AUSTRALIAN RAIL TRACK CORPORATION LTD

Discipline: Engineering (Signalling) **Category: Specification**

Lightning and Surge Protection Requirements

ESC-09-02

Applicability

ARTC Network Wide	✓	**RIC (NSW CRN)**	

Primary Source

SC 06 01

Document Status

Version	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.0	12 Oct 09	Standards	Signal Standards Engineer	Manager Standards	Exec Mgr Stds, Sys & Perf 12/10/2009

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Version	Date Reviewed	Clause	Description of Amendment
1.0	12 Oct 09		SC 06 01 v1.0 renumbered to reflect approved numbering scheme. References to other renumbered standards updated.

Contents

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

IEC 587-1994: Test methods for evaluating resistance to tracking and erosion of an electrical insulating material.

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

DP	Diverter Panel
IDP	Inductor/Diverter Panel
ELD	Earth Leakage Detector
IVAP	Inductor/Varistor/Arrestor Panel
LPU	Line Protection Unit
LCP	Load Cell Protector
S&CES	Signals & Communications Earthing System
VAP	Varistor/Arrestor Panel
VP	Varistor Panel

Electronic Equipment: equipment that has more than 5% of its electrical parts as electronic components.

Electro-Mechanical Equipment: equipment that primarily contains inductors, electric motors, solenoids, relays, contactors, switches, resistors, etc.

Electrical Equipment: is considered to be either Electronic equipment or Electro-mechanical equipment. If there is any doubt then it will be considered to be electronic equipment.

Protection Earth: An earth provided for lightning and surge protection purposes.

Equipment Earth: An earth provided to an item of equipment for shielding or purposes other than surge protection.

Location: A small building or protective enclosure inside which equipment is installed.

Main Location: A critical location, or a location containing significantly more than the average quantity of equipment.

Transient Earth Clamp: It is used to limit the potential difference between two separate earths.

Surge: A transient electrical overload condition due due to lightning, power supply switching, and fault conditions appearing at interfaces.

Category A pulse A test surge pulse as defined in AS1768.

Category B pulse A test surge pulse as defined in AS1768.

Category C pulse A test surge pulse as defined in AS1768.

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.

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

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.

Equipment Type	Earth Resistance
Electronic Equipment installed inside locations	5 ohm
Electro-mechanical equipment installed inside locations	10 ohm
Electronic Equipment installed external to locations	20 ohm
Electro-mechanical equipment installed external to locations	50 ohm

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)

Earth Resistivity Range	R = 5 ohms Length of Earth Electrode			R = 10 ohms Length of Earth Electrode		
(Ohm.cm)	2 m	4 m	6 m	2 m	4 m	6 m
0000 to 1000	1	NR	NR	1	NR	NR
1001 to 1700	2	1	NR	1	NR	NR
1701 to 2000	2	2	1	1	NR	NR
2001 to 2003	3	2	1	2	1	NR
2301 to 3000	3	2	2	2	1	NR
3001 to 3400	4	2	2	2	1	NR
3401 to 4000	4	3	2	2	2	1
4001 to 5000	CS	3	2	3	2	1
5001 to 5500	CS	3	3	3	2	2
5501 to 6000	CS	4	3	3	2	2
6001 to 7000	CS	4	3	4	2	2
7001 to 7500	CS	CS	3	4	3	2
7501 to 8000	CS	CS	4	4	3	2
8001 to 10000	CS	CS	4	CS	3	2
10001 to 14000	CS	CS	CS	CS	4	3
14001 to 15000	CS	CS	CS	CS	CS	3
15001 to 20000	CS	CS	CS	CS	CS	4
20001 & over	CS	CS	CS	CS	CS	CS

NR = Not Required

CS = Consult ARTC's Representative.

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

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

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:

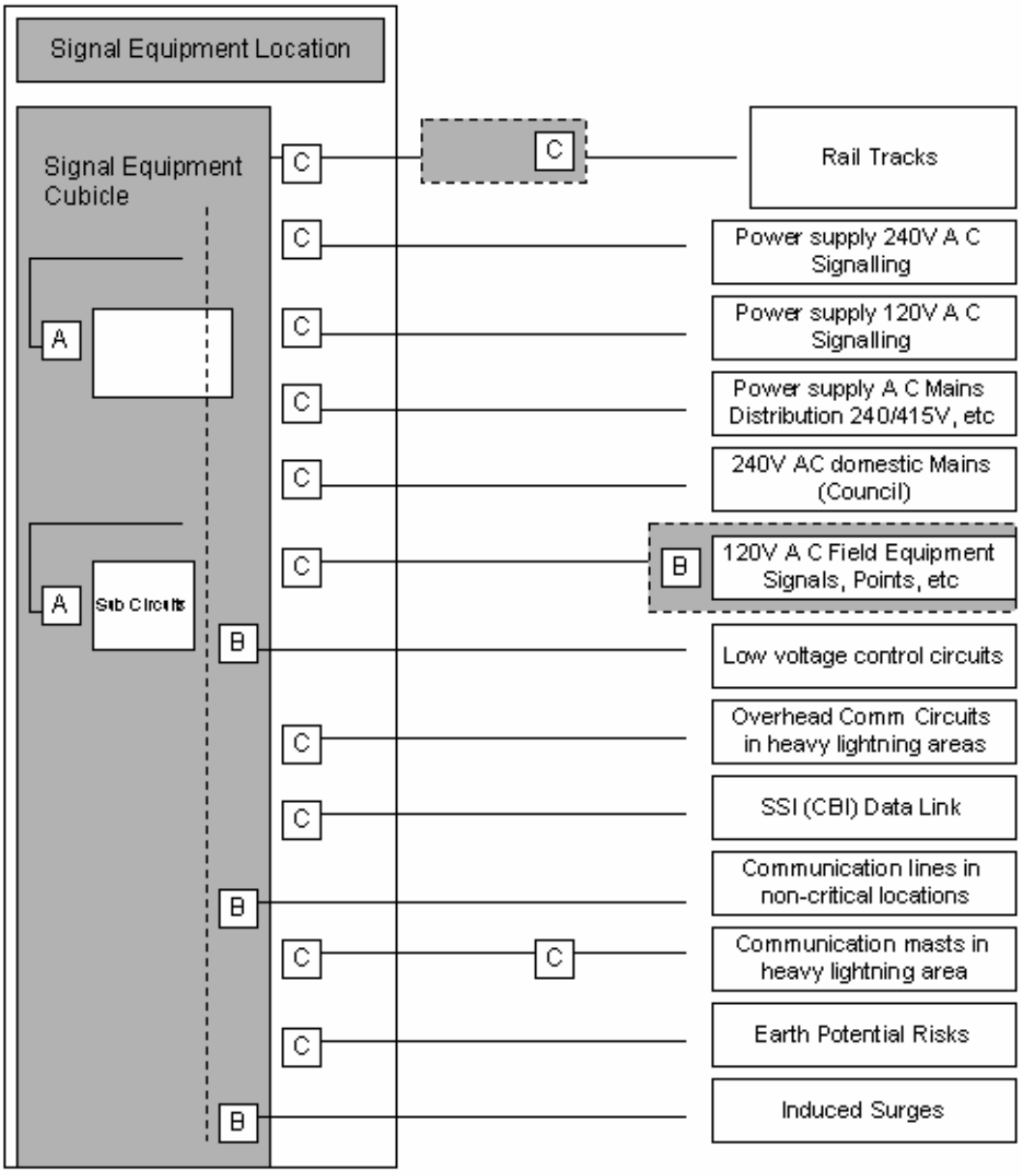
- S&CES Earth
- ELD test Earth and
- Supply Authority Earth.

Note: Refer to Appendix H for Typical drawings

7 Appendix B: Expected Exposure Of Equipment Interfaces

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

8 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/Diverter 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.

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

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.

11 Appendix F: Lightning Protection Equipment

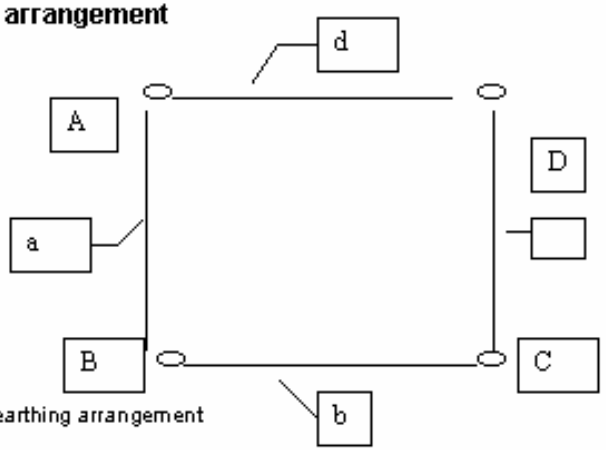
	Description	Remarks / Issue Unit
1.	Arrestor, “Sankosha” type Y08JSZ-350D	(Type#1)
2.	Arrestor Holder, “Sankosha” type AT	
3.	Arrestor, “Sankosha” type 3Y20-290GT	(Type#2)
4.	Arrestor, “Sankosha” type 3Y20-700GT	(Type#3)
5.	Base, octal to suit non-vital relays and Arrestor “Sankosha” GT type, “Omron”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

12 Appendix G: Earthing and Surge Protection Installation Test

Area/District: Location: Km:

Project:

Earthing arrangement



Sketch of earthing arrangement

Earth Stake Length				Earth Leeds (2 mm SS or 7/1.7Cu)			
A=	B=	C=	D=	A=	B=	C=	D=

Continuity tested?	Yes/No
Earth Resistivity (measured or calculated reading)	=Ohm.cm
Condition of soil (Marshy/wet/moderate/dry/rocky)	
Earth Resistance (1) – tested at Earth Busbar/Electrode Earth Resistance (2)	=Ohm =
Earth Resistance main earth busbar (with all earths connected)	=Ohm
Remarks (material, practices, specification deviations, etc.): Name of Contractor: Representative: Signature: Date: / /	

