areas painted with Dulux Pioneer colour enamel or similar.

The lettering shall have a height of 50 mm for doors and 100 mm for SERs.

4.12 Hand Rails

Handrails shall be provided to any path where:

a) any part of the path is within 3 m of the nearest rail of any railway line; or

b) the edge of the path is within 2 m of the top of fall areas (such as the top of embankments or cuttings, drains or culverts) and that there is a danger to persons falling greater than 2 m; or

c) slopes of greater than 1 in 1.15 are encountered.

If handrails are to be installed then a minimum distance of 400 mm clearance is required between the edge of any open door and the closest handrail.

For further requirements, refer to AS 1657 “Fixed Walkways, Handrails and Ladders”.

4.13 Retaining Walls

Retaining walls may be required to reinforce soil on a slope, where the soil instability poses a hazard to persons or equipment. Embankments adversely affected by excavation works shall be investigated to determine the need for retaining walls.

For further details, refer to VRIOGS 12.2 Section 16 “Retaining Walls, Steps Ladders and Handrails” and AS 4678 “Earth-retaining structures”.

4.14 Security Fence Gate

Where fencing of the railway reserve prevents access to any signalling equipment, the fence shall be cut and modified, and an access gate shall be supplied and installed. The gate is to match the existing fencing and maintain security. The gate shall be secured and padlocked with a railway 1P5P lock, or ARO approved locking system.

4.15 Siting

Care shall be taken to ensure that housings are positioned clear of:

a) Structure gauges

b) Access roads and pathways
c) Drainage paths or structures unless measures are put in place to provide for continued operation of drains
d) The area into which catchpoints or a derail will deflect a derailed vehicle
e) The ends of sidings where error may lead to overrun
f) Non-interlocked (hand thrown) points in yard areas
g) Line of sight of signals
h) Line of sight of level crossings (including pedestrian crossings)

Where possible, no part of the housing shall be closer than 2 m to an access road; but outside this limit, as close as possible for accessibility purposes.

Where located close to a road crossing, the housing shall be positioned as close as practicable to the railway boundary and be positioned to not obstruct the road vehicle driver's line of sight relative to approaching trains.

Detailed site survey plans shall be developed to show the position of housings and relevant site features.

4.16 Telemetry

Telemetering of the electrical and electronic systems within (or adjacent to) vital housings shall be provided. These systems may include one or more of the following:

a) Signalling system
b) Power system
c) Security system
d) Fire protection system
e) Temperature

The telemetry requirements are specified by the respective ARO, in line with their policies on alarms and indications.

4.17 Exterior Finish

The exterior surfaces of housings shall be finished with an ARO approved anti-graffiti finish which both resists the adhesion of applied paints and sprays, and responds readily to removal of graffiti with non-aggressive cleaning materials, with no deterioration of the anti-graffiti finish itself.

Any finish to housings shall be glare-free for the life of the housing.

4.18 Exterior Finish

Housings that enclose electricity generating sets shall comply with AS 3010 "Electrical installations - Generating sets".

4.19 Pipe and Duct Identification

Identify all pipes and ducts in accordance with AS1345 with "Safetyman" Labels or equivalent

5. Signal Equipment Rooms Requirements

5.1 Power Supply

5.1.1 240 Volt Electrical Services

This 240 V supply should be independent from the signalling power supply. A 240 V switchboard with separate power and light circuits shall be provided. The work shall be as required by AS 3000 for low voltage application. Residual current device protection shall be provided covering both power and lighting circuits.

Cabling to light fittings, switches and socket-outlets shall be carried in conduit encased in the floor, walls and roof.

In each SER, at least one double 240 V socket-outlet shall be provided per 10 m2 (or part) of floor area, evenly distributed around the room. A separate socket-outlet shall be provided for every permanent electrical fixture provided in the room (e.g. air-conditioning).

Two distinctive red socket-outlets supplying 240 V signalling power shall be provided adjacent to 240 V signalling maintenance equipment (e.g. at maintenance terminals). Consideration shall be given to providing two additional red socket-outlets in the SER for future-proofing.

240 V signalling maintenance equipment (e.g. at maintenance terminals) shall operate off the 240 V signalling power supply. Two distinctive red socket-outlets supplying 240 V signalling power shall be provided adjacent to the signalling maintenance equipment, with consideration given to future-proofing the SER by installing two additional red socket-outlets.

Where a power room is established as part of the equipment building or hut, as a minimum the following requirements shall be met:

- A separate external door (and associated pathway) with the same security features as the SER (e.g. alarms)
- Signage (nameplates) identifying this power room
- Adequate size for the maintenance of power equipment within the room
- Lighting as defined for SERs throughout this standard
- Temperature controls as defined for SERs throughout this standard
- Fire protection consistent with the adjacent SER

5.1.2 Additional Requirements for High Voltage Equipment Rooms

High voltage equipment such as switchgear, busbars and transformers shall be installed in a lockable area separate to the SER.

High voltage equipment rooms have additional requirements to ensure the safety of personnel working in the electrically hazardous area. Some of these requirements include:

a) A high voltage warning sign(s)

b) An earth mat is provided around high voltage housings as part of the earth protection arrangements for the high voltage installations

c) Provision of Residual Current Devices in areas where there is significant risk of an electric shock due to the failure of other protection measures and operator carelessness.

Comprehensive requirements can be found in AS 2067 “Substations and high voltage installations exceeding 1 kV A.C.”

5.2 Fire Protection

5.2.1 Building Materials and Design

All components shall have a minimum fire rating of two hours.

SERs shall be constructed from non-flammable materials.

Where buildings consist of multiple rooms, the design shall be such as to minimise the potential for fire in one room to propagate to adjacent rooms.

Voids (including roof spaces) shall be avoided. Dividing walls between rooms shall be continued to the roof line. Where air-conditioning is provided, the use of ducting between rooms is to be avoided, with separate rooms having separate systems.

Penetrations between rooms or on walls shall be sealed at the wall positions by suitable fire resistant material.

Any open areas beneath SERs shall be enclosed.

