Lightning and Surge Protection Requirements
ESC-09-02

Applicability

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<th>ARTC Network Wide</th>
<th>RIC (NSW CRN)</th>
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SC 06 01

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1 General

1.1 Scope
This Specification details the general requirements for Lightning and Surge Protection for ARTC’s Railway Signalling systems.

The prime objective of this document is to specify the performance requirements for the lightning and surge protection so that the signalling system can meet its required availability using a cost effective level of maintenance, without a reduction in the safety.

The Appendices are provided as reference material. The Appendices detail a pre-existing approved method of achieving most of the required surge protection performance for average conditions.

Except as otherwise noted in the Particular Specification, all items of equipment and all materials required for installation shall be supplied and installed by the Contractor as part of any Contract.

This Specification shall be read in conjunction with all other relevant Signalling Standard Specifications referenced within this document and the Particular Specification.

1.2 Safety
The Contractor shall at all times ensure the safety of employees, not cause danger, delay, obstruction or stoppage to railway traffic and not interfere with the business of ARTC or its Operators.

The Contractor shall ensure that all staff working on the Contract including sub-contractors staff are appropriately accredited for work on or about Rail corridors in accordance with ARTC network Operational and Safeworking requirements.

1.3 Occupational Health and Safety
The Contractors and sub-contractors, if any, shall comply with the relevant safety legislation of the Occupational Health and Safety Act.

1.4 Drawings
The documentation and drawings to be used in the execution of the works shall be the relevant approved Contractors drawings plus any other drawings referenced in this specification and/or nominated in the Particular Specification.

1.5 Definitions
In this document, the following definitions of terms shall apply:

**ARTC** – Australian Rail Track Corporation

**Contractor** – A person, company or authority nominated by ARTC or ARTC’s primary contractor to manage a specific contract.

**ARTC’s Representative** – A person, company or authority nominated by ARTC to make engineering determinations on ARTC’s behalf.

1.6 Quality
The standard of materials and workmanship shall ensure that the installed system is fit for purpose, over the lifetime of the asset in its physical and operational environment, in terms of safety and reliability.
Quality of materials and workmanship shall be such that life cycle routine maintenance of the asset is minimised.

All material and equipment supplied to this specification shall be warranted free of defect in manufacture or assembly for a period of twenty four (24) months from delivery.

All material and equipment, including consumables, shall be warranted as complying with this or any referenced specification and as being fit for purpose.

1.7 Submissions for Approval

Where alternatives or new equipment types are proposed, the matter shall be submitted by the Contractor with documented justification in writing, in accordance with ARTC’s PP122 acceptance process for "New Equipment and Systems" approval.

1.8 Referenced Documents

The following documents are referenced in this specification:

1.8.1 International Standards


ANSI/IEEE C 62.41: Guide for Surge Voltages in low voltage AC power circuits - major feeder short branch circuit service panel (indoor)

1.8.2 Australian Standards

AS1768 Lightning Protection
AS3000 Electrical Installations-Building, Structures & Premises

1.8.3 ARTC Specifications

ESC-07-04 Installation of Equipment Racks & Termination of Cables and Wiring
ESC-03-01 Level crossing Equipment
ESC-07-03 Small Buildings, Location Cases, Terminal and General Purpose Cases
ESD-09-01 Signalling Power Systems
ESC-07-01 Installation of Trackside Equipment
ESC-11-01 Construction of Cable Routes and Associated Civil Works
SC 10 01 Computer Based Interlockings

1.8.4 Drawings

Refer to Appendix H

1.9 Special Conditions

When working in the vicinity off or adjacent to overhead electrified areas Special Conditions shall apply.

2 Abbreviations and Definitions

CE Supply Authority (Supply Authority) Earth
EPR Earth Potential Rise
3 Railway Signalling Environment

3.1 General

The railway signalling environment consists of a large number of diverse types of equipment with complex interconnections spread out alongside a railway line, and housed in a wide range of exposed equipment housings.

The railway line and the structures around the railway line are of such a nature that they tend to attract lightning strikes.

Supply Authority (Service Provider) power supplies across country areas of the various jurisdictions are subject to variances in supply voltages depending on consumer demand resulting in localised spiking.

3.2 Safety

The railway signalling system is a safety system. Care must be taken to ensure that the surge protection provided cannot create an alternative path between items of signalling equipment as this may cause a significant hazard to personnel and property.

The lightning and surge protection must be considered as part of the ‘failsafe’ signalling system.
3.3 **Equipment Locations**

Signalling equipment locations are situated adjacent to the railway tracks. They include brick, concrete or pre-fabricated sandwich panel buildings (relay room, huts, etc), and metallic track-side location cases.

3.4 **Types of Equipment Requiring Protection**

Two general types of electrical signalling equipment require surge protection. In this specification these are termed electronic equipment and electro-mechanical equipment.

The electronic equipment requires a greater level of protection from surges than that required for the electro-mechanical equipment.

Some of the existing equipment and systems currently in use as part of railway signalling system are as follows. Note that these equipment types will vary as new technology is introduced.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Power supplies, linear</td>
<td>Electro-mechanical</td>
</tr>
<tr>
<td>DC Power supplies, switchmode</td>
<td>Electronic</td>
</tr>
<tr>
<td>Track monitoring systems: hot box detectors, dragging equipment</td>
<td>Electronic</td>
</tr>
<tr>
<td>Axle-counter systems</td>
<td>Electronic</td>
</tr>
<tr>
<td>Telemetry systems</td>
<td>Electronic</td>
</tr>
<tr>
<td>Computer Based Interlockings</td>
<td>Electronic</td>
</tr>
<tr>
<td>Event loggers</td>
<td>Electronic</td>
</tr>
<tr>
<td>Impulse track circuit transmitters</td>
<td>Electronic</td>
</tr>
<tr>
<td>Impulse track circuit relays</td>
<td>Electro-mechanical</td>
</tr>
<tr>
<td>Audio Frequency track circuit tuning units</td>
<td>Electronic</td>
</tr>
<tr>
<td>Audio Frequency track circuits (CSEE, ABB TI 21, WBS FS2500, WBS FS2600)</td>
<td>Electronic</td>
</tr>
<tr>
<td>AC and DC track circuits</td>
<td>Electro-mechanical</td>
</tr>
<tr>
<td>Coded track circuits</td>
<td>Electronic</td>
</tr>
<tr>
<td>Level crossing monitors, level crossing flashers</td>
<td>Electronic</td>
</tr>
<tr>
<td>Point machines</td>
<td>Electro-mechanical</td>
</tr>
<tr>
<td>Colour light signals</td>
<td>Electro-mechanical</td>
</tr>
<tr>
<td>Cables (Telecommunications, power, data)</td>
<td>Electro-mechanical</td>
</tr>
</tbody>
</table>