Inspection & testing of lightning protection installation	
Physical and mechanical inspection	(OK/Remarks)
Protective equipment tested	(OK/Remarks)
Continuity test of earth conductors	(OK/Remarks)
Earth Resistance at Main Busbar (vertified or witness tested) (Y/N)	

Signature of ARTC representative	Date: / /
Name/Title:	

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

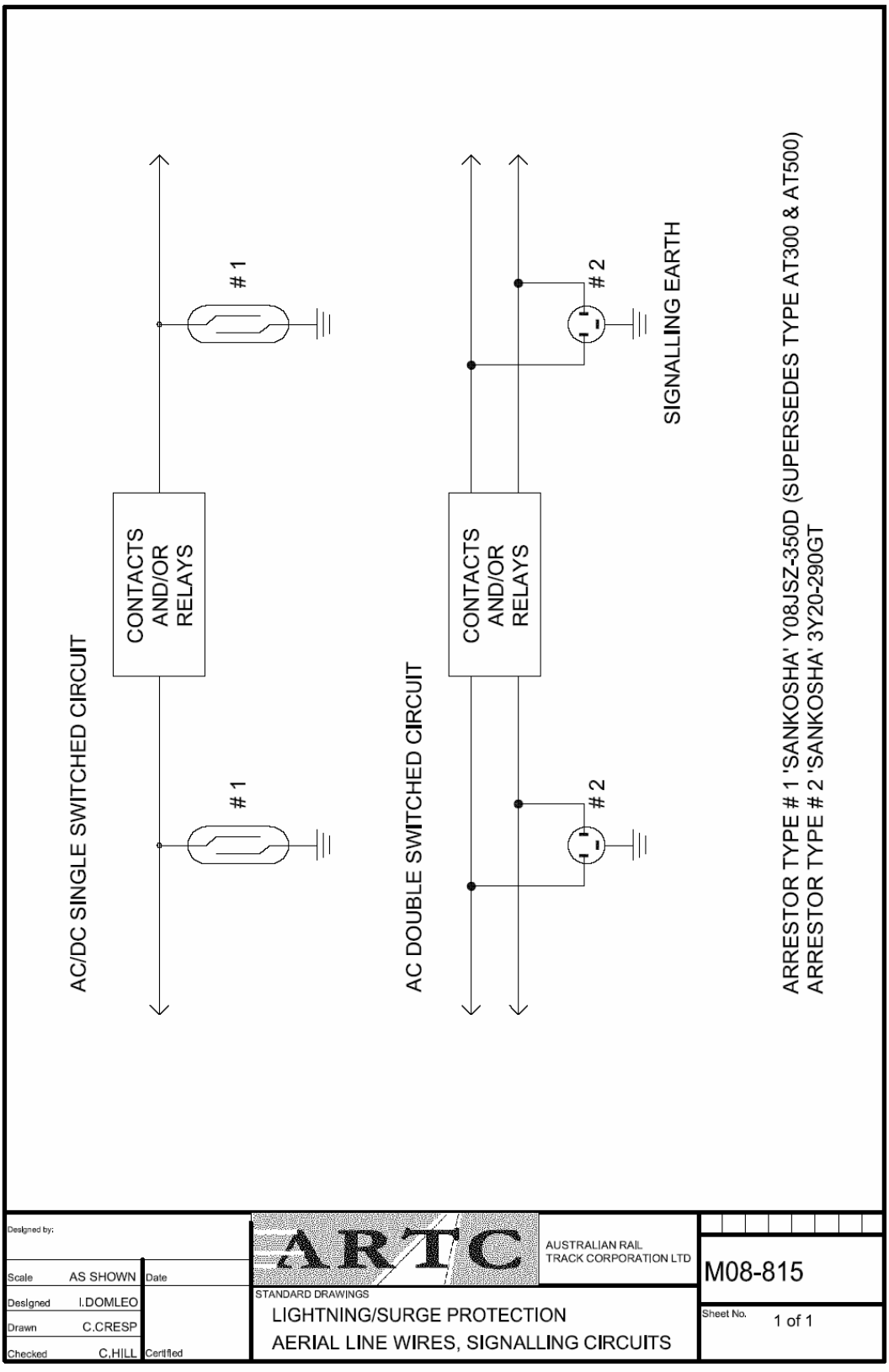
Preferred layout of Relay Room with Motor/Alternator set M08-833

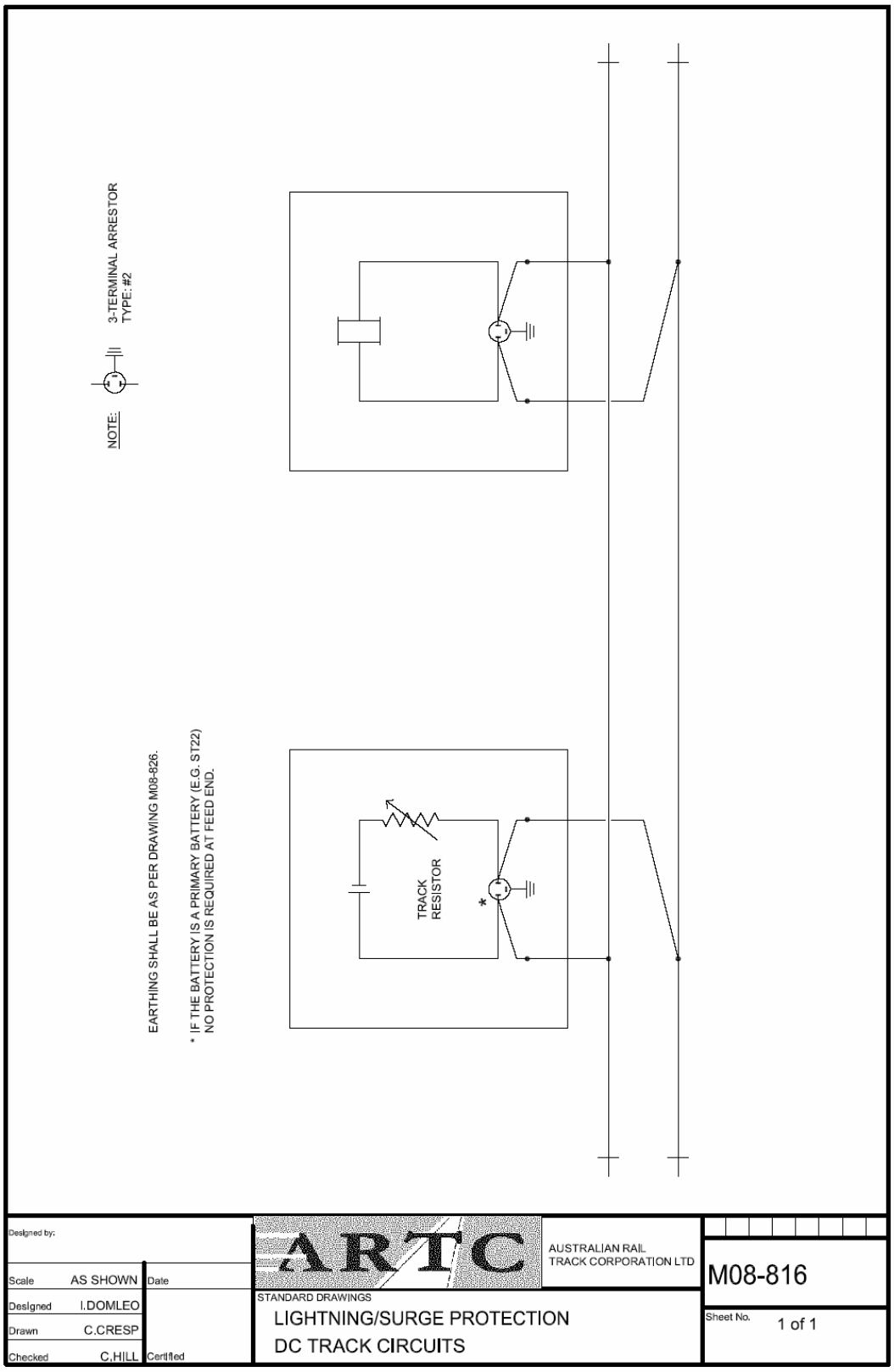
Preferred layout of Relay Room with dual transformer supplies 240/415/2KV/11KV M08-834