5.2.2 External Location and Environment

By suitable design, SERs shall be protected against external fires, including bush and grass fires.

Vegetation shall be prevented from growing against walls by clearing the area surrounding the SER (typically 2–3m wide) and resurfacing the clearing (typically with crushed rock). Refer to the procedures of the respective ARO.

Penetrations and vents shall be designed to prevent the ingress of windborne sparks.

5.2.3 Fire Protection Systems

A minimum of one 6 kg dry-powder fire extinguisher shall be provided in every SER. This is sufficient for most SERs; however, large SERs may require additional fire extinguishers to comply with AS 2444 “Portable fire extinguishers and fire blankets—Selection and location”. An appropriate fire extinguisher location notice and information sign shall be installed above the fire extinguisher. The respective ARO shall implement appropriate maintenance procedures for the fire extinguisher. For detailed requirements, refer to AS 2444.

All SER’s shall have a fire alarm device connected to the VicTrack security system. A gas discharge fire suppression system connected to the local fire authority shall also be provided if the SER controls more than 20 signals.

Where installed, fire protection systems shall comply with ATS 5387.7 “Guidelines—Fire safety engineering—Detection, activation and suppression” and AS 1670.1 “Fire detection, warning and intercom systems—system design, installation and commissioning”.

5.2.4 Security

Any SER walls and doors on the outside of the respective structure shall be of construction capable of withstanding malicious vandal attack.

Access should not be gained by removing panels or in-wall air conditioners.

Generally, masonry construction is preferred for all walls.

CCTV monitoring shall be provided inside and outside of SERs where there are substantial security risks to the systems and equipment. Intruder detection and alarms shall be provided in vital SERs. DOT retains the design authority on all security system projects and shall be directly involved in all scope change decisions and technical information exchanges throughout the project lifecycle. For further information on security systems, refer to VRIOGS 13.1 “Communications Equipment Room Brief”.

Conduits shall be inserted into walls during construction to provide a cable pathway to the electric lock and power transfer hinge on the door, and to the proximity card reader located outside.

Where such doors are part of a masonry wall, the doors shall be contained within a steel door frame with fixed pin hinges to prevent door removal externally.

Doors shall be provided with a cored cable pathway from the electric lock to the hinged side to allow cabling to be run from a power transfer hinge or flexible cable assembly through the door to the lock.

Doors shall be fitted with Lockwood 3570 series electric-mortice locks (with cylinder to fit the standard respective rail operator key) and monitored free-handle egress.

The single leaf door with access control fitted shall be opened by the access control system releasing the electric lock bolt (not the door striker plate).

The door shall be fitted with a separate “door open” triple-biased reed switch at the top of the opening (handle) side of the door to monitor door open status independently of built-in status monitoring inside electric locks.

Where double doors are required to provide for access to unusually large equipment as a project specific requirement, magnetic locks with bond and status sensing shall be provided on both leaves together with a wall-mounted egress request button and emergency break-glass release in lieu of the free handle egress electric mortice lock. A triple-biased reed switch shall be fitted to each leaf next to the electromagnetic lock, wired to a single junction box above the door and single security panel sector.

The system master panel and door controller shall be wall-mounted on the front SER wall or in another position that does not impact on equipment rack clearances.

The system shall operate in silent mode within the SER apart from low level audible alerts. There will not be any alarm screamers installed in the SER.

An alarm sector shall be wired in four core 7/0.2 security cable to each equipment rack position. After racks are installed, the sector shall be connected to the rack door tamper switches and End-of-Line resistors fitted (at the first switch).

The system shall incorporate its own DC power supply and minimum 8-hour backup batteries and operate from wall power outlets.

A 16 area remote arming station (RAS) shall be provided inside the SER and near the door. Its function is to allow technicians to:

a) view the status of all sectors and arming areas;

b) arm and disarm other station areas; and

c) perform maintenance and administration of arming and user codes.

A proximity card reader shall be mounted in a secure manner on the outside wall adjacent to the SER door. This shall be installed and configured to release the SER door and provide arming and disarming operations.

An industrial grade triple biased balanced reed switch, Sentrol 2707A, shall be provided inside the door on the top corner of the opening (non hinged) side, with end-of-line resistors fitted inside a tamper-

alarmed junction box, and connected via conduit enclosed wiring to the station security alarm system Master Panel.

All SER's security systems shall be connected to the VicTrack security system.

In respect of SER alarming and control, the system shall be configured for one alarm arming area for the SER space itself, one area per SER tenant or user group, and one smoke detection area. These shall be configured to function as follows:

a) When the system is initially armed, a valid user card badge shall disarm the SER area (including reed switch and forced door alarm) together with the rack tamper alarm area for the respective user (if applicable). The status change shall be indicated on the card reader by indicator LED colour or mode change.

b) If another user badges the reader, the rack tamper alarm area for that user shall also be disarmed.

c) When the last user leaves, that user will badge the reader outside three times to re-arm all SER alarm areas and the card reader status LED shall change to "armed" colour or mode. A rejection audible and visual alert shall be provided if the operation has failed due to one or more sectors being in alarm.

d) The system shall automatically issue a warning alert (from the RAS) and then re-arm all SER areas of the system (not being in an alarm state) after two hours of inactivity. Alarms shall be reported for any sectors in an alarm condition at this time.

5.3 Floor Area

Details of the equipment to be installed (e.g. size, weight, access requirements and mountings) shall be determined and documented in project specifications and drawings. The SERs shall be sized to adequately house the equipment.

Adequate clearances shall be provided to ensure that the equipment are accessible, and that the SER is safe and without risks to the health of persons using it as a workplace. The designers of SERs shall comply with this duty under Section 28 of the Occupational Health and Safety Act.

The dimension of the SERs shall be determined from a consideration of the following minimum clearances:

a) At the rear of any rack that requires rear access – 900 mm

b) At the front of any rack – 900 mm

c) Between racks – 1200 mm

d) At the SER door end of the rack – 2000 mm

e) Between one end of a rack and any other fixed object – 800 mm (one end may abut a wall or other rack providing no access is required)

The minimum internal width of an SER shall be 2.4 m.