3.5 **Entry Points for Lightning and Surges**

In the railway signalling environment lightning and/or surges occur, enter, or are induced into the signalling system through one or several of the following:

- AC Power supply entry points 240v AC or 110/120v AC
- Overhead 33KV / 11KV / 2.2KV transmission / distribution systems
- 240V AC or 110/120v AC Cable Transmission / distribution systems
- 240v AC or 110/120v AC power supply aerial cables.
- Rails and track connections into signalling equipment locations
- Signalling control and indication circuit cables connecting to field equipment
- Communication lines
- Communication equipment on high masts
• Ground as a result of Earth Potential Rise
• Induction in power supply/communications/control wiring etc.

Typically the electrical insulation of wiring has a higher breakdown voltage than normal and therefore higher surge voltages can be propagated.

3.6 Power Supplies for Signalling Equipment

Power supplies for signalling equipment typically have large tolerances from the nominal voltage. For example:

The 110/120 volt AC signalling power supply varies from 100 to 132 volts.
The 50 volt DC signalling power supplies are full wave rectified, and are not always filtered. These supplies are typically set at 55 volts but may vary from 48 to 60 volts. This results in up to 85 volts peak on the supply.
The 24 volt DC signalling power supplies vary from 20 to 32 volts DC.
The 12 volt DC signalling power supplies vary from 11 to 20 volts DC.
The main power supply distribution for signalling equipment is generally a 110/120 volt AC 50Hz unearthed supply that is derived from AC Supply Authority supplies. In some locations there are alternate power sources such as motor generator sets, solar supplies, etc.

3.7 Earthing Systems

Different earthing systems exist in the railway signalling environment. These earthing systems are:

• Signalling Earth (SE)
• Supply Authority 240V MEN Earth (CE)
• Communications Earth (S&CES)

3.8 Physical Structures

The following physical structures exist in the railway signalling environment:

High communication masts and towers adjacent to signalling locations where communication interfaces exists.
High voltage and low voltage transmission and distribution system lines.
Power supply poles close to the signalling equipment locations.
Signalling equipment locations at elevated and exposed sites.

4 Required Protection Performance

4.1 General

The need for protection against power supply, and interface fault condition surges is essential in all cases.

The need for protection against lightning surges is essential unless the location provides an inherent zone of protection from lightning surges.

The lightning and surge protection provided shall comply with AS1768 Lightning Protection including any recommendations and follow practices in the Appendices of AS1768 unless varied by this specification.

It is the responsibility of the Contractor to ensure that the system is protected against lightning and surges so that the signalling system can achieve its required level of performance.
The surge protection equipment shall be rated for more than 150% of the intended interface load.

The surge protection equipment shall have an insertion loss of less than 1dB to valid signals for the interface during normal conditions.

4.2 Safety
The surge protection equipment must not reduce the level of safety provided by the signalling system.

A Failure Modes And Effects Criticality analysis of the surge protection equipment and its proposed use is an accepted method of determining the affect of the surge protection on the safety of the signalling system.

The surge protection equipment shall present a low risk to personnel working near the surge protection equipment if a nearby lightning strike occurs.

The safety of personnel working on or near the surge protective equipment shall be considered when designing the layout of the surge protective equipment or the route for Earth conductors.

4.3 Life
The surge protection system shall have a design life such that it does not compromise the required life of the signalling system.

The surge protection system shall have a design such that items that only withstand a particular number of surge events or size of surge event are only required to be replaced once every two years on average.

4.4 Failure Modes
The expected failure modes of the surge protection equipment must not prevent the protected equipment continuing normal operation if the protected equipment is still operational.

4.5 Earthing
The earthing shall maintain the required earth resistance and earth impedance for required life of the signalling system with no corrective maintenance required for the average installation.

The expected level of corrosion, and electrolysis for the site shall be considered when choosing the earthing.

The earthing system shall have physical protection from activities that may be carried out in the vicinity and be vandal resistant.

The maximum value for Earth provided for surge protection for electrical equipment to be protected shall be equal to or better than that nominated in the following table.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Earth Resistance</th>
</tr>
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<tbody>
<tr>
<td>Electronic Equipment installed inside locations</td>
<td>5 ohm</td>
</tr>
<tr>
<td>Electro-mechanical equipment installed inside locations</td>
<td>10 ohm</td>
</tr>
<tr>
<td>Electronic Equipment installed external to locations</td>
<td>20 ohm</td>
</tr>
<tr>
<td>Electro-mechanical equipment installed external to locations</td>
<td>50 ohm</td>
</tr>
</tbody>
</table>

The resistance value of each earthing arrangement shall be recorded in accordance with the approved test procedure and Appendix G.

Earth impedance for the earth connected at each item of surge protection shall be less than 10 times the nominated Earth Resistance when measured using earth impedance test equipment operating in the frequency range of 25KHz to 50KHz.
If an Earth Leakage Detector (ELD) is required at a location then a separate test earth shall be installed. The test earth shall have an earth resistance of less than 100 ohms.
Separate earths shall have a minimum physical separation of at least twice the length of the longest earth stake used.

4.6 Earth Potential Rise (EPR)

Earth potential rise due to a Category C surge pulse at the location shall be less than 430 volts.
Earth potential rise due to surges at adjacent locations or on different earth’s shall be limited to 430 volts by the use of equi-potential bonding or transient earth clamp between the surge protection earth and the other earth.
A transient earth clamp shall be used to connect earth’s provided for different purposes unless the owners of both earth’s agree to equi-potential bonding of their earth.
The test earth for an ELD shall be bonded to the protection earth using a transient earth clamp.
The earth for a Multiple Earthed Neutral shall be bonded to the protection earth using a transient earth clamp.