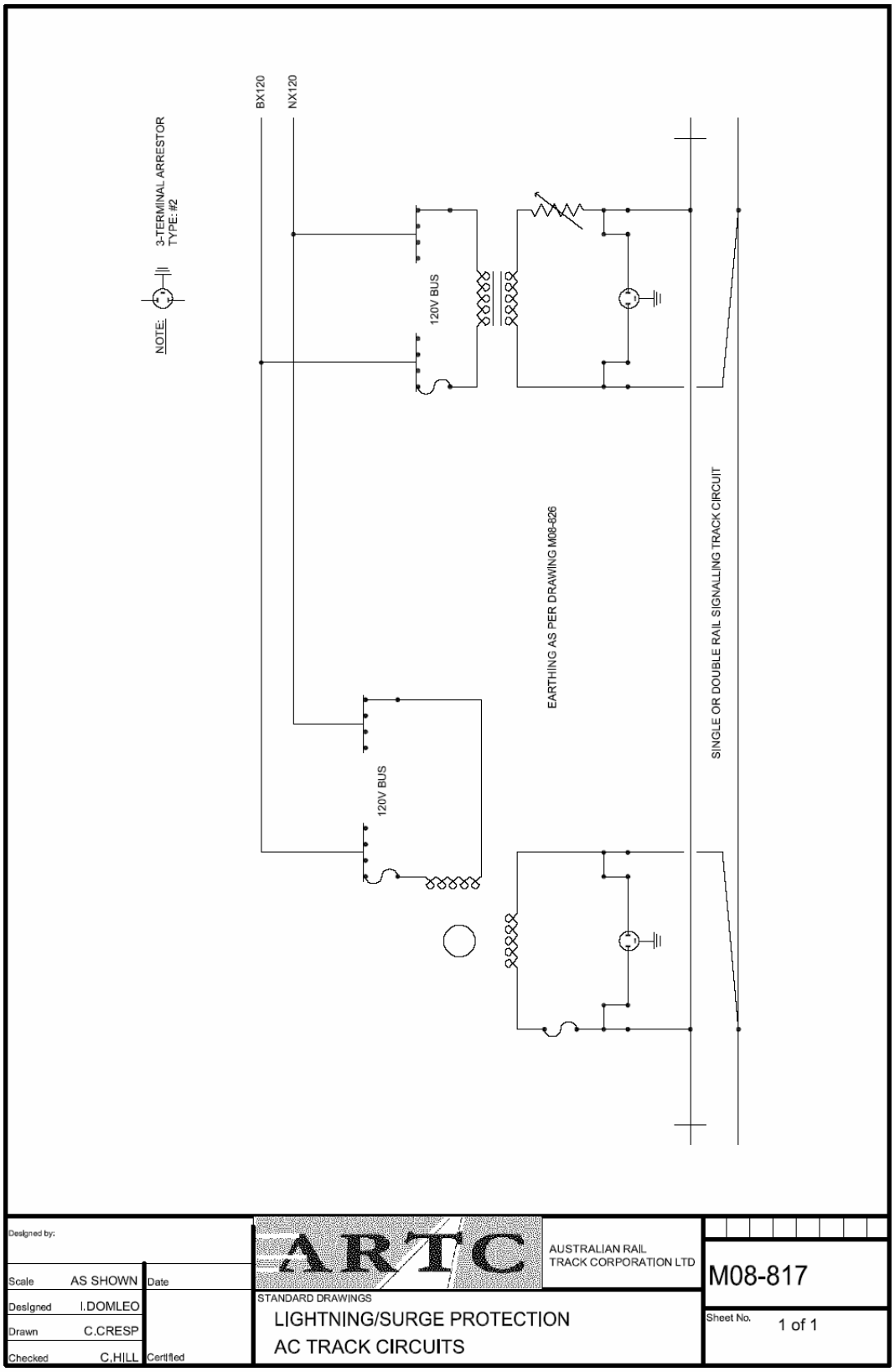
Signalling Power Supply - General Arrangement M08-836

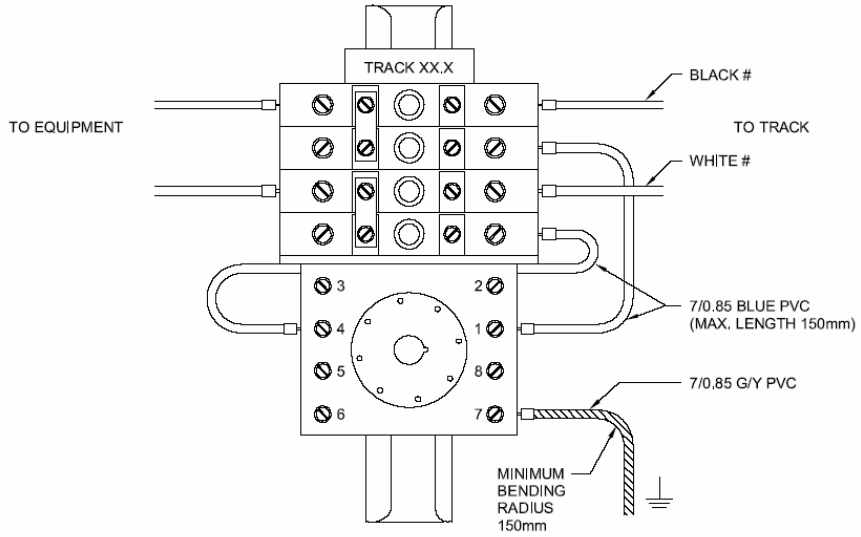
Signalling Power Supply - Configurations M08-837

Signalling Power Supply - Protection of secondary of supply transformer M08-838


AC/DC SINGLE SWITCHED CIRCUIT
CONTACTS AND/OR RELAYS
1
1
AC DOUBLE SWITCHED CIRCUIT
CONTACTS AND/OR RELAYS
2
2
SIGNALLING EARTH
ARRESTOR TYPE # 1 'SANKOSHA' Y08JSZ-350D (SUPERSEDES TYPE AT300 & AT500)
ARRESTOR TYPE # 2 'SANKOSHA' 3Y20-290GT
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
AERIAL LINE WIRES, SIGNALLING CIRCUITS
M08-815
Sheet No. 1 of 1


3-TERMINAL ARRESTOR
TYPE: #2
NOTE:
TRACK
RESISTOR
*
EARTHING SHALL BE AS PER DRAWING M08-826.
* IF THE BATTERY IS A PRIMARY BATTERY (E.G. ST22)
NO PROTECTION IS REQUIRED AT FEED END.
Designed by:
Scale AS SHOWN
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Date
Certified
AUSTRALIAN RAIL
TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
DC TRACK CIRCUITS
M08-816
Sheet No.
1 of 1

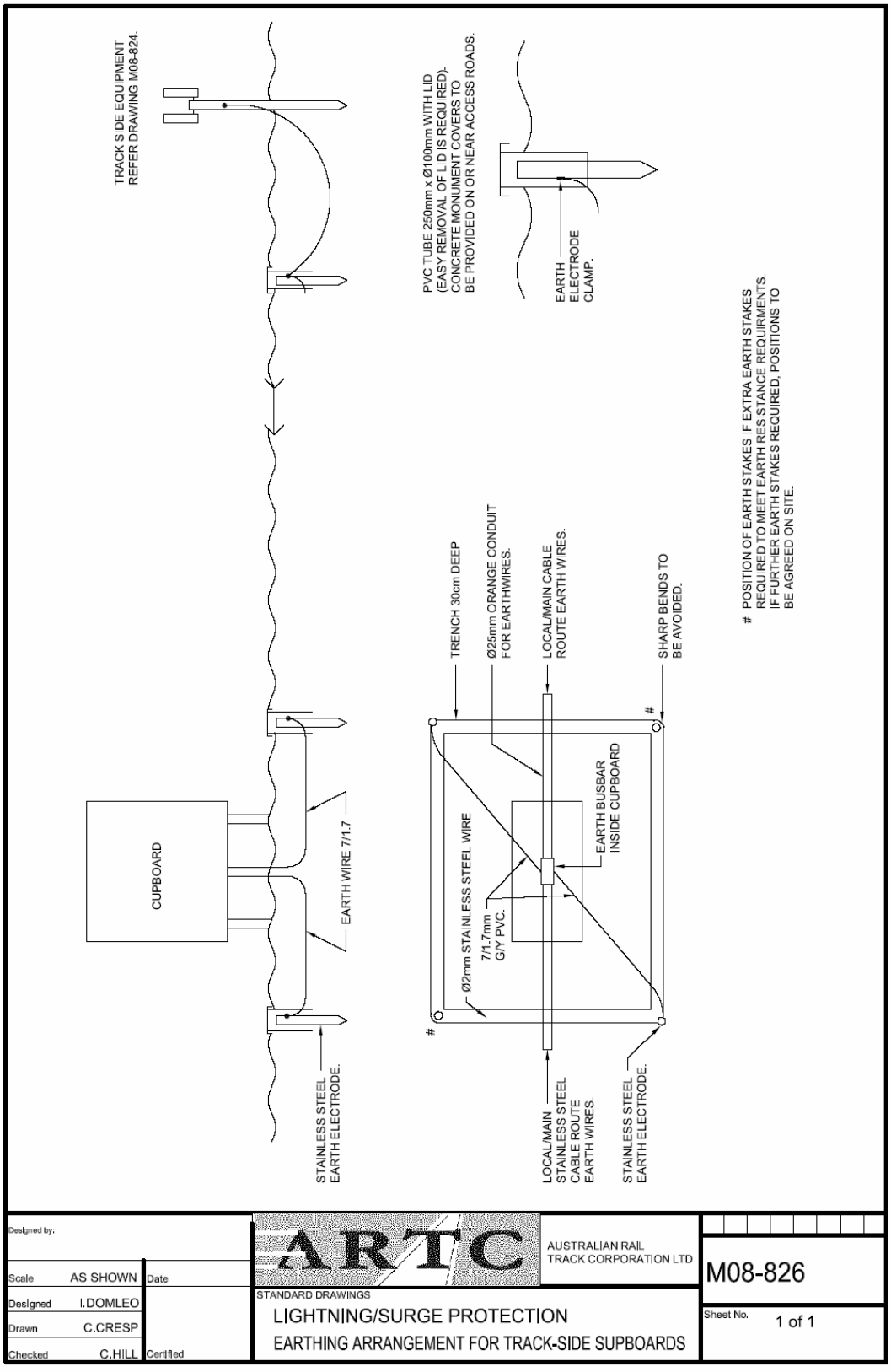

BX120
NX120
3-TERMINAL ARRESTOR
TYPE: #2
NOTE:
120V BUS
120V BUS
EARTHING AS PER DRAWING M08-826
SINGLE OR DOUBLE RAIL SIGNALLING TRACK CIRCUIT
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
AC TRACK CIRCUITS
M08-817
Sheet No. 1 of 1