All SERs shall be future-proofed by allocating sufficient unused space that allows for a 20% increase in the quantity of equipment to be housed therein. This includes providing unused rack space to mount spares of relays, terminals and other equipment.

5.4 Earthing Conduits

Earthing conduits shall be provided in or below the floor slab.

Radial conduits for earth conductors shall be provided from the Main Earth Busbar to the earth stakes at the corners of the signalling earth grid surrounding the SER. These shall be run straight from the busbar to immediately adjacent to each earth stake, with no bends.

Conduits for earth bonding conductors shall be provided direct from each equipment rack to the Main Earth Busbar.

One conduit shall be provided for the Main Earth Conductor from the 240 Volt switchboard to the Multiple Earth Neutral (MEN) Main Earth Electrode located clear of the signalling earth grid.

If there is no MEN main earth electrode, one conduit shall be provided for the ELD Test Earth connection, from below the cable termination rack to the ELD Test Electrode located clear of the signalling earth grid.

The Transient Earth Clamp connection between the MEN Main Earth Busbar and the Signalling Main Earth Busbar should be run above floor level, and should not require a conduit. This facilitates the periodic testing of the Transient Earth Clamps.

5.5 Underground Cable Entry Conduits

The entry conduits shall not cross tracks between the SER appearance and the pit.

When planning conduit placement, ease of pulling in new cables and routing to cable trays or terminals shall be considered.

By design, it shall not be necessary to physically pull cables past equipment after the SER is fully fitted out.

Conduits shall not terminate in aisle space or under racks.

Entry conduits shall be set out prior to floor slab pours so that they emerge close to a designated wall.

The exact entry arrangement will depend on the quantity and size of conduits, with conduits set out in a maximum of two rows along the wall, occupying a space within the range 10–250mm from the wall.

Conduits shall be cut off in the range 100–200mm above finished floor level.

5.6 Cable Trays and Ducts

Cable trays shall be procured and fitted according to the specifications of the respective ARO. Considerations for cable trays include:

a) Installation height to be suitable for the equipment racks and meet OHS requirements

b) Mounting system (suspension or wall-fastened) to be suitable for the weight of the cables

c) Support and guides at cable bends

d) Material to be suitable for the cable weight and environment (consider corrosion and accumulation of dust)

Alternatively, with approval from the respective ARO, cable ducts may be provided in the foundation and floor of buildings and huts. The duct shall be in the form of a channel whose top shall have metal covers fitted around the terminated cables, and finishing flush with the floor level.

The duct depth shall be sufficient to allow all cables to be run and terminated without exceeding their minimum bending radii. In prefabricated SERs, the floor cut-outs will be considered to be part of the cable duct.

Consideration shall be given to the separation of the cables from the earthing conductors (see section 5.6).

5.7 Roof Ventilators

Industrial rotary roof ventilator(s) shall be provided in every SER.

Roof ventilator(s) shall be sealed to prevent water entry, and the design and installation shall be such that condensation or leakage from the ventilator cannot drip on equipment below even with degradation of the roof ventilator(s). Roof ventilators shall be designed to minimise the entry of airborne dust, and be fitted with effective insect barriers which provide minimal restriction to the air flow.

Vandal resistant cages shall be provided for the roof ventilator(s). The cages must not significantly restrict the air flow.

5.8 Air Conditioning

The use of air conditioners is the least preferred method of controlling temperatures in SERs, after ventilation and shading.

Air conditioning should be provided only in extreme cases where the other means are not effective or not possible.

The air conditioning unit shall be a wall mounted split system, capable of maintaining the SER temperature at less than 28□C and the relative humidity at less than 70%. (Note that the requirements in section 4.3 still apply, such that the air conditioning unit shall be capable of meeting the more restrictive requirements.)

The air conditioner should have at least a 4-star energy rating for cooling. Heating cycle is not required.

With the main power switch “on”, automatic restart after power outage must be provided.

Air conditioners should be rated for significantly more than the normal equipment heat load. Twice the equipment heat load is considered appropriate.

Consideration must be given to insulation of the SER for an air conditioner to be economically operated over its lifecycle.

The peak solar load shall be calculated on the basis of Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) publication AIR-DA09 “Load Estimation and Psychrometrics” under Melbourne outdoor ambient design conditions for critical process loads (36°C DB, 21°C WB).

At peak outdoor ambient conditions and maximum equipment rack load, the supply air to the front of all racks shall not exceed 20°C.

The power consumption per rack space shall be determined. Where data is unavailable or as a minimum requirement, the total (maximum) cooling capacity shall meet or exceed the [peak solar load] + [500 W per equipment rack space].

The unit selected shall be rated for continuous 24×7 operation with a minimum field service life of 5 years.

The indoor unit shall blow cold air into the aisle in front of the equipment racks whilst drawing return air from above and behind racks.

The indoor noise level created by the air conditioning system (as measured with other systems switched off) shall not exceed 60 dB (a).

Outdoor unit noise levels shall comply with local authority requirements.

Rooms with equipment cooling load exceeding 7 kW or deemed critical shall be provided with standby capacity in an N+1 redundancy configuration.

The unit provided shall be of a make and model available with a telemetry interface as described in section 4.16.

A remote temperature monitor shall be mounted on the wall behind the equipment racks at 2200 mm AFFL, set to cut in the air conditioner if the temperature exceeds 28°C and cut out if the temperature declines below 26°C.

The indoor unit shall not be located above equipment racks or wall distribution frames to ensure that any leaks do not put equipment or interconnections at risk.

5.9 Lighting

The light switches for each SER shall be surface mounted adjacent to the lock side of every door frame.

Light fittings shall be selected to ensure their installation does not detract from the SER's two hour fire rating.

A maintained emergency exit light / sign shall be provided above the door. Emergency escape lighting and exit signs shall be in accordance with AS 2293.1 "Emergency escape lighting and exit signs for buildings—System design, installation and operation".

The lighting level shall be designed on the basis that the SER is unoccupied (and therefore the shadowing effect of occupants is accounted for by virtue of the relatively high lighting level specified).