4.7 Surges

Each location or building shall withstand, without the normal operation of the equipment contained within it being degraded:
- more than 400 of each applicable type of Category C pulse on the power supply interfaces to the location.
- more than 100 of each applicable type of Category A pulse on each communications interface to the location.
- more than 100 of each applicable type of Category B pulse on all other electrical interfaces to the location.

When the surge is applied to the external interfaces of the location as both common mode and differential pulses.
Track-side equipment installed external to signalling equipment locations shall withstand more than 200 Category B pulses on all interfaces.
The protective action of the surge protection equipment in response to the nominated surges shall not cause circuit breakers to trip or fuses to ‘blow’.

4.8 Acceptable Voltage or Current at Equipment

The following sub-sections define the maximum acceptable surges that may appear at the interfaces to the equipment when any of the surge pulses nominated in Section 4.7 occurs.
The rated voltage or current for an interface is to include the ratings for both differential mode and common mode voltages or currents.
In the case where the interface is an output only, the rated voltage or current for the interface will be the rated output voltage or current.

4.8.1 Electronic Equipment

Electronic equipment is considered to have three interfaces for the purposes of surge protection. They are the power supply, communications, and all other electrical interfaces.
The communications interface only applies to telephone lines or data communications interfaces that comply with an International standard. The communications interface is not intended to include proprietary interfaces of a particular product, these are classified as “other electrical interfaces”.

4.8.1.1 Power Supply Interface

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed 300% of the rated voltage or current for the interface.

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed 200% of the rated voltage or current for the interface for more than 1mS.

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed 150% of the rated voltage or current for the interface for more than 10mS.

4.8.1.2 Communications Interface

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed 1000% of the rated voltage or current for the interface.

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed 400% of the rated voltage or current for the interface for more than 10mS.

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed 150% of the rated voltage or current for the interface for more than 10mS.

4.8.1.3 All Other Interfaces

The voltage or current appearing at any interface to an item of electronic equipment shall not exceed 1000% of the rated voltage or current for the interface.

The voltage or current appearing at any interface to an item of electronic equipment shall not exceed 400% of the rated voltage or current for the interface for more than 1mS.

The voltage or current appearing at any interface to an item of electronic equipment shall not exceed 150% of the rated voltage or current for the interface for more than 10mS.

4.8.2 Electro-Mechanical Equipment

Electro-mechanical equipment is considered to have two interfaces for the purposes of surge protection. They are the power supply, and all other electrical interfaces.

4.8.2.1 Power Supply Interface

The voltage or current appearing at the interface to an item of equipment shall not exceed 500% of the rated voltage or current for the interface.

The voltage or current appearing at the interface to an item of equipment shall not exceed 200% of the rated voltage or current for the interface for more than 10mS.

The voltage or current appearing at the interface to an item of equipment shall not exceed 150% of the rated voltage or current for the interface for more than 100mS.

4.8.2.2 All Other Interfaces

The voltage or current appearing at any interface to an item of equipment shall not exceed 1000% of the rated voltage or current for the interface.

The voltage or current appearing at any interface to an item of equipment shall not exceed 400% of the rated voltage or current for the interface for more than 10mS.

The voltage or current appearing at any interface to an item of equipment shall not exceed 150% of the rated voltage or current for the interface for more than 100mS.

4.9 Maintainability

Surge protection equipment shall be able to be tested without disruption to the operation of the equipment being protected.

Equipment that is not readily accessible for maintenance purposes shall not contain parts that require preventative maintenance or periodic inspection to check correct operation.
5 Proof of Performance

The contractor shall produce and submit a technical report on the performance of the proposed surge protection. The technical report must detail how the performance criteria will be met (to ARTC’s Representative’s satisfaction) for the particular site or sites with the nominated equipment and installation practices.

The technical report is also to consider any special needs for the particular installation due to site or equipment aspects.
6 Appendix A: Earthing

6.1 A.1 General

Earthing systems (dependant on the type of system to be protected) shall be installed in accordance with the relevant drawings in Appendix H.

These Earthing systems shall be referred to as the S&C Earthing System (S&CES) and shall not be directly connected to any other earthing system installed by Supply Authorities or other Service Providers.

All different Earthing systems (namely the Supply Authority Earth, Signalling Earth, Communications Earth, etc.) shall be bonded together by using transient earth clamps.

These devices are to be installed inside the equipment room to facilitate the periodic testing of these transient earth clamps.

Separation between the Signalling Earth of the S&C Earthing System and other Earthing systems shall be greater than 5 metres.

Earthing systems shall be designed for the effective operation of surge protection equipment.

To achieve this the earth connections shall be made as short and straight as practicable with large radius bends.

Earth leads may cross signalling cables at right angles to each other as applicable.

All Earthing equipment and material other than the approved types shall be subject to approval before installation.

6.2 A.2 Design of S&C Earthing System

The design of the earthing systems will be dependant on the type of system to be protected and the value of Earth resistance required at the location. Equipment used for Earthing shall be as specified in Appendix D and also in Appendix F.

The procedure for achieving the specified earth resistance and installation of S&C Earthing system is in accordance with the Measurement of Earth Resitivity section A12.

6.3 A.3 Earth Resistance - Main Locations

Main locations are considered to be points where Signalling AC power supply originates. The measured Earth resistance of the earthing arrangement at main locations shall not exceed 5 ohms in dry ground.

6.4 A.4 Earth Resistance/Trackside Locations

Earth resistance at track-side locations with electronic equipment shall not exceed 5 ohms in dry ground; otherwise it shall not exceed 10 ohms.

6.5 A.5 Earth Connection Leads

The earth leads used at various stages shall be as follows:

- **Earth Electrode - Main Busbar**: 7/1.7 mm (Green & Yellow) PVC insulated cable.
- **Main Busbar - Subsidiary Busbar**: 2 x 7/1.7 mm (Green & Yellow) PVC insulated cable.

6.6 A.6 Main and Subsidiary Earth Busbars

The incoming Earth leads shall be individually terminated on a copper Main Earth busbar. The minimum dimensions of Main and Subsidiary Earth Busbars shall be 150mm x 30mm x 6 mm.
The earth wire (or terminating lug) shall be installed in direct physical contact with the busbar plate.