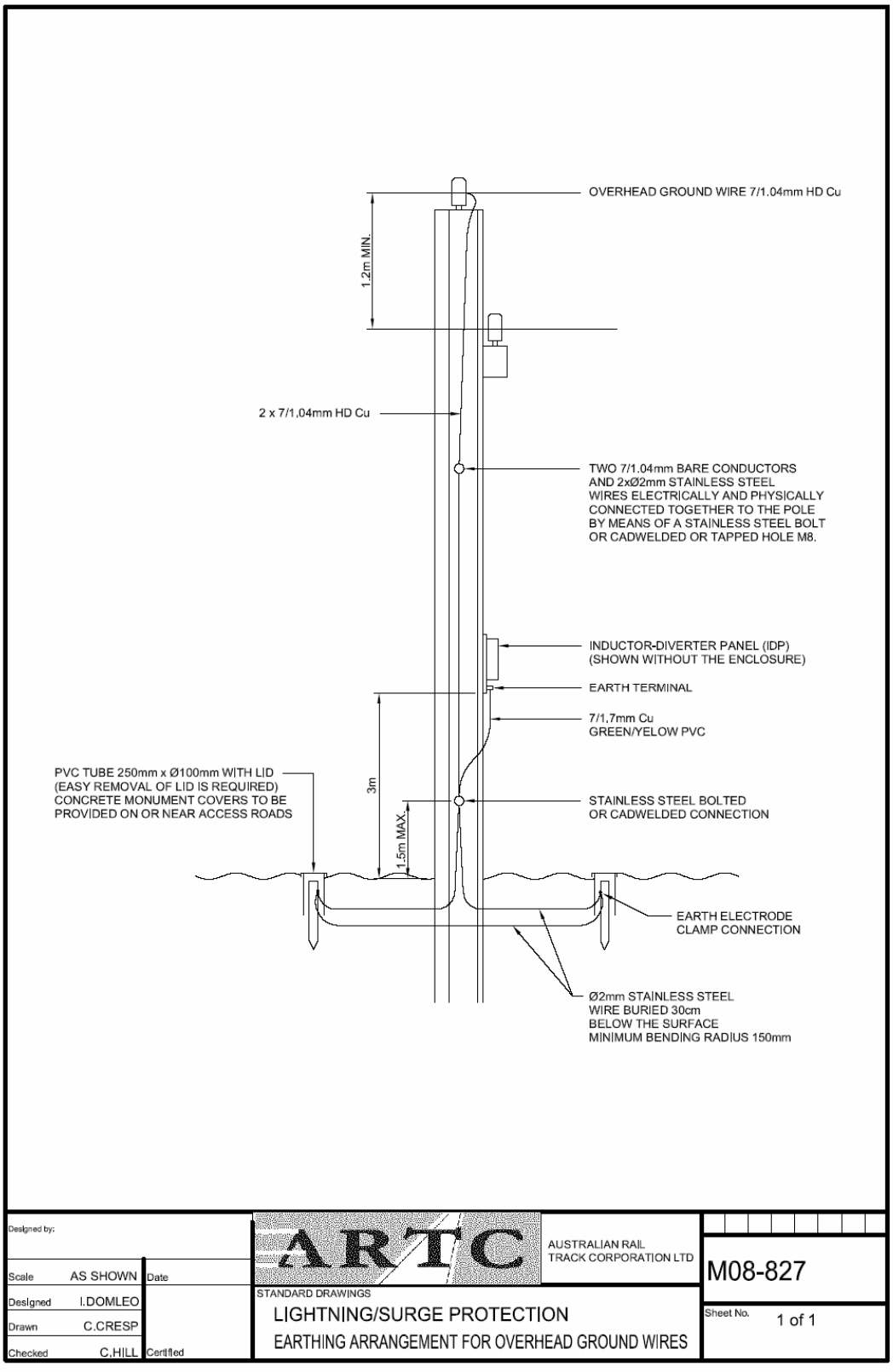


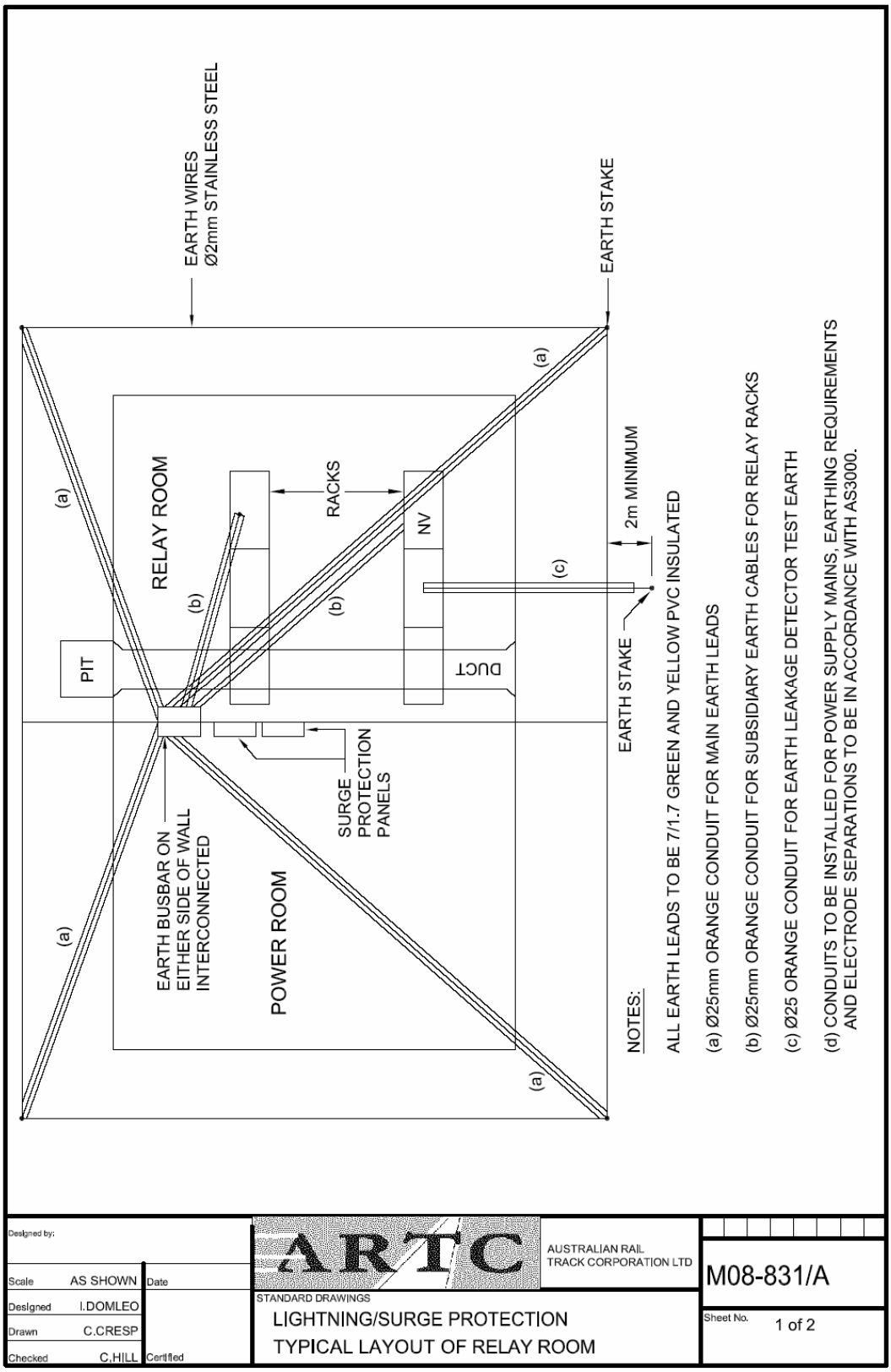
TERMINALS - KLIPPON SAK C10
ARRESTOR BASE - OMRON PF-083A

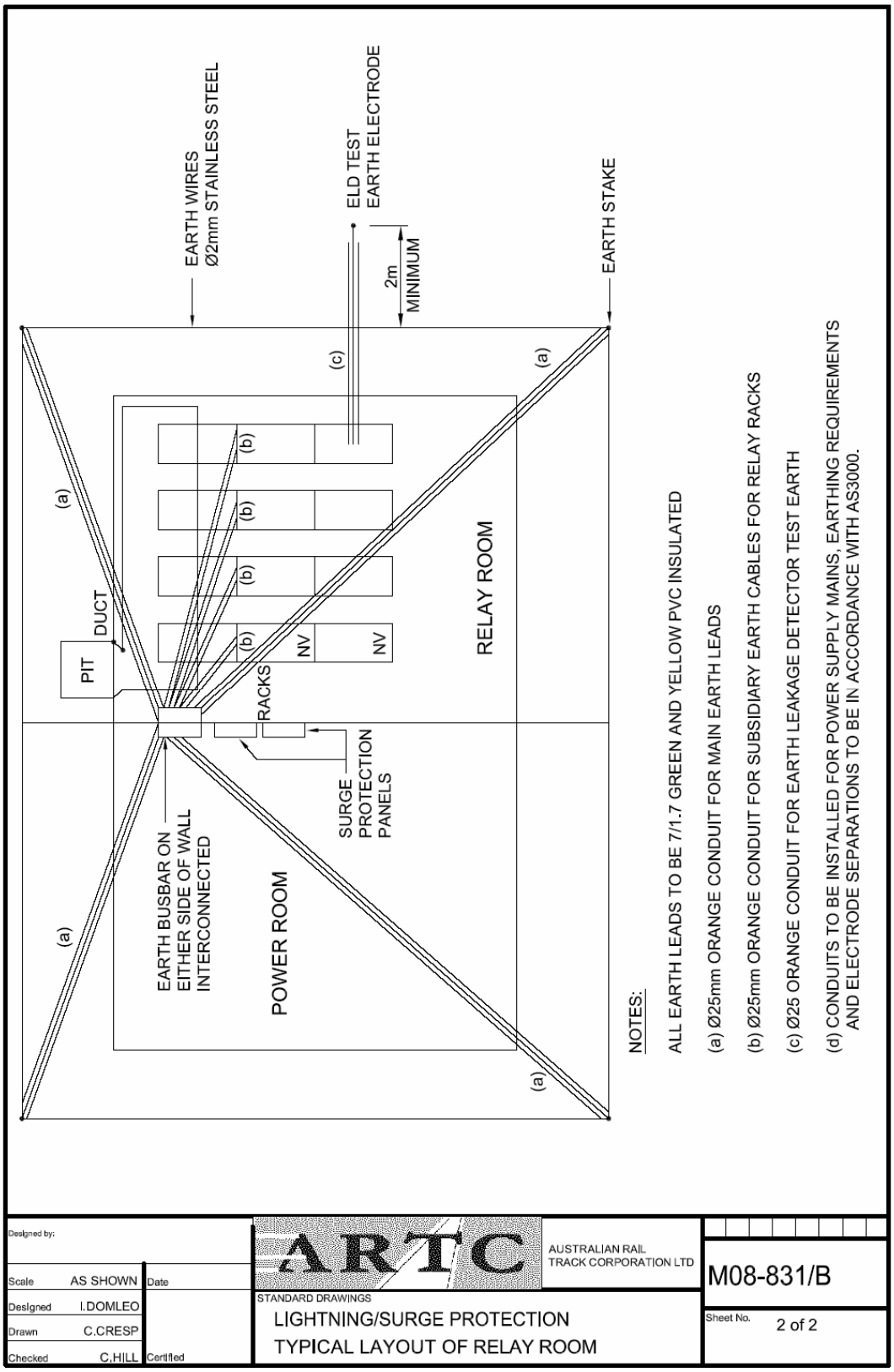
CORE COLOURS WHERE APPLICABLE

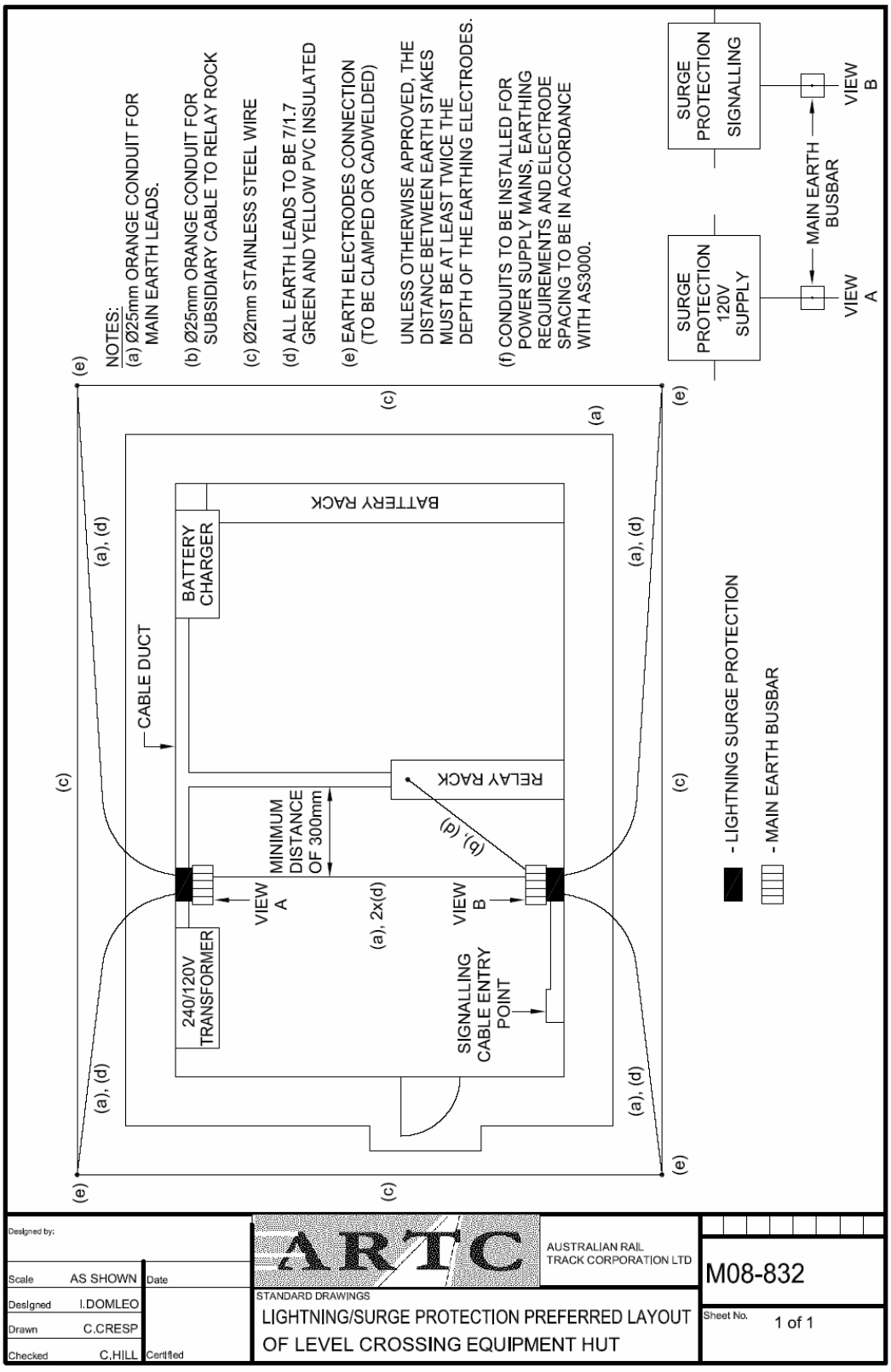
Designed by:		AUSTRALIAN RAIL TRACK CORPORATION LTD	M08-818
Scale AS SHOWN	Date	STANDARD DRAWINGS	Sheet No. 1 of 1
Designed I.DOMLEO		TRACK CIRCUIT SURGE PROTECTION	
Drawn C.CRESP		TERMINAL AND ARRESTOR LAYOUT	
Checked C.HILL	Certified		

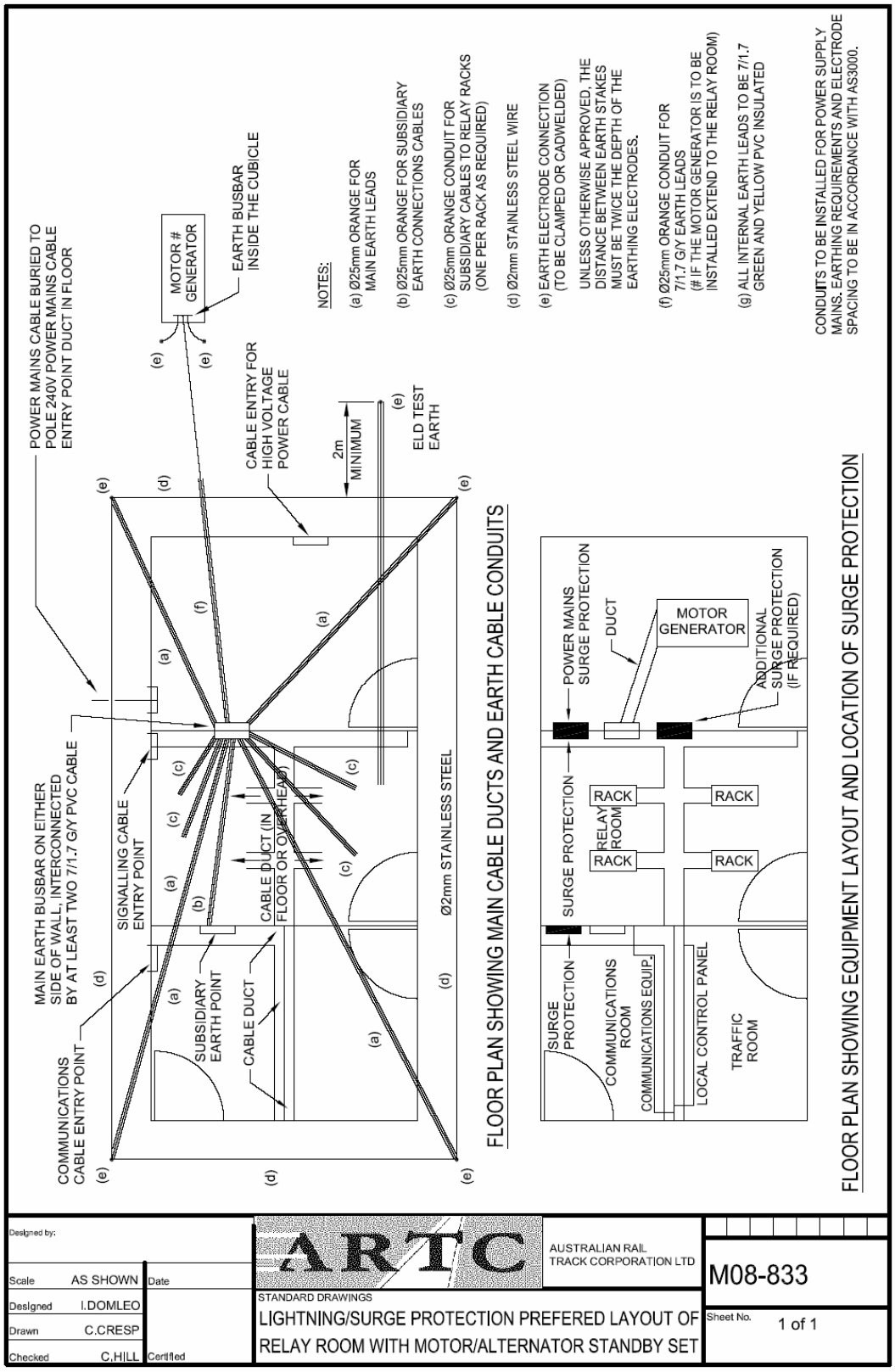

TRACK SIDE EQUIPMENT
REFER DRAWING M08-824.
PVC TUBE 250mm x Ø100mm WITH LID
(EASY REMOVAL OF LID IS REQUIRED).
CONCRETE MONUMENT COVERS TO
BE PROVIDED ON OR NEAR ACCESS ROADS.
EARTH
ELECTRODE
CLAMP.
POSITION OF EARTH STAKES IF EXTRA EARTH STAKES
REQUIRED TO MEET EARTH RESISTANCE REQUIRMENTS.
IF FURTHER EARTH STAKES REQUIRED, POSITIONS TO
BE AGREED ON SITE.
TRENCH 30cm DEEP
Ø25mm ORANGE CONDUIT
FOR EARTHWIRES.
LOCAL/MAIN CABLE
ROUTE EARTH WIRES.
SHARP BENDS TO
BE AVOIDED.
CUPBOARD
EARTH WIRE 7/1.7
EARTH BUSBAR
INSIDE CUPBOARD
Ø2mm STAINLESS STEEL WIRE
7/1.7mm
G/Y PVC.
STAINLESS STEEL
EARTH ELECTRODE.
LOCAL/MAIN
STAINLESS STEEL
CABLE ROUTE
EARTH WIRES.
STAINLESS STEEL
EARTH ELECTRODE.
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL
TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
EARTHING ARRANGEMENT FOR TRACK-SIDE SUPBOARDS
M08-826
Sheet No. 1 of 1