The lighting level in access and circulation spaces within the SER (such as the aisle providing access between the front and rear of the rack) may be lower, but shall exceed 150 lux at the centre of the aisle.

5.10 Telephones

5.10.1 SER Entrance Telephone

A wall mounted telephone and handset shall be provided and fitted to the inside wall of the SER. It shall be located closest to the main SER doorway entrance, at a height of 1500mm.

The cabling shall be installed and connected to provide a telephone service from the VicTrack network.

The telephone shall have an individual service number.

5.10.2 Signals Maintainer Work Area

A desk-mounted telephone and handset shall be provided at an ARO nominated point within the signal maintenance works area.

The cabling shall be installed and connected to provide a telephone service from the VicTrack network.

The telephone shall have an individual service number.

5.11 Data Points

5.11.1 Data Points and Sockets

A twin connection data point shall be provided, and at an ARO nominated point within the signal maintainer works area.

The cabling shall be installed and connected such as to provide a data service from the VicTrack network and connected to a nominated WAN or LAN.

The data points shall have individual addresses.

5.12 Doors

5.12.1 General

Doors shall have a minimum fire rating of two hours.

External doors shall be of all steel construction. The door shall be large enough to enable ready access for the installation of pre-wired equipment racks, preferably sized at 2040 mm height x 820 mm width. The door shall consist of a 25 x 25 Rectangular Hollow Sections (RHS) perimeter frame with four cross members (two at mid-height to support the locking mechanism).

The exterior skin shall consist of 2.4 mm (minimum) thick steel sheet with light cross breaks to prevent drumming. The skin shall either be folded around the frame and intermittently welded or, if not folded, shall be continuously welded to the frame all round.

The lower section of the door shall be fitted with, or have pressed into the exterior skin, a vent panel 600 mm wide x 200 mm high. The panel shall be suitably proofed against vermin and insect entry. Doors shall be fitted with adjustable weather and dust seals to prevent ingress of water and contaminants into the SER.

Internal doors may be of any material but must meet the required two hours fire rating. The door shall have dimensions 2040 mm height x 820 mm width.

In accordance with Building Code of Australia (BCA) clause D2.21, doors along the exit path shall be readily openable without a key from inside, by a single hand downward action or pushing action on a single device which is located between 0.9–1.1m AFFL.

5.12.2 Hardware

Door jambs shall be formed from steel (3 mm thick) and sized to match the door thickness and wall thickness which is dependent on the type of building construction. The type of construction and installation has to maintain the fire rating of the door system. They shall be fitted with an awning over the doorway (50 mm wide).

The doors shall be hinged with four 100 mm stainless steel fixed pin hinges per door, welded or screwed to the door and bolted or screwed to the door jamb. Doors shall be hinged on the left hand side as observed from outside of the building.

A catch, which fits over the handle to restrain the door in the open position, shall be fixed to the building wall with chemset anchors.

Bottom edge door seals shall be provided on all external doors and shall fit neatly in the recessed step to prevent water and vermin entry.

5.12.3 Corrosion Protection

External doors and jambs shall be coated with one coat inorganic zinc silicate primer to a preferred dry film thickness of 75 µm and one coat white Vinyl Copolymer paint to a minimum dry film thickness of 100 µm. Painting shall be carried out after welding and assembling has been completed. Colour shall be the same as the external walls of the building.

Internal doors are to be painted using a coating system appropriate to the door material. Colour and finish shall be the same as internal walls.

5.13 Flooring

Floors shall be covered in a static dissipative material offering a smooth washable durable surface and a non-slip surface texture.

With approval from the respective ARO, “false type” floors for the SER will be permitted. They shall be designed to be capable of withstanding the full loading of all equipment and items housed within the enclosure, plus allowance for all future requirements.

5.13.1 Windows

Windows are not permitted.

5.14 Fall Restraints

Buildings and huts shall be provided with approved roof anchor points for attachment of fall restraint devices.

5.15 Site Works

5.15.1 Site Preparation

The site shall be cleared of all vegetation and topsoil stripped to a depth of 100 mm and stockpiled for reuse. An area encompassing of at least 2 m (up to 5 m) away from the SER on all sides is to be cleared and graded to achieve a minimum fall away from the SER of 1:100. This shall preferably be done with the use of compacted 10 mm “A” grade crushed rock to a depth of 150 mm.

Where it is necessary to excavate into a cutting wall or fill over a bank to locate the SER, a suitable retaining wall shall be provided and provision made for drainage around the SER.

Earthworks shall be carried out as required to:

a) Allow correct finished levels and falls for floor slabs and external paved or graded areas;

b) Allow for any required underground services (such as storm water drainage, sewerage, power cable, earthing cable, cable route entry to the SER, pits, ducts etc.).

To achieve an acceptable pad for the SER and surrounds, the site may require excavation or filling.

The SER finished floor levels, grading around the SER, cut and/or fill batters and details of retaining walls if required shall be determined and documented in the project specification and drawings, to be used as the basis for construction.

Excavation shall be carried out to achieve design finished levels. Excavated material will be either disposed of or used as fill. Excavated material shall be selected to ensure that the best quality material – lower plasticity, evenly graded, no organic content, high California Bearing Ratio (CBR) value –, available from the excavation is used for any filling or back-filling.

Excess or unsuitable excavated material may be disposed of by spreading elsewhere on or near the site. Any such disposal site must be clear of any access roads, must not impede or restrict access to trackside equipment or obstruct or restrict any drainage paths. If no suitable local site can be found spoil has shall be disposed offsite by the Contractor in accordance with Local Council and Government regulations and requirements. The proposed method for disposal is to be agreed by the respective ARO.

Filling or back-filling shall not be carried out before all organic material and rubbish has been removed from the area to be filled.

Any voids created by the removal of unsuitable materials will be backfilled with clean material consistent with the natural material on site or using imported materials. If material excavated on site is insufficient or unsuitable, then suitable filling material shall be provided. All filling or back-filling material shall be brought to optimum moisture content and placed in layers and compacted to 95% Standard Density in accordance with AS 1289 “Methods of Testing Soils for Engineering Purposes”.