All equipment Earths and surge protection Earths shall be connected wherever possible directly to the Main Earth Busbar making it a single Earth system or if totally impracticable, to Subsidiary Earth Busbars which in turn are connected by duplicated 7/1.7 green and yellow P.V.C. insulated earth cables to the Main Earth Busbar. These connecting earth cables are to be run in orange conduit set into the floor of the signalling equipment building or location.

6.7 A.7 Running of Earth Conductors in Main Locations and Trackside Locations.
The typical arrangement shall be in accordance with drawings listed in Appendix H. The incoming Earth leads are to be run in 25 mm orange conduit set into the floor of the relay room and at least 300 mm away from the signalling, power and communications cable entries.

Earthing conductors that do not have surge protection shall not be run in the same conduit as the signalling conductors, or parallel within 300 mm, as far as practicable.

In all cases the earth conductors are to be run with a minimum of bends. The minimum radius for a bend is 150 mm.

6.8 A.8 Connection of Earth Conductors to Earth Electrodes
Earth conductors shall be bonded to earth electrodes by a cast copper clamp type connection. The earth electrode connection shall not be buried and shall be located so as to be readily accessible for inspection purposes.

The type of protection is to be of sufficient strength to suit the physical position (i.e. truck axle loads in access roads). The top of the protection with lid/cap fitted to be not less than 20mm above ground level. Easy removal of the lid, for inspection purposes, is required.

Where the protection is positioned within the location case or equipment housing surround, the protection with lid/cap fitted shall be finished level with the surround.

6.9 A.9 Earthing of Racks and Equipment Housings
All racks and equipment housings shall be earthed to the Main or Subsidiary Earth Busbars.

All surge protection equipment shall be grouped together in close proximity to the Main Earth Busbar or Subsidiary Earth Busbar and be physically isolated from other signalling equipment. The minimum size of Earthing conductors shall be 7/0.85mm. The conductor insulation shall be green and yellow P.V.C. and shall be run in orange conduit. The conduit shall be set into the floor of the signalling equipment building on location.

6.10 A.10 Measurement of Earth Resistance
a) The earth resistance shall be measured at the S&CES Main Earth Busbar or each separate Earth system using an approved earth resistance metre. Each local earth system is to be tested independently.

b) The Earth probes on the earth resistance metre shall be connected such that a line drawn between them is at right angles to the railway line.

c) Where (b) cannot be achieved due to physical limitations of a site, unusual earth potential voltages or due to any other difficulty arising, this must be noted and included in testing records.

6.11 A.11 Procedure for Installation of the S&CES
1) Take measurements of Earth resistivity at the site. (refer Measurement of Earth Resistivity A.12)
2) Determine the number of Earth electrodes needed, from the Table below, to obtain the required Earth resistance. The Table stated hereunder shall be used as a guideline to determine the initial installation of earth electrodes.

Table 1.1 Earthing Arrangements (Number of Earth Stakes)

<table>
<thead>
<tr>
<th>Earth Resistivity Range (Ohm.cm)</th>
<th>R = 5 ohms Length of Earth Electrode</th>
<th>R = 10 ohms Length of Earth Electrode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 m</td>
<td>4 m</td>
</tr>
<tr>
<td>0000 to 1000</td>
<td>1</td>
<td>NR</td>
</tr>
<tr>
<td>1001 to 1700</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1701 to 2000</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2001 to 2003</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2301 to 3000</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3001 to 3400</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3401 to 4000</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4001 to 5000</td>
<td>CS</td>
<td>3</td>
</tr>
<tr>
<td>5001 to 5500</td>
<td>CS</td>
<td>3</td>
</tr>
<tr>
<td>5501 to 6000</td>
<td>CS</td>
<td>4</td>
</tr>
<tr>
<td>6001 to 7000</td>
<td>CS</td>
<td>4</td>
</tr>
<tr>
<td>7001 to 7500</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>7501 to 8000</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>8001 to 10000</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>10001 to 14000</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>14001 to 15000</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>15001 to 20000</td>
<td>CS</td>
<td>CS</td>
</tr>
<tr>
<td>20001 &amp; over</td>
<td>CS</td>
<td>CS</td>
</tr>
</tbody>
</table>

NR = Not Required
CS = Consult ARTC’s Representative.

However Earth Electrodes shall not be installed exceeding or less than the following limits:

<table>
<thead>
<tr>
<th>Location</th>
<th>Earth Resistance (ohms)</th>
<th>Required Number Minimum</th>
<th>Required Number Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Track-side units at Matching/Tuning Units</td>
<td>10</td>
<td>1 x 2 m</td>
<td>1 x 4 m</td>
</tr>
<tr>
<td>2 Locations without electronic equipment</td>
<td>10</td>
<td>2 x 2 m</td>
<td>4 x 2 m</td>
</tr>
<tr>
<td>3 Locations with electronic equipment</td>
<td>5</td>
<td>4 x 2 m</td>
<td>4 x 4 m</td>
</tr>
<tr>
<td>4 Main Locations (power supply entry points)</td>
<td>5</td>
<td>4 x 2 m</td>
<td>6 x 4 m</td>
</tr>
</tbody>
</table>

When installing multiple Earth Electrodes the minimum separation between Earth Electrodes shall be twice the length of the longer Earth stake.

Where the maximum number of earth Electrodes does not achieve the required value for earth resistance, the details must be noted in the test records and brought to the attention of the ARTC’s Representative.
6.12  A.12 Measurement of Earth Resistivity
Earth Resistivity shall be measured as outlined in AS1768 Lightning Protection.

6.13  A.13 Earth Electrode in Rocky Area/Earth Enhancing Compound
Soil Resistivity is generally high in dry and rocky areas and also difficult to drive earth rod into the rocky soil. In such areas holes shall be drilled for earth stakes.
To ensure maximum contact between the earth stakes and the surrounding earth, the hole shall be filled with earth enhancing compound to improve the earth conductivity.

6.14  A.14 Relay Room Earth Schematic
Foundation drawings for Relay Rooms or Walk-in huts shall include details of all Earthing conduits.
For every signalling location the Contractor shall attach to the Lightning/Surge protection test report a dimensioned layout sketch of the ‘as-built’ Earthing arrangements. This shall show:
• Earth conductors
• Conductor sizes
• Conduits
• Earth electrodes
• Electrode lengths
• Main and subsidiary Earth busbars and
• Transient earth clamps.
It shall also indicate:
• S&CES Earth
• ELD test Earth and
• Supply Authority Earth.