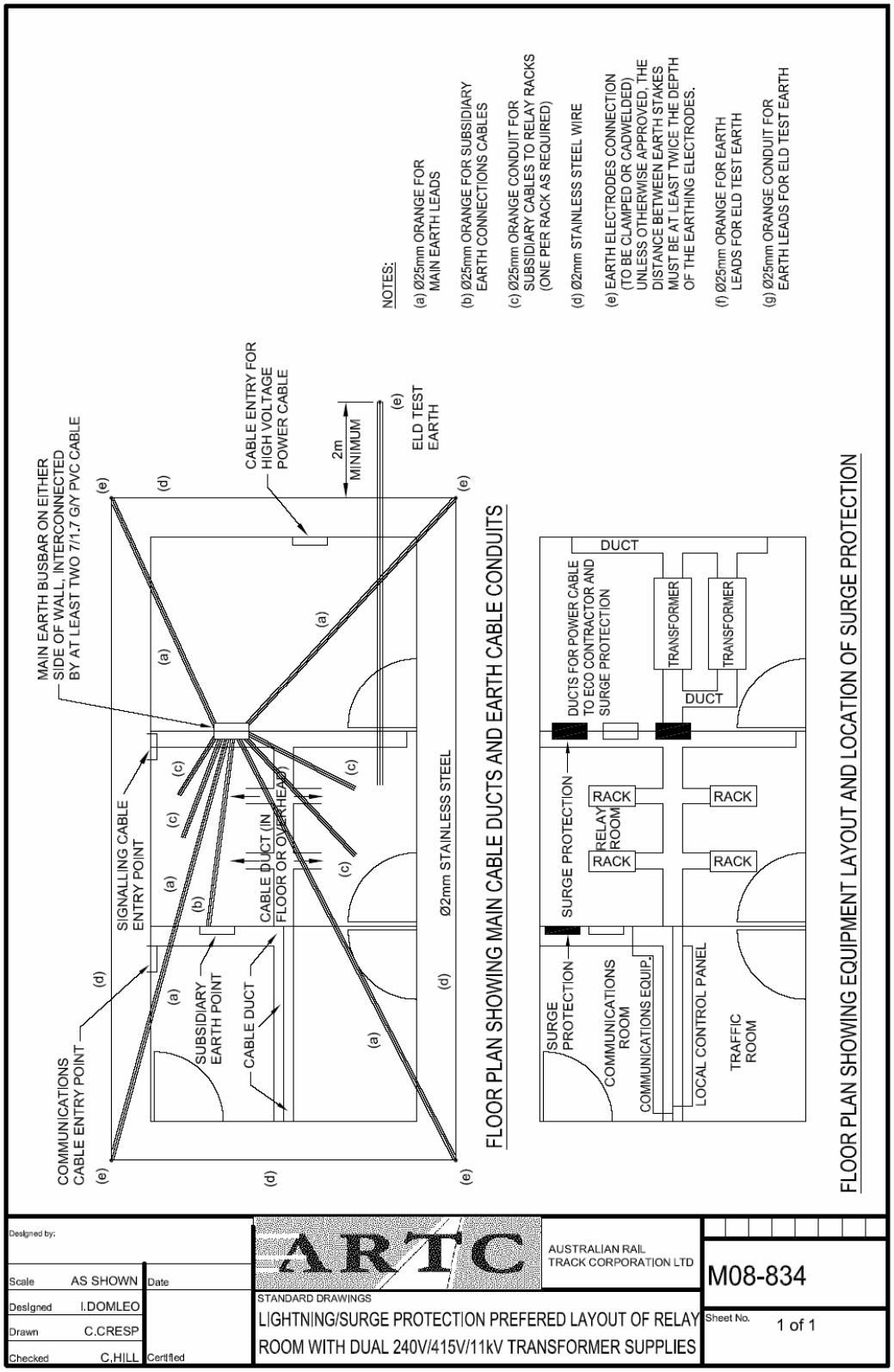

OVERHEAD GROUND WIRE 7/1.04mm HD Cu
1.2m MIN.
2 x 7/1.04mm HD Cu
TWO 7/1.04mm BARE CONDUCTORS
AND 2xØ2mm STAINLESS STEEL
WIRES ELECTRICALLY AND PHYSICALLY
CONNECTED TOGETHER TO THE POLE
BY MEANS OF A STAINLESS STEEL BOLT
OR CADWELDED OR TAPPED HOLE M8.
INDUCTOR-DIVERTER PANEL (IDP)
(SHOWN WITHOUT THE ENCLOSURE)
EARTH TERMINAL
7/1.7mm Cu
GREEN/YELOW PVC
PVC TUBE 250mm x Ø100mm WITH LID
(EASY REMOVAL OF LID IS REQUIRED)
CONCRETE MONUMENT COVERS TO BE
PROVIDED ON OR NEAR ACCESS ROADS
3m
1.5m MAX.
STAINLESS STEEL BOLTED
OR CADWELDED CONNECTION
EARTH ELECTRODE
CLAMP CONNECTION
Ø2mm STAINLESS STEEL
WIRE BURIED 30cm
BELOW THE SURFACE
MINIMUM BENDING RADIUS 150mm
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL
TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
EARTHING ARRANGEMENT FOR OVERHEAD GROUND WIRES
M08-827
Sheet No. 1 of 1

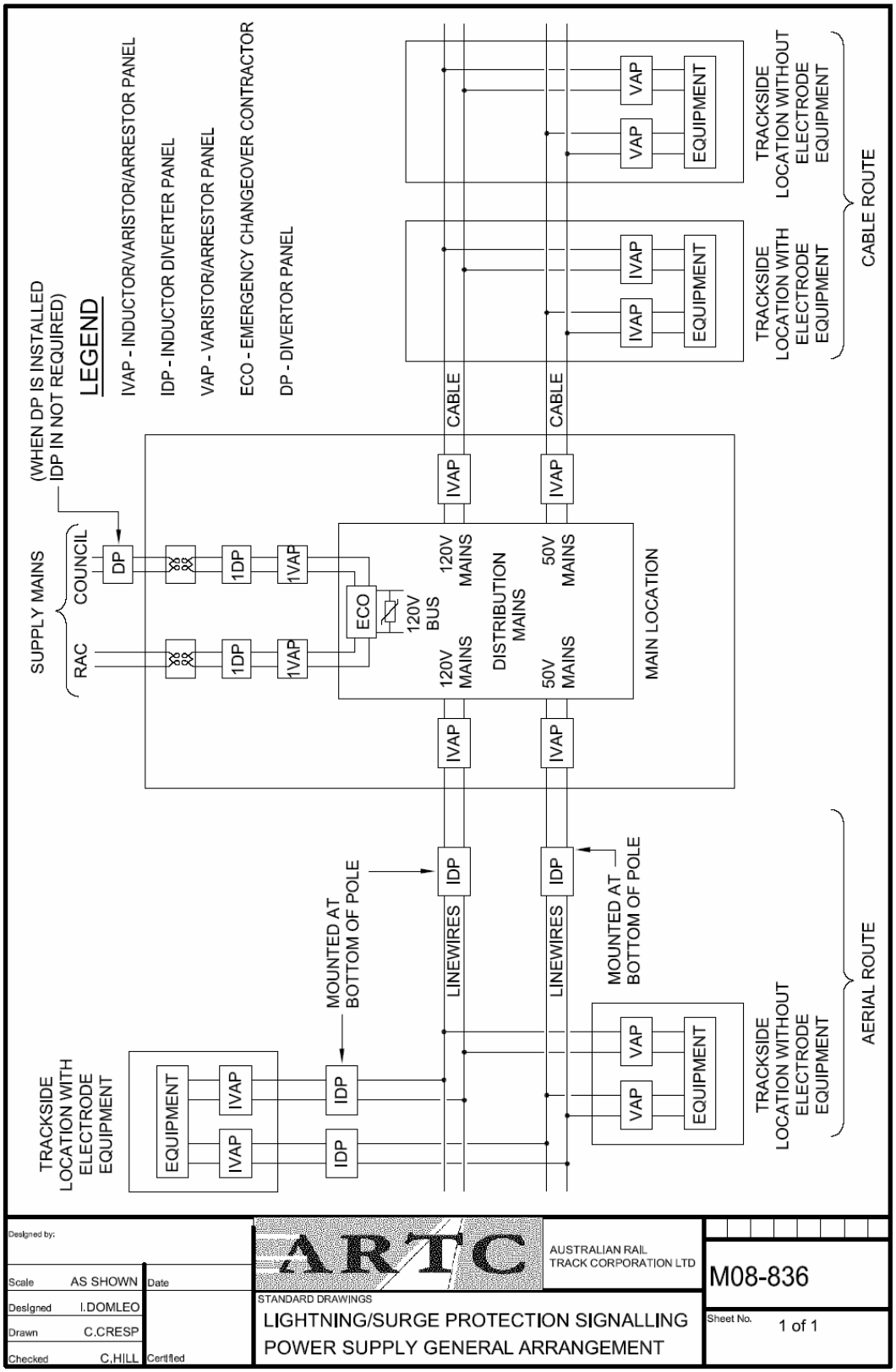

EARTH WIRES
Ø2mm STAINLESS STEEL
EARTH STAKE
RELAY ROOM
RACKS
NV
2m MINIMUM
PIT
DUCT
SURGE PROTECTION PANELS
EARTH STAKE
EARTH BUSBAR ON EITHER SIDE OF WALL INTERCONNECTED
POWER ROOM
(a)
(b)
(c)
NOTES:
ALL EARTH LEADS TO BE 7/1.7 GREEN AND YELLOW PVC INSULATED
(a) Ø25mm ORANGE CONDUIT FOR MAIN EARTH LEADS
(b) Ø25mm ORANGE CONDUIT FOR SUBSIDIARY EARTH CABLES FOR RELAY RACKS
(c) Ø25 ORANGE CONDUIT FOR EARTH LEAKAGE DETECTOR TEST EARTH
(d) CONDUITS TO BE INSTALLED FOR POWER SUPPLY MAINS, EARTHING REQUIREMENTS AND ELECTRODE SEPARATIONS TO BE IN ACCORDANCE WITH AS3000.
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
TYPICAL LAYOUT OF RELAY ROOM
M08-831/A
Sheet No. 1 of 2