All excavated and filled areas shall be finished to an even surface and be within +/-± 25 mm of specified levels.

Earth resistance testing shall be conducted to enable the design of an effective earthing system. Soil treatment may be warranted to fulfil the requirements of section 4.5.3.

5.15.2 Site Clean Up

On completion of installation of the SER the site shall be restored to as close as possible to its original topography and (where previously improved, e.g. by landscaping) its original appearance. The clearing around the building up to 5 m away from the building shall be graded, and all rubbish, surplus materials and surplus excavated materials shall be removed from the site.

Where special drainage provision has been made to protect the building, care shall be taken to ensure that run-off from these drains will not cause erosion or direct water onto access roads or pathways or into private property unless this is a natural drainage route.

5.16 Footpath

An 800 mm wide concrete footpath shall be constructed between the nearest vehicular access point to the location and to each of the SER entry points.

The concrete strength shall at minimum be N20, as specified in AS 1379 “Specification and supply of concrete”.

The concrete thickness should be 75 mm, and with a base of compacted 10 mm "A" grade crushed rock to a depth of 150 mm. For excavation and filling requirements in footpath construction, refer to section 5.17.

5.17 Maintenance Facilities

When designing a new SER, the infrastructure manager of the respective ARO shall be consulted on the need for maintenance and associated facilities within the SER. This will depend on the maintenance procedures of equipment in and near the SER. This may include providing one or more of the following facilities:

a) A suitably sized lockable steel cabinet for the purpose of storage of maintenance spares

b) A two drawer steel filing cabinet for the use of maintenance staff

c) Computer system (or maintenance terminal), typically consisting of a computer case, visual display unit(s), a keyboard and a mouse

d) Furniture (desk and chair) to accommodate computerised maintenance equipment

e) Mimic signal maintenance diagrams or layouts, displayed in a suitable holder and be geographically representative of the actual field layout and position, such that no confusion should arise when comparing the field layout to that within the SER

f) Telephone service to enable communications to and from the SER for operational, maintenance or emergency purposes, typically connected to the VicTrack telephone exchange and provided with its own unique number.

g) Racks for spare equipment (including relays)

h) Delatch bases for latch relays

i) Circuit plan proforma holders, located in visible areas and in close proximity to associated equipment racks and cable terminations

j) Vehicle parking

k) Tool storage

l) Worker amenities at larger buildings that function as major periodic or permanent workplaces.

Examples of worker amenities include:

a) Toilets (male and female);

b) restrooms;

c) tables and seating;

d) cooking and dining areas;

e) shower and change rooms;

f) cold drinking water;

g) lockers and storage of personal belongings; and

h) washing facilities.

Additional features shall be provided at any areas that require compliance to DDA standards.

5.18 Renovated Rooms

Where existing rooms are required for reuse as an SER, the following shall apply:

a) Any damage to the building (walls, floor, ceiling and roofing) in the renovated area shall be repaired and repainted. Additional floor covering or finishing shall be provided if the requirements in section 5.14 are not met or for patch up purposes upon removal of redundant racks or equipment.

b) An inspection of the SER shall be conducted to identify the non-compliances to this standard and their implications. In consultation with stakeholders of the SER, appropriate measures shall be determined and taken, to ensure that the requirements for the SER are met.

5.19 Painting

All exposed surfaces (excluding external brickwork and steel chequer plate) which have not been paint finished at manufacture shall be painted in accordance with AS 4548 “Guide to long-life coatings for concrete and masonry” and other any other Australian Standards relevant to the exposed surface.

Prior to the application of any coating, the surface shall be properly prepared. The finishes to be applied depend on the surface material as set out in the following table. The exterior finish shall meet the requirements of section 4.17.

Surface	Paint System
Woodwork	primer coat, undercoat and two finishing coats
Steelwork and metalwork	primer coat and two finishing coats
Internal brick and concrete block walls	two coats of clear silicone based sealer
Cement render	sealer coat and two finishing coats
Fibrous Cement and Plaster Board	sealer/undercoat coat and two finishing coats
Cement flooring	sealer coat and two finishing coats of paving paint
Cement flooring where batteries are installed	paving paint will be of the electrolyte resistant type and shall have a sealer coat and two finishing coats

Table 3 Paint Systems for Exposed Surfaces

6. Cavity Brick or Cavity Concrete Block Buildings

6.1 Brick and Concrete Block Work

All brick and concrete block work associated with the building shall be supplied and constructed in accordance with AS 3700 “Masonry Construction”, AS 4773 “Masonry in Small Buildings” and AS 4455 “Masonry units, pavers, flags and segmental retaining wall units”.

The external face bricks and concrete blocks shall be of similar colour and texture to any adjacent buildings and the internal surface shall be smooth surfaced face and of light colour.

Footings shall be constructed in accordance with the Building Code of Australia and in accordance with AS 2870 “Residential slabs and footings – Construction”. The top of footings will be a minimum depth of 300mm below finished level and founded in the natural ground. Footings may need to be stepped to suit natural ground levels. Following the excavation and before any concrete is placed, a certificate from a Structural Engineer certifying the suitability of the foundations for the proposed building, recognising the geotechnical conditions, shall be supplied.

Walls should be 280 mm cavity brick or 200 mm waterproof cavity concrete blockwork with waterproof mortar. Walls shall have all necessary damp proof courses, cavity flashings, etc. Concrete block walls shall have bond beam and reinforced masonry lintels as required. The roof shall be anchored to the footings, preferably by galvanized wall cyclone bolts.

Brick and concrete blocks shall be laid in a mortar, preferably using a mix ratio of 1:1:6, cement: lime: sand. They shall be laid to give a regular pattern. Mortar shall be placed such that beds and perpends are filled solid with mortar.

Finished brick and concrete block work shall be acid cleaned, preferably with a solution containing 1 part Muriatic acid to 10 parts water. Following the acid cleaning, the brickwork shall be thoroughly washed down with clean water.