Note: Refer to Appendix H for Typical drawings
## Appendix B: Expected Exposure Of Equipment Interfaces

<table>
<thead>
<tr>
<th>Surge Category</th>
<th>Discharge Pulse</th>
<th>Equipment Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category C</td>
<td>70KA, 8/20us</td>
<td>Tall communication antennas in heavy lightning area close to signalling equipment locations.</td>
</tr>
<tr>
<td></td>
<td>70KA, 8/20us</td>
<td>Some power supply entry points in hilly open areas that have a history of serious lightning damage, and critical installations.</td>
</tr>
<tr>
<td></td>
<td>60KA, 8/20us</td>
<td>Power supply entry points 240 VAC, 50 Hz</td>
</tr>
<tr>
<td></td>
<td>40KA, 8/20us</td>
<td>Power supply entry points (locations) 120 VAC 50 Hz</td>
</tr>
<tr>
<td></td>
<td>20KA, 8/20us</td>
<td>Open Wire Line</td>
</tr>
<tr>
<td></td>
<td>20Ka, 10/350us</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20KA, 8/20us</td>
<td>Some field equipment</td>
</tr>
<tr>
<td></td>
<td>20KA, 8/20us</td>
<td>Track circuit input cables at track-side locations</td>
</tr>
<tr>
<td></td>
<td>60KA, 8/20us</td>
<td>Power supply entry point (AC Supply Authority supplies)</td>
</tr>
<tr>
<td></td>
<td>40KA, 8/20us</td>
<td>Power supply distribution to field locations (120/240/415V, etc)</td>
</tr>
<tr>
<td></td>
<td>20KA, 8/20us</td>
<td>External communication circuits</td>
</tr>
<tr>
<td>Category B</td>
<td>3KA, 8/20us</td>
<td>Sub circuits, Field equipment</td>
</tr>
<tr>
<td></td>
<td>or 6kV, 1.2/50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3KA, 8/20us</td>
<td>Solid State Interlocking Data Links (installations not exposed to lightning)</td>
</tr>
<tr>
<td></td>
<td>or 6kV, 1.2/50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3KA, 8/20us or 6kV, 1.2/50</td>
<td>Low Voltage control circuits</td>
</tr>
<tr>
<td>Category A</td>
<td>6KV, 200A</td>
<td>Final equipment or devices, sub-circuits</td>
</tr>
</tbody>
</table>
Appendix C: Lighting Protection for Railway Signalling

Represents lightning protection equipment suitable for protection against the nominated Category of surge as detailed in AS 1768
9 Appendix D: Lightning/Surge Protection Equipment

9.1 D.1 Types of Equipment
The following types of surge protection equipment are permitted to be installed as applicable. Alternate devices that are superior in performance than the ones specified are acceptable. These alternate devices and designs shall meet the application requirements in terms of the performance requirements and may be acceptable subject to submission in accordance with Section 1.7.

9.2 D.2 Arrestors & Arrestor Holders

9.2.1 D.2.1 Two Terminal Arrestors
The two terminal arrestor shall be the Type #1 Arrestor as specified in Appendix-F with breakdown voltage of 350V rms.
Arrestor holder for above shall be "Sankosha" type Arrestor holder or an approved equivalent type.

9.2.2 D.2.2 Three Terminal Arrestors
The three terminal arrestors shall be as follows:
• Type#2 - with breakdown voltage of 290Vrms; and
• Type#3 - with breakdown voltage of 700Vrms.
The octal-pin socket for the above shall be "Sankosha" GT-3P, "Omron" PF 083A, or an approved equivalent type. Terminations shall be on the front side of the base.

9.3 D.3 Varistors
Suitable varistors approved for the application considering the signal application voltage and surge current capability.

9.4 D.4 Diverters
Diverters shall meet the application requirements.

9.5 D.5 Diverter Panels (DP)
Diverter Panels shall be designed to install inside the switchboards on Supply Authority 240VAC incoming supplies.

9.6 D.6 Inductor/Diverters Panels (IDP)
This provides the primary level of lightning/surge protection on signalling power supply feeders, usually installed on 240 Volt AC side. The IDP shall be as specified in Signalling Design drawings.

9.7 D.7 Inductor/Varistor/Arrestor Panel (IVAP)
This provides secondary protection (or primary if IDP is not installed). The IVAP shall be as specified in Signaling Design drawings.
9.8 **D.8 Varistor/Arrestor Panel (VAP)**
This provides secondary protection on power supply feeders. The VAP shall be as specified in Signalling Design drawings.

9.9 **D.9 Varistor Panel (VP)**
The Varistor panel shall be as specified in Signalling Design drawings.

9.10 **D.10 Line Protection Unit (LPU)**
LPU’s shall be used to protect data communication lines (or voice communication if required). The LPU shall be as specified in Signalling Design drawings

9.11 **D.11 Load Cell Protector**
Load Cell Protectors shall be used to protect Load cells and weight indicating/reporting systems. This unit shall be as specified in Appendix F.

9.12 **D.12 Earthing Equipment**
The following components are suitable for use in Earthing and surge protection systems.

<table>
<thead>
<tr>
<th>Item</th>
<th>Type No./(part#)</th>
<th>Manufacturer/Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth Electrode Clad</td>
<td>Stainless steel grade 316; Type STE1420</td>
</tr>
<tr>
<td>2</td>
<td>Earth Electrode Clamp</td>
<td>Type: EP 01</td>
</tr>
<tr>
<td>3</td>
<td>Earth Electrode Coupling</td>
<td>Type: SCT 15</td>
</tr>
<tr>
<td>4</td>
<td>Earth Electrode Driving Head</td>
<td>Type: DHT 15</td>
</tr>
<tr>
<td>5</td>
<td>Earth Electrode Star Driving Point</td>
<td>Type: SDP 15T</td>
</tr>
<tr>
<td>6</td>
<td>Earth Enhancing Compound</td>
<td>Earth Rite Compound</td>
</tr>
<tr>
<td>7</td>
<td>Cable untinned PVC insulated annealed copper conductor</td>
<td>Single core 7/0.85 or larger, Yellow/Green</td>
</tr>
<tr>
<td>8</td>
<td>Earth Cable stainless steel, 2 mm dia. Solid conductor single strand</td>
<td>Grade 304</td>
</tr>
</tbody>
</table>

9.13 **D.13 Current Ratings and Selection of Panels**
Current ratings of IDP and IVAP panels shall be selected for:

a) The continuous rating of the supply transformer (on the supply side of the switchboard).