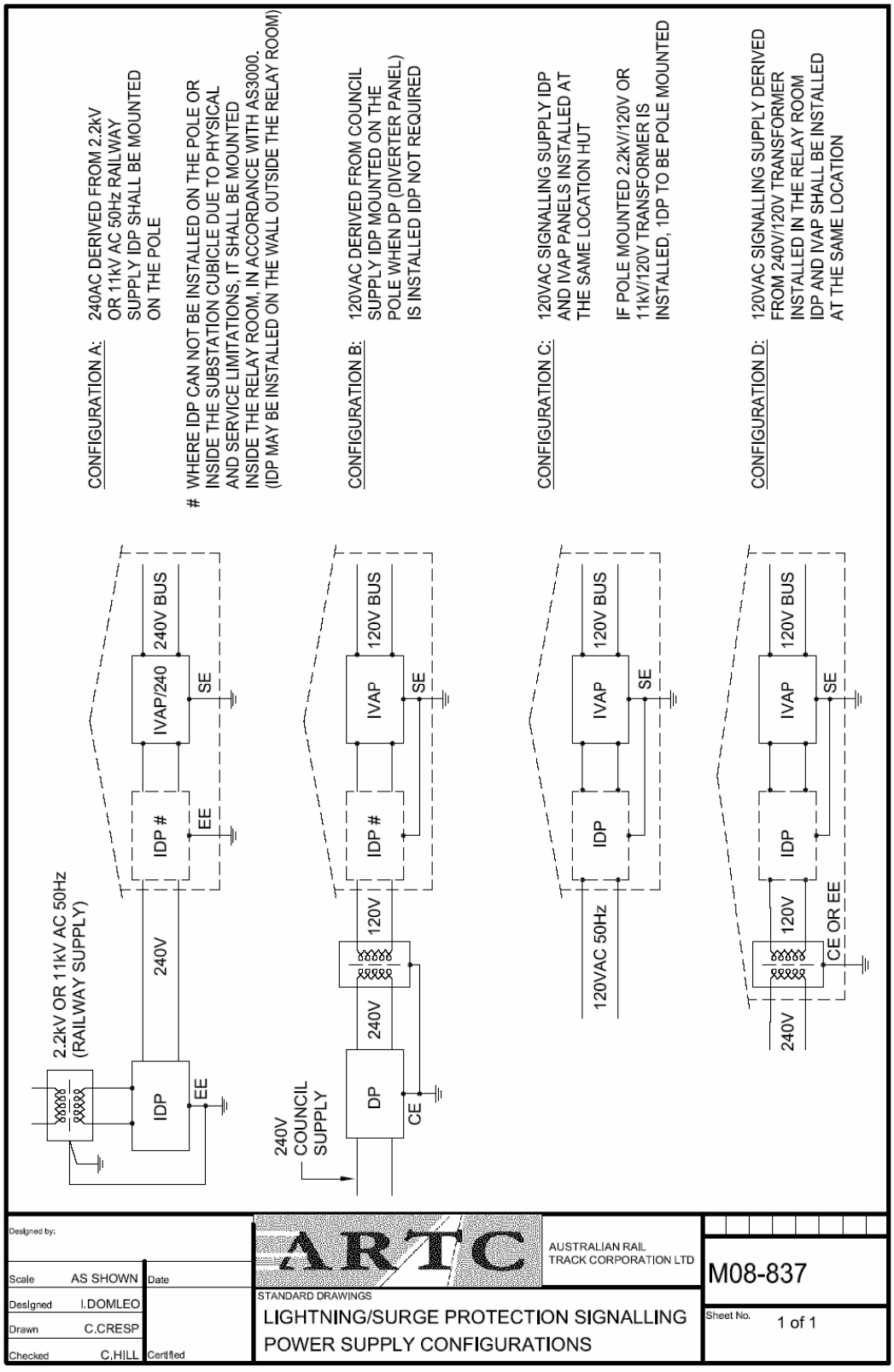

EARTH WIRES
Ø2mm STAINLESS STEEL
ELD TEST
EARTH ELECTRODE
2m
MINIMUM
EARTH STAKE
(a)
(b)
(c)
DUCT
PIT
RACKS
NV
RELAY ROOM
SURGE
PROTECTION
PANELS
EARTH BUSBAR ON
EITHER SIDE OF WALL
INTERCONNECTED
POWER ROOM
NOTES:
ALL EARTH LEADS TO BE 7/1.7 GREEN AND YELLOW PVC INSULATED
(a) Ø25mm ORANGE CONDUIT FOR MAIN EARTH LEADS
(b) Ø25mm ORANGE CONDUIT FOR SUBSIDIARY EARTH CABLES FOR RELAY RACKS
(c) Ø25 ORANGE CONDUIT FOR EARTH LEAKAGE DETECTOR TEST EARTH
(d) CONDUITS TO BE INSTALLED FOR POWER SUPPLY MAINS, EARTHING REQUIREMENTS
AND ELECTRODE SEPARATIONS TO BE IN ACCORDANCE WITH AS3000.
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL
TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION
TYPICAL LAYOUT OF RELAY ROOM
M08-831/B
Sheet No. 2 of 2

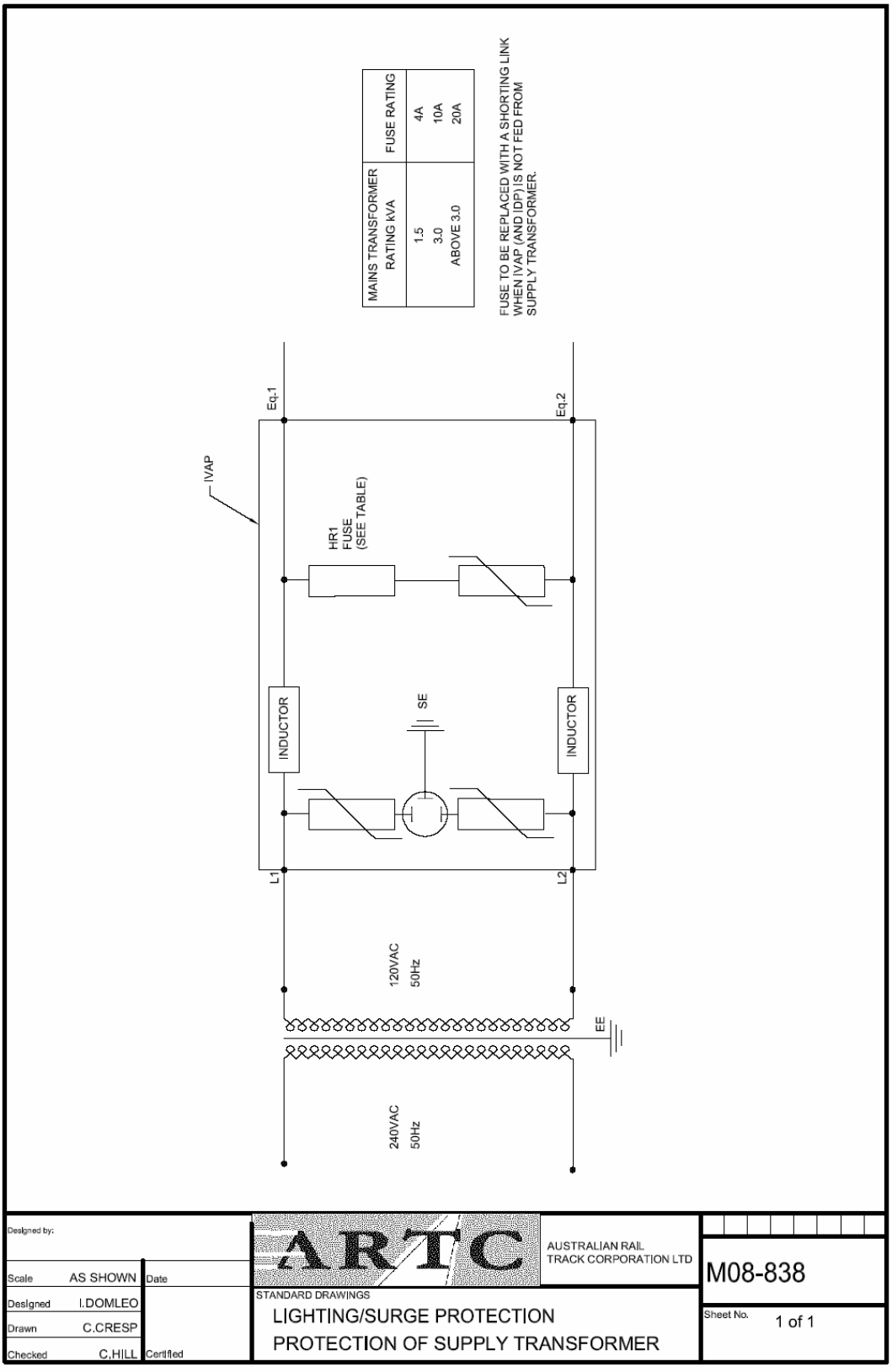

NOTES:
(a) Ø25mm ORANGE CONDUIT FOR MAIN EARTH LEADS.
(b) Ø25mm ORANGE CONDUIT FOR SUBSIDIARY CABLE TO RELAY ROCK
(c) Ø2mm STAINLESS STEEL WIRE
(d) ALL EARTH LEADS TO BE 7/1.7 GREEN AND YELLOW PVC INSULATED
(e) EARTH ELECTRODES CONNECTION (TO BE CLAMPED OR CADWELDED)
UNLESS OTHERWISE APPROVED, THE DISTANCE BETWEEN EARTH STAKES MUST BE AT LEAST TWICE THE DEPTH OF THE EARTHING ELECTRODES.
(f) CONDUITS TO BE INSTALLED FOR POWER SUPPLY MAINS, EARTHING REQUIREMENTS AND ELECTRODE SPACING TO BE IN ACCORDANCE WITH AS3000.
SURGE PROTECTION 120V SUPPLY
SURGE PROTECTION SIGNALLING
MAIN EARTH BUSBAR
VIEW A
VIEW B
BATTERY RACK
BATTERY CHARGER
CABLE DUCT
RELAY RACK
MINIMUM DISTANCE OF 300mm
(b), (d)
VIEW A
VIEW B
(a), 2x(d)
240/120V TRANSFORMER
SIGNALLING CABLE ENTRY POINT
(a), (d)
(c)
(e)
- LIGHTNING SURGE PROTECTION
- MAIN EARTH BUSBAR
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION PREFERRED LAYOUT OF LEVEL CROSSING EQUIPMENT HUT
M08-832
Sheet No. 1 of 1