Lintels shall be supplied and installed over masonry openings. They shall preferably be hot dipped galvanised mild steel flat or angle lintels. For spans of less than 2 m, the lintels shall have a minimum bearing at each end of 150 mm. For spans of greater than 2 m and up to 3 m, the minimum bearing area at each end shall be 230 mm.

Damp course and flashing shall be provided where necessary and shall preferably be bitumen coated aluminium 0.7 mm thick.

Joints in internal face brick and concrete block work shall be cut flush. External face brick and concrete block work should have 5 mm deep-ironed joints. Where control joints are required, they should be 15 mm wide, and shall be completely filled with an elastomeric sealing compound.

6.2 Roofing

6.2.1 Roof Cladding

Roofing shall be constructed in accordance with AS 1562.1 “Design and installation of sheet roof and wall cladding – Metal” and be consistent with good building practice. It shall comprise colour-bonded metal roofing and reflective thermal insulation sarking, plus mineral wool insulation.

Mineral wool insulation and double-sided aluminium reflective thermal insulation shall be placed on bird wire placed on top of the roof purlins and shall be mineral wool batts, preferably 75 mm thick with a minimum rating R2.5. Reflective thermal insulation shall be Sisalation 430 or material equivalent.

Metal roofing shall be steel sheeting with Colourbond finish, colour to be matched to the local environment. Ridge capping shall be preformed Colourbond, colour to match the roofing sheet.

The roof slope shall be a minimum 3 degrees, with the high point being on the front side of the building.

Eaves closures shall be factory formed eaves with the Colourbond finish, colour to blend with the brickwork and roofing colours. Barge flashings shall include preformed barge capping with Colourbond finish, colour to match the eaves closures.

Metal cladding and accessories shall be installed in accordance with good building practice and the manufacturer's specifications.

6.2.2 Gutters

Roof gutters shall be non-galvanised steel with Colourbond finish slotted with overflow holes, colour to match the barge flashings, and supported on brackets at no greater than 900 mm centres.

6.2.3 Down Pipes

Down pipes shall preferably be size 100 x 75 x 0.7 mm3 constructed from steel with Colourbond finish, colour to match the guttering, and supported with matching straps not exceeding 1200 mm centres. The down pipes are to discharge into a stormwater drainage system where available or over splash pads (preferably 300 mm x 300 mm x 100 mm) or the concrete apron. In all situations these shall drain away from the track.

6.2.4 Timberwork

Timber shall preferably be grade F5 as a minimum and shall be clean and straight and shall be fixed using galvanised fastenings.

6.3 Eaves Lining and Ceilings

Eaves lining shall be 6 mm fibrous cement sheeting e.g. Versilux or equivalent. Ceilings shall be minimum two hour fire resistant plaster board. All joints shall be taped and plastered.

6.4 Walls Finishing

There is no requirement for the rendering of concrete block or brick partition walls.

7. Pre-Cast Concrete Construction

7.1 General

This part of the standard sets out the requirements for the manufacture and installation of pre-cast concrete type buildings to a maximum size of two rooms. This structure is manufactured complete off-site and lifted or slid into place on a prepared foundation.

ARO approval is required to construct this type of housing.

This type of housing shall not be used in areas which are known to be subject to (local) flooding.

7.2 Roof, Wall and Floor Construction

Cement mortar used in the construction of the pre-cast buildings shall have strength not less than 32 MPa at 28 days.

The floor thickness shall be a minimum of 125 mm and should contain two layers of SL82 reinforcing mesh. Starter mesh to tie the floor to the walls shall preferably be two layers of G113 galvanised wire mesh with a minimum overlap of 300 mm.

Cable entry aperture(s) shall be provided in the floor.

Lifting hook sizes and positions shall be determined by the manufacturer and the capacity of the hooks to withstand all lifting and handling loads shall be the responsibility of the manufacturer.

Walls shall be manufactured from cement mortar preferably placed over two layers of G113 galvanised wire mesh. Walls shall have a minimum rendered thickness of 60 mm. Walls shall be vertical and have regular line and finish.

Roofs shall be manufactured from cement mortar placed over two layers of G113 galvanised wire mesh and shall have a minimum rendered thickness of 60 mm and shall be waterproof. Roof slope shall be 3 degrees or more with the high point at the centre (or on the centre line) of the building.

Additional reinforcement around apertures shall be positioned diagonally to corners and shall be not less than 25 mm from the aperture perimeter. The reinforcement shall preferably be G113 galvanised wire mesh.

Buildings shall be cured for at least 14 days following manufacture and shall not be transported, lifted or otherwise moved from their place of manufacture for 28 days following manufacture to ensure stability during construction handling.

7.3 External and Internal Finishes

The external surface shall be smooth rendered without voids and with a uniform architectural stipple. The surface shall be coated with one coat of acrylic sealer/undercoat and two finish coats of full gloss

acrylic. Colour is to be consistent with similar type buildings in the area and that of the local environment. The exterior finish shall meet the requirements of section 4.17.

The interior roof and wall surfaces shall be smooth rendered and free of voids. These surfaces shall be painted with one coat acrylic sealer/undercoat and two finish coats of acrylic paving paint.

The floor shall be coated with paving paint.

7.4 External and Internal Finishes

7.4.1 Foundation

A foundation of a minimum of 200 mm of a cement stabilised fine crushed rock suitable for road construction, compacted to 98% modified maximum dry density (MMDD) shall be placed over the graded building site. Cement content shall be at least 3% and aggregate size shall not exceed 20 mm.

The height of the foundation pad shall be 50 mm minimum above ground level whether natural level ground or levelled area. Variation to level is not to exceed 5 mm. The foundation pad shall cover the total area of building and surrounding path, and should include an additional 150 mm. The foundation pad shall be battered to ground level at not more than 30 degrees.

A layer of sand not less than 50 mm deep shall be laid between the foundation pad and the building floor. A waterproof membrane (Fortecon or similar) shall be laid between the sand and building floor to extend at least 300 mm outside the building.

Provision shall be made for underground services such as stormwater drainage, sewerage, power cable, earthing cable, and cable route entry to the building, pits, and ducts. These details are to be included on the site drawings.