Or

b) The distribution circuit breaker rating (on the load side of the switchboard).

Where the required rating exceeds the standard range of panels, a custom designed panel, generally in accordance with the specification, shall be submitted for approval by ARTC’s Representative in accordance with section 1.7.
10 Appendix E: Systems Protection

10.1 E.1 Supply Mains

At new locations or alterations to existing locations the Contractor shall ensure that lightning/surge protection is provided:

- On all incoming Supply authority supplies.
- On the secondary side of the 240v / 415v transformers.
- On the primary and secondary sides of 415v / 415v isolating transformers.
- On the primary side of 415v X 110v/120v transformers.
- On the secondary side of 240v X 110v/120v transformers.
- Where the signalling equipment location derives its power from Supply Authority or Railway 240v / 415v AC mains, the Contractor shall ensure that surge diverters are mounted, subject to the approval of the Supply Authority and earthed to the supply system earth.
- A Diverter Panel (DP) for the incoming supply shall be installed on the Supply Authority metre box. The DP shall be Supply Authority approved.
- The Contractor shall be responsible for obtaining the approval of the relevant Supply Authority.

10.2 E.2 Outgoing 110v/120v Signalling Distribution Mains: (Line wires from Main Locations)

At the load location on a linewire run, where a pair of linewires enters the location, only one set of protection units as defined in the following section is required.

If the outgoing linewires are not the same pair of linewires as the incoming linewires and location equipment is connected to the outgoing linewires, then a second set of protection units shall be installed for each pair of line-wires.

The same arrangement shall be installed as stated in the following section. In this case, looking from the exit point of the line-wire, the IDP where installed shall be mounted first and then the IVAP.

10.3 E.3 Incoming 110v/120V Signalling Distribution Mains: (Line Wire to Main Locations)

a) An IDP shall be installed where 50Hz AC signalling circuits or track circuits are installed.
b) The IDP shall be mounted at the base of the service pole and earthed in accordance with the drawing M08-827.
c) In case the linewire enters the location directly (not through cable) then the IDP can be installed within the location at the entry point.
d) An IVAP shall be installed immediately after the IDP.
e) The IDP and IVAP shall be positioned as close as practical to the entry point to the location.
f) They shall be earthed to the Signalling Earth point.
g) In locations where an IDP is not installed an IVAP shall be installed, and the fuse base should be bridged with a shorting link (see Drawing M08-838).


10.4 E.4 110v/120v Signalling Distribution Mains: (Cables In Main Locations)

An IVAP for each incoming and outgoing cable shall be installed. The IVAPs should be positioned as close as possible to the entry/exit point in the location and earthed to the signalling earth.

At the load location on a mains cable run, where the cable loops into and out of the housing (location cases) only one IVAP is required, between the main terminals and the location equipment.

The fuse base of the IVAP shall be bridged with a shorting link.

10.5 E.5 Outgoing 50 Volts DC Supply - Main Locations

The same level of protection shall be provided as in the section on 110v/120v.

10.6 E.6 110v/120V Signalling and 50VDC Supply at Track Side Locations

One VAP shall be installed in the location for each supply. The incoming cable or cables should be connected directly to the VAP terminals if possible, otherwise the connecting cables between the incoming terminals and the VAP should be as short and straight as practicable.

For track-side equipment with electronic equipment, an IVAP shall be installed as in drawing M08-836.

The VAP shall be grounded to the Signalling Earth.

When the VAP is used to protect a 50V supply, the varistors on the VAP shall be replaced with appropriately rated varistors to suit the supply and the VAP labeled appropriately.

10.7 E.7 Protection of Signalling Circuits - Aerials

Single switched circuits entering or leaving a location shall be protected by arrestors Type#1 connected between Line and Earth as shown in the drawing M08-815.

Double switched circuits entering or leaving a location shall be protected by a three terminal arrestor Type#2 tied across the line and the earth as shown in the drawing M08-815.

10.8 E.8 Protection of Multi-Core Cables

Separate protection will not be required on individual signalling circuits in multi-core signalling cables.

10.9 E.9 Protection of Track Circuits

As a minimum track circuit protection shall be as per the ARTC Circuit Design Standards unless otherwise specified, terminal and arrestor layout for the following track circuits shall be in accordance with drawing M08- 818.

10.9.1 E.9.1 DC Track Circuit

Relay end and track feed locations shall be protected by installing surge arrestor Type #2 as shown on the drawing M08-816.

10.9.2 E.9.2 AC Track Circuit

Protection of 50Hz AC track circuit equipment shall be in accordance with drawing M08-817.
10.10  E.10 Busbar Protection in Signalling Equipment Locations

Varistors with appropriate ratings shall be installed across all busbars, considering the no load voltage of power supply units and the manufacturing tolerances for breakdown voltage of Varistors.

Wherever there is a doubt, varistors with higher breakdown voltages shall be used.

Wiring to Varistors shall not be run in ducting containing other wiring.

Varistors shall be mounted on fire-proof hardware clear of any combustible materials. Minimum wiring size to Varistors shall be 7/0.85 mm Blue PVC.

Varistors are to be connected as close as practical to the power cables connections to the busbar.

10.11  E.11 TDM and FDM Telemetry Line Protection

10.11.1  E.11.1 Communication Lines

TDM and FDM Telemetry equipment should be protected from surges coming through the communication lines by means of a Line Protection Unit (LPU). The LPU shall be installed before the communication line terminates at the TDM/FDM equipment and near the Main Earth Busbar so that the earth connection can be made as short and straight as practicable.

The communication line connected to the terminals "Line" and "Equipment" on the LPU, shall not be laid with the other cables. They shall be separated from other cables by at least 30 mm.

10.11.2  E.11.12 Power Supply

A Varistor Panel VP-20KA or equivalent shall be installed in the input power supply line irrespective of type of supply voltage connected to the equipment.

Both the LPU and VP-20KA or equivalent shall be earthed to the Signalling Earth.