POWER MAINS CABLE BURIED TO POLE 240V POWER MAINS CABLE ENTRY POINT DUCT IN FLOOR
MOTOR # GENERATOR
EARTH BUSBAR INSIDE THE CUBICLE
CABLE ENTRY FOR HIGH VOLTAGE POWER CABLE
2m MINIMUM
ELD TEST EARTH
NOTES:
(a) Ø25mm ORANGE FOR MAIN EARTH LEADS
(b) Ø25mm ORANGE FOR SUBSIDIARY EARTH CONNECTIONS CABLES
(c) Ø25mm ORANGE CONDUIT FOR SUBSIDIARY CABLES TO RELAY RACKS (ONE PER RACK AS REQUIRED)
(d) Ø2mm STAINLESS STEEL WIRE
(e) EARTH ELECTRODE CONNECTION (TO BE CLAMPED OR CADWELDED)
UNLESS OTHERWISE APPROVED, THE DISTANCE BETWEEN EARTH STAKES MUST BE TWICE THE DEPTH OF THE EARTHING ELECTRODES.
(f) Ø25mm ORANGE CONDUIT FOR 7/1.7 G/Y EARTH LEADS (# IF THE 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.
MAIN EARTH BUSBAR ON EITHER SIDE OF WALL, INTERCONNECTED BY AT LEAST TWO 7/1.7 G/Y PVC CABLE
SIGNALLING CABLE ENTRY POINT
CABLE DUCT (IN FLOOR OR OVERHEAD)
Ø2mm STAINLESS STEEL
COMMUNICATIONS CABLE ENTRY POINT
SUBSIDIARY EARTH POINT
CABLE DUCT
FLOOR PLAN SHOWING MAIN CABLE DUCTS AND EARTH CABLE CONDUITS
POWER MAINS SURGE PROTECTION
DUCT
MOTOR GENERATOR
ADDITIONAL SURGE PROTECTION (IF REQUIRED)
SURGE PROTECTION
RELAY ROOM
RACK
RACK
RACK
RACK
SURGE PROTECTION
COMMUNICATIONS ROOM
COMMUNICATIONS EQUIP.
LOCAL CONTROL PANEL
TRAFFIC ROOM
FLOOR PLAN SHOWING EQUIPMENT LAYOUT AND LOCATION OF SURGE PROTECTION
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION PREFERED LAYOUT OF RELAY ROOM WITH MOTOR/ALTERNATOR STANDBY SET
M08-833
Sheet No. 1 of 1


NOTES:
(a) Ø25mm ORANGE FOR MAIN EARTH LEADS
(b) Ø25mm ORANGE FOR SUBSIDIARY EARTH CONNECTIONS CABLES
(c) Ø25mm ORANGE CONDUIT FOR SUBSIDIARY CABLES TO RELAY RACKS (ONE PER RACK AS REQUIRED)
(d) Ø2mm STAINLESS STEEL WIRE
(e) EARTH ELECTRODES CONNECTION (TO BE CLAMPED OR CADWELDED) UNLESS OTHERWISE APPROVED, THE DISTANCE BETWEEN EARTH STAKES MUST BE AT LEAST TWICE THE DEPTH OF THE EARTHING ELECTRODES.
(f) Ø25mm ORANGE FOR EARTH LEADS FOR ELD TEST EARTH
(g) Ø25mm ORANGE CONDUIT FOR EARTH LEADS FOR ELD TEST EARTH
FLOOR PLAN SHOWING MAIN CABLE DUCTS AND EARTH CABLE CONDUITS
MAIN EARTH BUSBAR ON EITHER SIDE OF WALL, INTERCONNECTED BY AT LEAST TWO 7/1.7 G/Y PVC CABLE
CABLE ENTRY FOR HIGH VOLTAGE POWER CABLE
2m MINIMUM
ELD TEST EARTH
SIGNALLING CABLE ENTRY POINT
CABLE DUCT (IN FLOOR OR OVERHEAD)
Ø2mm STAINLESS STEEL
COMMUNICATIONS CABLE ENTRY POINT
SUBSIDIARY EARTH POINT
CABLE DUCT
FLOOR PLAN SHOWING EQUIPMENT LAYOUT AND LOCATION OF SURGE PROTECTION
DUCT
DUCTS FOR POWER CABLE TO ECO CONTRACTOR AND SURGE PROTECTION
TRANSFORMER
TRANSFORMER
DUCT
SURGE PROTECTION
RELAY ROOM
RACK
RACK
RACK
RACK
SURGE PROTECTION
COMMUNICATIONS ROOM
COMMUNICATIONS EQUIP.
LOCAL CONTROL PANEL
TRAFFIC ROOM
Designed by:
Scale AS SHOWN Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL Certified
ARTC
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION PREFERED LAYOUT OF RELAY ROOM WITH DUAL 240V/415V/11kV TRANSFORMER SUPPLIES
M08-834
Sheet No. 1 of 1


LEGEND
IVAP - INDUCTOR/VARISTOR/ARRESTOR PANEL
IDP - INDUCTOR DIVERTER PANEL
VAP - VARISTOR/ARRESTOR PANEL
ECO - EMERGENCY CHANGEOVER CONTRACTOR
DP - DIVERTOR PANEL
(WHEN DP IS INSTALLED IDP IN NOT REQUIRED)
SUPPLY MAINS
COUNCIL
RAC
DP
1DP
1VAP
ECO
120V BUS
120V MAINS
50V MAINS
DISTRIBUTION MAINS
MAIN LOCATION
IVAP
CABLE
VAP
EQUIPMENT
TRACKSIDE LOCATION WITHOUT ELECTRODE EQUIPMENT
TRACKSIDE LOCATION WITH ELECTRODE EQUIPMENT
CABLE ROUTE
IDP
LINEWIRES
MOUNTED AT BOTTOM OF POLE
AERIAL ROUTE
Designed by:
Scale AS SHOWN
Designed I.DOMLEO
Drawn C.CRESP
Checked C,HILL
Date
Certified
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION SIGNALLING
POWER SUPPLY GENERAL ARRANGEMENT
M08-836
Sheet No. 1 of 1


CONFIGURATION A:
240AC DERIVED FROM 2.2kV OR 11kV AC 50Hz RAILWAY SUPPLY IDP SHALL BE MOUNTED ON THE POLE
WHERE IDP CAN NOT BE INSTALLED ON THE POLE OR INSIDE THE SUBSTATION CUBICLE DUE TO PHYSICAL AND SERVICE LIMITATIONS, IT SHALL BE MOUNTED INSIDE THE RELAY ROOM, IN ACCORDANCE WITH AS3000. (IDP MAY BE INSTALLED ON THE WALL OUTSIDE THE RELAY ROOM)
CONFIGURATION B:
120VAC DERIVED FROM COUNCIL SUPPLY IDP MOUNTED ON THE POLE WHEN DP (DIVERTER PANEL) IS INSTALLED IDP NOT REQUIRED
CONFIGURATION C:
120VAC SIGNALLING SUPPLY IDP AND IVAP PANELS INSTALLED AT THE SAME LOCATION HUT
IF POLE MOUNTED 2.2kV/120V OR 11kV/120V TRANSFORMER IS INSTALLED, 1DP TO BE POLE MOUNTED
CONFIGURATION D:
120VAC SIGNALLING SUPPLY DERIVED FROM 240V//120V TRANSFORMER INSTALLED IN THE RELAY ROOM IDP AND IVAP SHALL BE INSTALLED AT THE SAME LOCATION
2.2kV OR 11kV AC 50Hz (RAILWAY SUPPLY)
240V
IDP
EE
IDP #
IVAP/240
240V BUS
SE
240V COUNCIL SUPPLY
DP
CE
120V
IVAP
120V BUS
120VAC 50Hz
CE OR EE
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C,HILL
Certified
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTNING/SURGE PROTECTION SIGNALLING POWER SUPPLY CONFIGURATIONS
M08-837
Sheet No. 1 of 1


MAINS TRANSFORMER RATING kVA
FUSE RATING
1.5
3.0
ABOVE 3.0
4A
10A
20A
FUSE TO BE REPLACED WITH A SHORTING LINK WHEN IVAP (AND IDP) IS NOT FED FROM SUPPLY TRANSFORMER.
Eq.1
Eq.2
IVAP
HR1
FUSE
(SEE TABLE)
INDUCTOR
SE
INDUCTOR
L1
L2
120VAC
50Hz
EE
240VAC
50Hz
Designed by:
Scale AS SHOWN
Date
Designed I.DOMLEO
Drawn C.CRESP
Checked C.HILL
Certified
ARTC
AUSTRALIAN RAIL TRACK CORPORATION LTD
STANDARD DRAWINGS
LIGHTING/SURGE PROTECTION
PROTECTION OF SUPPLY TRANSFORMER
M08-838
Sheet No. 1 of 1

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)