7.4.2 Handling of Building

The building shall be lifted onto or may be slid off a tilt tray directly onto the foundation pad. If slid off the tilt tray, care shall be taken to ensure that the prepared sand surface on the foundation pad is not disturbed causing voids under the floor.

8. Prefabricated Sandwich Panel Buildings

8.1 General

The building shall be a prefabricated type transportable building, constructed of steel framing with walls and roof of metal sandwich panel.

ARO approval is required to construct this type of SER.

The building shall be suitable for installation and pre-wiring of the equipment to be housed off site then for transporting and erecting on site.

The building shall be designed to withstand weather conditions for the area in which it is to be installed but shall have as a minimum W65 wind load rating. The building shall be robust and designed to withstand all but the most determined attempt at forced entry. The insulation materials used to maintain the required temperature range shall be sufficiently robust that they are not easily damaged.

The racks for signalling relays and/or supervisory equipment shall be free standing and securely fixed to the floor and shall have minimum clearances consistent with section 5.4. These clearances shall be maintained when determining the building size as will the minimum width, which shall be 2400 mm.

The Contractor will be required to prepare drawings, specifications and documentation for the building as part of the Contract and provide a Certificate of Approval from a registered Engineer/Architect prior to commencing construction. The Contractor shall provide cable diagrams to show all wiring that has been run in the building for electrical services.

8.2 Frame

The base frame shall preferably be constructed on skid bearers 250 x 50 x 4 RHS set at 1800 mm centres. The joists shall be welded to the bearers and side frame. The skid bearers shall preferably have 50 mm towing and lifting holes drilled close to each end. The skid bearers shall have provision for bolting the prefabricated building to the base slab and/or supports.

Provision shall be made for a cable entry area to all external cable pits.

The frame shall be galvanised, and the base frame shall be hot dipped galvanised after welding and drilling, and then protected during manufacture of the building.

8.3 Walls and Roof

Walls shall be constructed of 75 mm (minimum) thick sandwich panels, using 0.6 mm metal sheeting inside and outside, with fire resistant insulating material between.

The roof shall be constructed of 100 mm (minimum) thick sandwich panels, using 0.6 mm metal sheeting inside and outside, with fire resistant insulating material between.

All internal and external joints shall be neatly trimmed and sealed with silicone. Stainless steel rivets, sealed with silicone shall be used throughout.

The walls and roof shall have a Colourbond baked polyester low gloss finish, colour matching the local environment.

Special attention shall be given to preventing the entry of ants into these panels and to this end, drain holes shall not be provided in the wall panels. A non-volatile residual insecticide shall be used to achieve this requirement.

Colourbond barge capping shall be used to provide a watertight and attractive finish to the roof.

The roof shall have a minimum fall of 3% across the building. All buildings shall be provided with galvanised sheet steel gutter and downpipe discharging into a stormwater drainage system where available or over splash pads (preferably 300 mm x 300 mm x 100 mm) or the concrete apron. In all situations these shall drain away from the track.

8.4 Foundation

The building may be set directly onto a reinforced concrete raft slab or set on supporting galvanised steel posts. If set on posts the floor shall not be higher than 600 mm above the surrounding ground level.

Foundations shall be constructed generally in accordance with the manufacturer's recommendation and shall be designed to meet the site conditions and buildings characteristics (e.g. weight, size, bearing points etc.).

The design will detail an appropriate method of fixing the building to the foundation to ensure it resists all loadings.

If the building is mounted on posts, concrete paving (that should be 75 mm thick) shall be provided under the building and extending at least 600 mm beyond the walls. The raft slab or concrete paving will accommodate the requirements for cable pits.

8.5 Flooring

The floor shall preferably be constructed of 19 mm minimum thickness structural tongue and groove water resistant plywood, mechanically fastened to the floor joists.

The floor shall be finished with 2 mm thick acid resistant sheet vinyl, bonded to the floor. The vinyl shall be supplied in minimum roll widths of 2000 mm, and all joints welded using a hot air welding gun and welding rod matching the colour of the vinyl. The vinyl shall be coved up the walls to a preferred height of 100 mm above floor level. The cove is to be formed using the heat method. All corners in the coving shall be fabricated using the envelope method. Mitred corners shall be avoided.

Vinyl floors shall be cleaned then sealed with two coats of sealer within two days of laying. Two coats of polish shall then be applied. The type and application of sealer and polish shall be to the vinyl manufacturer's recommendations. Aluminium nosing shall be provided at the door sills.

9. Equipment Boxes

9.1 Construction & Materials

The box should be made of 1.6 mm stainless steel 304 2B grade or an approved equivalent.

For typical equipment box construction specifications and materials list, refer to drawings listed in Table 2 (See 10.0).

Variations on the standard equipment box may be acceptable in consultation with the respective ARO. However, general requirements for equipment boxes are presented in the following subsections.

9.2 Box Orientation

Equipment boxes should be installed with the equipment box installed at right angles to the track; and with the rear of the box facing towards the signal, to allow a signal maintainer working at the front of the box to easily observe signal aspects.

Common siting requirements are described in section 4.15.

9.3 Installation

Boxes shall be installed on foundations of the polyethylene constructed type foundation, commonly referred to as “bathtub foundation” type, or of a type as approved by the respective ARO. The foundations shall be installed on either:

a) a concrete pad; or

b) a level and compacted bedding of crushed rock (preferably 100 mm thick bedding of 20 mm “A” grade crushed rock).

The pad or bedding shall encompass the foundation “footprint area” plus a minimum of 900mm in all directions past the perimeter of the foundation. The inspection cover plates of the foundation shall be positioned at the rear of the equipment box.

When located on embankments or in flood-prone areas, equipment boxes shall be installed on elevated structures, complete with compliant walkway, handrails and steps as required. Refer to section 4.2 for further details.

Boxes less than 750 mm wide may also be installed on foundations, or may be fastened or clamped to a galvanised steel pipe. Cable entry shall always be through the bottom of the box. Refer to drawing STD_G0068 (See SECTION 10.0 for the table of drawings).