10.12  E.12 Protection of Axle-Counter Equipment

Protection of axle-counter equipment shall be done in accordance with manufacturer's recommendations and additional protections as follows:

10.12.1  E.12.1 Axle-Counter Central Equipment

Shall be protected by varistors with appropriate ratings arranged in "Delta" arrangement (as in VP-20KA panel). The equipment should also be protected from surges emanating through the data communication line, by installing an LPU on the line before it terminates on the Distribution Frame.

10.12.2  E.12.2 Track-side equipment

Track-side equipment shall be protected by varistors with appropriate ratings arranged in "Delta" arrangement (as in VP-20KA panel) and mounted as a card inside the vandal proof cover.

10.12.3  E.12.3 Earthing

Earthing shall be installed in accordance with Appendix A.

Track-side locations shall be done similarly.
10.13 E.13 Protection of Weighbridge Equipment

10.13.1 E.13.1 Protection of Load Cells & Weight Indicating Equipment
Load Cell Protector type "CRITEC" LCP-01 or equivalent shall be installed on the load cell cables as close as practical to each Load Cell.
The same device shall be used to protect the weighbridge indicator, which shall be installed on the Load Cell extension cable as close as practicable to the weight indicator.

10.13.2 E.13.2 Protection of Data Communication Lines
Line Protection Units (LPUs) shall be installed between the modem and communication line.

10.13.3 E.13.3 Power Supply for Weighbridge Equipment
The weighbridge equipment shall also be protected from surges induced on the power supply. IVAP-15A/240V panels shall be installed at Weighbridge Equipment Location hut as detailed in the sections for 110v/120v distribution.

10.13.4 E.13.4 Earthing
Earthing shall be as laid down in Appendix A. The Earth resistance shall be less than 1 ohm.
Earth electrodes up to 6 metre length shall be installed in bored holes and filled with earth enhancing compound.
An Earth busbar shall be provided at the weighbridge hut. Earth cables shall be extended from the earth electrode, which is closest to the pit. (For new installations of weighbridges an earth busbar may be installed within the weighbridge pit).
An "Equi-potential Earth" may be provided by connecting the Earth terminals of load cells together.

10.14 E.14 Protection of Stand-by Power plants (Motor/Alternator sets)
Each motor/alternator standby set shall be provided with an Earth busbar within the unit. Earth electrodes 2x2m shall be installed to form the earthing system (the frame and the enclosure if applicable shall be connected to the Earth busbar).
If the Motor/Alternator stand-by set is installed external to the equipment hut two Earth wires (7/1.7 G/Y PVC) shall interconnect the Main Earth Busbar in the equipment room and the busbar of the unit.
A typical earthing arrangement shall be as detailed in drawing M08-833.
Earthing of Motor/Alternator sets, rated other than 110v/120v AC, shall be done in accordance with AS3000.

10.15 E.15 Solid State/Computer-Based Interlocking protection
Solid State Interlocking equipment protection shall include:
- Primary power supply protection for both normal and emergency supplies.
- Secondary power supply protection.
- Protection against EMI and electro-static effects.
- Protection against traction system harmonics.
- Data Link protection.
10.16 E.16 Protection of Equipment Operating on 240V AC 50Hz (Unprotected Supplies)

Whenever there is a necessity to operate equipment on 240V AC 50Hz at signal equipment locations, it is necessary to make sure the 240V AC supply is protected against lightning/surge protection. Wherever there is a doubt a commercially available approved surge suppression/filter shall be installed.
## Appendix F: Lightning Protection Equipment

<table>
<thead>
<tr>
<th>Description</th>
<th>Remarks/Issue Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Arrestor, &quot;Sankosha&quot; type Y08JSZ-350D (Type#1)</td>
<td></td>
</tr>
<tr>
<td>2. Arrestor Holder, &quot;Sankosha&quot; type AT</td>
<td></td>
</tr>
<tr>
<td>3. Arrestor, &quot;Sankosha&quot; type 3Y20-290GT (Type#2)</td>
<td></td>
</tr>
<tr>
<td>4. Arrestor, &quot;Sankosha&quot; type 3Y20-700GT (Type#3)</td>
<td></td>
</tr>
<tr>
<td>5. Base, octal to suit non-vital relays and Arrestor &quot;Sankosha&quot; GT type, &quot;Omron&quot; PF083A or Equivalent</td>
<td></td>
</tr>
<tr>
<td>6. Cable, 7/0.85 PVC Green &amp; Yellow</td>
<td>Metre</td>
</tr>
<tr>
<td>7. Cable, Stainless Steel 2 mm (Approx. 3036M)</td>
<td>75Kg coil</td>
</tr>
<tr>
<td>8. Earth Electrode 2 m x 14 mm Dia. Stainless Steel</td>
<td></td>
</tr>
<tr>
<td>9. Earth Electrode Clamp, Cast Copper 14 mm</td>
<td></td>
</tr>
<tr>
<td>10. Earth Electrode Coupling</td>
<td></td>
</tr>
<tr>
<td>11. Earth Electrode Driving Head</td>
<td></td>
</tr>
<tr>
<td>12. Earth Electrode Star Driving Points</td>
<td></td>
</tr>
<tr>
<td>13. Earth Enhancing Compound (Earth-rite compound or an equivalent)</td>
<td></td>
</tr>
<tr>
<td>14. Line Protection Unit</td>
<td></td>
</tr>
<tr>
<td>15. Panel Diverter (DP-240V)</td>
<td></td>
</tr>
<tr>
<td>16. Panel, Inductor/Diverter Panel (IDP-50A)</td>
<td></td>
</tr>
<tr>
<td>17. Panel, Inductor/Diverter Panel (IDP-100A)</td>
<td></td>
</tr>
<tr>
<td>18. Panel, Inductor/Varistor/Arrestor Panel (IVAP-50A)</td>
<td></td>
</tr>
<tr>
<td>19. Panel, Inductor/Varistor/Arrestor Panel (IVAP-100A)</td>
<td></td>
</tr>
<tr>
<td>20. Panel, Varistor/Arrestor (VAP)</td>
<td></td>
</tr>
<tr>
<td>21. Varistor, Siemens SIOV B32K150 or &quot;National ERZC32EK241 (20KA, for 110v / 120v bus)</td>
<td></td>
</tr>
<tr>
<td>22. Varistor, SIOV S20K17 (5KA, for 12V bus)</td>
<td></td>
</tr>
<tr>
<td>23. Varistor, SIOV S20K30 (5KA, for 24V bus)</td>
<td></td>
</tr>
<tr>
<td>24. Varistor, SIOV B32K75 (20KA, for 50V bus)</td>
<td></td>
</tr>
<tr>
<td>25. Varistor, SIOV B60K150 (60KA, for 110v / 120v bus)</td>
<td></td>
</tr>
<tr>
<td><strong>Test Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>26. Earth Tester type YEW 3235 or equivalent</td>
<td></td>
</tr>
<tr>
<td>27. Lightning Arrestor/Varistor Tester</td>
<td></td>
</tr>
</tbody>
</table>
12 Appendix G: Earthing and Surge Protection Installation Test

Area/District:  
Project:  

Earthing arrangement

<table>
<thead>
<tr>
<th>Earth Stake Length</th>
<th>Earth Leads (2 mm SS or 7/1.7Cu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A= B= C= D=</td>
<td>A= B= C= D=</td>
</tr>
</tbody>
</table>

Sketch of earthing arrangement

<table>
<thead>
<tr>
<th>Continuity tested?</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Resistivity (measured or calculated reading)</td>
<td>=Ohm.cm</td>
</tr>
<tr>
<td>Condition of soil (Marshy/wet/moderate/dry/rocky)</td>
<td></td>
</tr>
<tr>
<td>Earth Resistance 1 (tested at Earth Busbar/Electrode)</td>
<td>=Ohm</td>
</tr>
<tr>
<td>Earth Resistance 2 ( )</td>
<td></td>
</tr>
<tr>
<td>Earth Resistance main earth busbar (with all earths connected)</td>
<td>=Ohm</td>
</tr>
<tr>
<td>Remarks (material, practices, specification deviations, etc):</td>
<td></td>
</tr>
</tbody>
</table>

Inspection & testing of lightning protection installation

<table>
<thead>
<tr>
<th>Physical and mechanical inspection</th>
<th>(OK/Remarks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective equipment tested</td>
<td>(OK/Remarks)</td>
</tr>
<tr>
<td>Continuity test of earth conductors</td>
<td>(OK/Remarks)</td>
</tr>
<tr>
<td>Earth Resistance at Main Busbar (verified or witness tested) (Y/N)</td>
<td></td>
</tr>
</tbody>
</table>

Signature of ARTC representative  
Name/Title:  
Date: / /
13 Appendix H: Drawings

Protection of Aerial line Wires, Signalling Circuits  M08-815
Protection for DC Track Circuits  M08-816
Protection for AC Track Circuits  M08-817
Track Circuit Protection- Terminal & Arrestor layout  M08-818
Earthing Arrangement for track-side cupboards  M08-826
Earthing arrangement for overhead ground wires  M08-827
Typical layout of Relay Room, Part A  M08-831/A
Typical layout of Relay Room, Part B  M08-831/B
Layout of Level Crossing Equipment Hut  M08-832
Preferred layout of Relay Room with Motor/Alternator set  M08-833
Preferred layout of Relay Room with dual transformer supplies 240/415/2KV/11KV  M08-834
Signalling Power Supply - General Arrangement  M08-836
Signalling Power Supply - Configurations  M08-837
Signalling Power Supply - Protection of secondary of supply transformer  M08-838
OVERHEAD GROUND WIRE 7/1.04mm HD Cu

2 x 7/1.04mm HD Cu

TWO 7/1.04mm BARE CONDUCTORS AND 2 x 0.42mm STAINLESS STEEL WIRES ELECTRICALLY AND PHYSICALLY CONNECTED TOGETHER TO THE POLE BY MEANS OF A STAINLESS STEEL BOLT OR CADWELDED OR TAPPED HOLE M8.

INDUCTOR/INVERTER PANEL (DP) (SHOWN WITHOUT THE ENCLOSURE)

7/1 1.30mm MINIMAL

7/1 0.7mm Cu GREEN/YELLOW PVC

STAINLESS STEEL, BOLTED OR CADWELDED CONNECTION

PVC TUBE 200mm x Ø10mm WITH Lid (EASY REMOVAL OF Lid IS REQUIRED) CONCRETE MONUMENT COVERS TO BE PROVIDED ON OR NEAR ACCESS ROADS

EARTH ELECTRODE CLAMP CONNECTION

Ø20mm STAINLESS STEEL WIRE BURIED 90cm BELOW THE SURFACE MINIMUM BENDING RADIUS 150mm
Engineering (Signalling) Specification
ESC-09-02 Lightning and Surge Protection Requirements
Appendix H: Drawings

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FLOOR PLAN SHOWING MAIN CABLE DUCTS AND EARTH CABLE CONDUITS

FLOOR PLAN SHOWING EQUIPMENT LAYOUT AND LOCATION OF SURGE PROTECTION

NOTES:
(a) 025m ORANGE FOR MAIN EARTH LEADS
(b) 025m ORANGE FOR SUBSIDIARY EARTH CONNECTIONS CABLES
(c) 025m ORANGE CONDUIT FOR SUBSIDIARY CABLES TO RELAY RACKS (ONE PER RACK AS REQUIRED)
(d) 02mm STAINLESS STEEL WIRE
(e) EARTH ELECTRODE CONNECTION (TO BE CLAMPED OR CAGED/WELDED)
UNLESS OTHERWISE APPROVED, THE DISTANCE BETWEEN EARTH (STAKES) MUST BE TWICE THE DEPTH OF THE EARTHING ELECTRODES.
(f) 025m ORANGE CONDUIT FOR 7/1.7 GY EARTH LEADS (IF MOTOR GENERATOR IS TO BE INSTALLED EXTEND TO THE RELAY ROOM)
(g) ALL INTERNAL EARTH LEADS TO BE 7/1.7 GREEN AND YELLOW PVC INSULATED

CONDUITS TO BE INSTALLED FOR POWER SUPPLY MAINS, EARTHING REQUIREMENTS AND ELECTRODE SPACING TO BE IN ACCORDANCE WITH AS3000.
14 Items to be Specified in the Particular Specification

Items to be specified in the Particular Specification shall include but is not limited to:

1)