Small boxes (e.g. junction boxes) shall be able to be securely mounted on a galvanised steel post or fastened directly onto a wall.

Where stainless steel boxes are mounted on dissimilar metals, including galvanised steel, precautions shall be taken to provide an effective isolating barrier between the two metals, to prevent galvanic corrosion.

For high voltage power supply boxes, the 110 V switchboard shall be separately accessible from the high voltage equipment. This is typically done by placing the 110 V switchboard inside a single-width box, located adjacent to the high voltage power supply box, or use of a double-width box with one half dedicated to low voltage equipment, while the other half is accessible by a different key and dedicated to high voltage equipment.

At a level crossing, the test switch box shall preferably be attached to the equipment box, on the side wall that is closest to the roadway.

9.4 Equipment Mounting

Equipment shall be mounted on a central rack(s) within the equipment box. Batteries are exempted, and shall be placed on the floor or on shelves. Equipment shall not be mounted on the wall of the box.

All equipment boxes shall be future-proofed by dimensioning them such that they will accommodate the equipment proposed with a minimum 20% allowance for future additional equipment.

9.5 Security

One ARO approved padlock or V7P series padlock (or other ARO approved security system) per door shall be provided.

NOTE: As SER security systems are moving towards electromechanical solutions, it is likely that the V7P padlocks will be replaced by a superior lock.

9.6 Temperature Control

Common temperature control requirements are described in section 4.3. The typical equipment box drawings already specify air vents. However, superior temperature controls may be required to manage the greater heat loading of modern equipment boxes.

9.7 Doors

Swing doors shall be provided front and rear. The maximum width of a single door shall not exceed 1125 mm.

All doors shall be secured with a three-point locking system (top, bottom and centre) and the door handle shall be recessed when in the locked position.

Doors shall be provided with automatic latching top and bottom stays to support the door in the open position (which shall generally be approximately 135 degrees) in wind speeds up to 45 m/s. The stays shall be secured to door and box such that the method of securing is stronger than the stay.

Door sealing shall be with synthetic rubber or PVC foam material securely and permanently attached to either case or door, to qualify for IP rating as per VRIOGS 12.7.25.

9.8 Roof

The roof of the box shall extend by at least 50 mm beyond the doors to form weather protection, and shall also be such that water drains easily from the roof area and does not pool on the surface of the roof.

9.9 Lighting

Equipment box lighting shall meet the common requirements as described in section 4.8.

The light switch for an equipment box shall be mounted on the front side. To prevent unnecessary power wastage, consideration shall be given to using adjustable spring “push-in” timer light switches or other approved devices.

10. Equipment Boxes

The following standard drawings related to signalling equipment housings are available from the DMS Compliant Vault:

Drawing Number	Title
STD_G0009	EARTHING ARRANGEMENT FOR EQUIPMENT BOXES AND RELAY ROOMS
STD_G0010	EARTHING ARRANGEMENT FOR MULTIPLE EQUIPMENT BOXES
STD_G0064	2 DOOR METER BOX GENERAL ASSEMBLY AND MATERIAL LIST
STD_G0065	HIGH VOLTAGE SINGLE WIDTH EQUIPMENT BOX GENERAL ASSEMBLY
STD_G0066	JUNCTION BOX FOR NEGATIVE CONNECTIONS AT SUBSTATION GENERAL ASSEMBLY
STD_G0067	TELEPHONE BOX GENERAL ASSEMBLY
STD_G0068	TELEPHONE CABINET PEDESTAL MOUNTED
STD_G0083	FOUNDATION FOR SINGLE WIDTH S. S. EQUIPMENT BOX
STD_G0085	TYPICAL SIGNAL EQUIPMENT ROOM
STD_G0086	TYPICAL COMPUTER ROOM LAYOUT
STD_G0099	SINGLE WIDTH EQUIPMENT BOX GENERAL ASSEMBLY
STD_G0100	DOUBLE WIDTH EQUIPMENT BOX GENERAL ASSEMBLY
STD_G0101	SINGLE WIDTH JUNCTION BOX GENERAL ASSEMBLY
STD_G0102	2 DOOR JUNCTION BOX GENERAL ASSEMBLY

Table 4 Standard Drawings of Signalling Equipment Housings References

10.1 Australian Standards

The following Australian Standards shall be complied with and have been referenced in this document:

Document Number	Title
AS 1289	Methods of Testing Soils for Engineering Purposes
AS 1379	Specification and supply of concrete
AS 1562.1	Design and installation of sheet roof and wall cladding – Metal
AS 1657	Fixed Walkways, Handrails and Ladders
AS 1670.1	Fire detection, warning and intercom systems-system design, installation and commissioning
AS 1768	Lightning Protection
AS 2067	Substations and high voltage installations exceeding 1 kV a.c.
AS 2293.1	Emergency escape lighting and exit signs for buildings - System design, installation and operation
AS 2444	Portable fire extinguishers and fire blankets - Selection and location
AS 2870	Residential slabs and footings – Construction
AS 3000	Wiring Rules
AS 3010	Electrical installations - Generating sets
AS 3700	Masonry Construction
AS 4455	Masonry units, pavers, flags and segmental retaining wall units
AS 4548	Guide to long-life coatings for concrete and masonry
AS 4678	Earth-retaining structures
AS 4773	Masonry in Small Buildings
ATS 5387.7	Guidelines - Fire safety engineering - Detection, activation and suppression
AS 60529	Degrees of protection provided by enclosures (IP Code)

Document Number	Title
BCA	Building Code of Australia

Table 5 Referenced Australian Standards

10.2 VRIOG Standards

The following VRIOG Standards shall be complied with and are referenced in this document:

Document Number	Title
VRIOGS 12.2	Specification for Signalling Supply, Construction and Installation
VRIOGS 12.2.1	Standard for Construction of Cable Route and Signalling Civil Works
VRIOGS 12.7.9	Lightning and Surge Protection – General Requirements
VRIOGS 12.7.11	Power Supply Units for Signalling Equipment – General Requirements
VRIOGS 12.7.25	Environmental Conditions
VRIOGS 13.1	Communications Equipment Room Brief

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