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CRN SC 004

**Specification**

# **Lightning & Surge Protection Requirements**

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# 1. Introduction

This Specification details the general requirements for Lightning and Surge Protection provided for CRN's Railway Signalling systems.

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

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.

## 2. Applicable Standards

### 2.1. International Standards

This Specification refers to the following international Specifications and 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)

### 2.2. Australian Standards

AS 1768:2003	Lightning Protection
AS 3000	Electrical Installations-Building, Structures & Premises

### 2.3. CRN Standard Specifications

This Specification refers to the following CRN signalling standard Specifications and Standards:

CRN SC 003	Specification – Signalling Power Systems
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## 3. Abbreviations and Definitions

CE	Council (Supply Authority) Earth
EE	Railway Electrical Supply Earth
EE HIGH VOLTAGE	Railway Electrical Supply Earth High Voltage
EPR	Earth Potential Rise
DP	Diverter Panel

IVAP	An approved Inductor/Varistor/Arrestor Panel for primary surge protection of power supplies.
LPU	Line Protection Unit
SE	Signalling Earth (same as S&CES)
S&CES	Signals & Communications Earthing System
VAP	An approved Varistor/Arrestor Panel for secondary surge protection of power supplies.
VP	Varistor Panel
Cadweld	Generic term for the process of Exothermic welding
CRN	Transport for New South Wales Country Regional Network
CRN's Representative	A person, company or authority nominated by CRN to make engineering determinations on CRN's behalf.
Supplier	The person, company or authority responsible for providing protection in accordance with this specification.
Electronic equipment	Electronic equipment is defined as equipment that has more than 5% of its electrical parts as electronic components. Electronic components are considered to be semi-conductor based devices, and capacitors.
Electro-mechanical equipment	Electro-mechanical equipment is defined as equipment that primarily contains inductors, electric motors, solenoids, relays, contactors, switches, resistors, etc.
Electrical equipment	Electrical equipment is considered to be either Electronic equipment or Electro-mechanical equipment. If there is any doubt as to the type of a particular item of equipment, 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. The terms relay room, walk-in hut, bungalow, location case, equipment cupboard, track-side locations are types of location.
Main location	A critical location, or a location containing significantly more than the average quantity of equipment.
Transient earth clamp	Also known as a differential earth clamp. It is used to limit the potential difference between two separate earths.
Surge	A transient electrical overload condition due to external influences. A surge includes overloads and transient conditions due to lightning, power supply switching, and fault conditions appearing at interfaces.
Category A pulse	A test surge pulse as defined in AS 1768.
Category B pulse	A test surge pulse as defined in AS 1768.
Category C pulse	A test surge pulse as defined in AS 1768.

## **4. Railway Signalling Environment**

### **4.1. 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 exposed equipment locations.

The railway line and the structures around the railway line tend to attract lightning strikes.

### **4.2. 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 'fail-safe' signalling system.

### **4.3. Equipment Locations**

Signalling equipment locations are situated adjacent to the railway tracks. They include brick or concrete buildings (relay room, huts, etc), and metal track-side cupboards. In the Sydney Trains area, these signalling equipment locations are fairly well protected against direct lightning strikes because of the 1500 VDC overhead wire structure and 240 VAC and 11 kV transmission lines. But extremely high surges can be experienced on the power supply feeders. In the CRN these signalling equipment locations are more exposed to lightning strikes and ground surges due to their isolated installation locations along the rail corridor with few nearby metallic structures to attract lightning towards.

### **4.4. 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 1 – Railway Signalling System Equipment**

<b>Equipment</b>	<b>Type</b>
DC Power supplies, linear	Electro-mechanical
DC Power supplies, switch mode	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 signal (mostly LED based)	Electronic
Cables (Telecommunications, power, data)	Electro-mechanical

## 4.5. 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:

- Power supply entry points 240 VAC or 120 VAC
- 240 VAC or 120 VAC power supply aerial cables (in the country areas)
- 240 VAC or 120 VAC power supply 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 wiring standards and arrangements allow very high surge voltages and currents to be propagated through the signalling system.

## 4.6. Power Supplies for Signalling Equipment

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

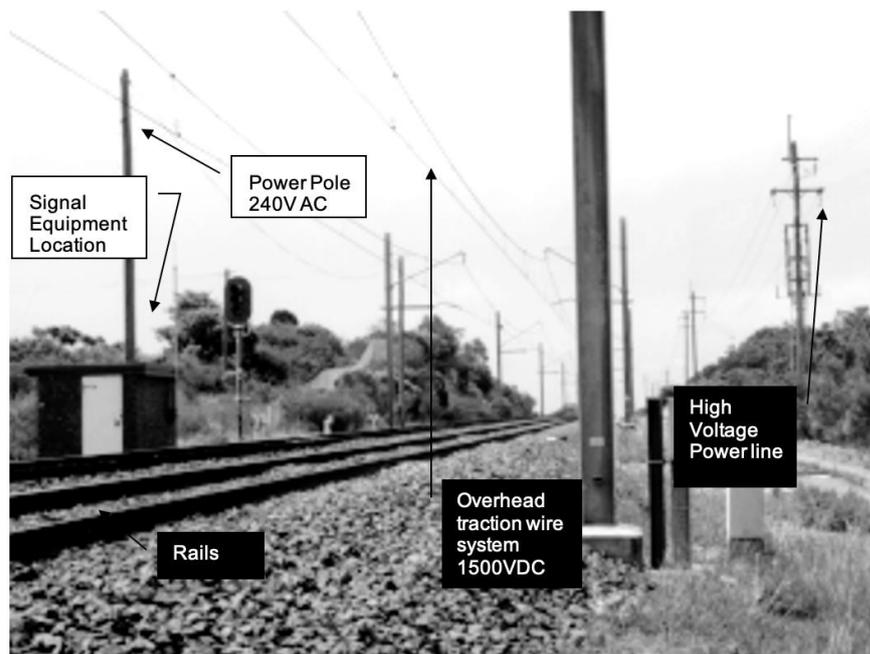
- The 120 volt AC signalling power supply varies from 108 to 132 volts.
- The 50 volt DC signalling power supplies are full wave rectified and are not always filtered. These supplies are typically set at 55 volts but may vary from 48 to 60 volts. This results in up to 85 volts peak on the supply.
- The 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 120 VAC 50 Hz and the supply is unearthed. The 120 VAC supply is derived from 240 VAC Council supplies. In some locations there are alternate power sources such as motor generator sets, solar supplies, etc.

## 4.7. Earthing Systems

Different earthing systems exist in the railway signalling environment. These earthing systems are: Signalling Earth and Council 240V MEN Earth.

### 4.7.1. Physical Structures



**Figure 1 – Typical Signal Equipment Location Illustrating the Sydney Trains Railway Environment**

The following physical structures exist in the railway signalling environment:

- The 1500 VDC traction overhead wire structure in the electrified area (bounded by Lithgow on the Western line, Newcastle on the Northern line, Macarthur on the Southern line and Kiama on the South Coast line)
- High communication masts adjacent to signalling locations where communication interfaces exist.
- High voltage and low voltage transmission and distribution lines.
- Power supply poles close to the signalling equipment locations.
- Signalling equipment locations at elevated and exposed areas

## **5. Required Protection Performance**

### **5.1. 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 AS 1768 Lightning Protection including any recommendations and follow practices in the Appendices of AS 1768 unless varied by this specification.

It is the responsibility of the Supplier of the signalling system 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 at least 130% of the intended interface load current.

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

### **5.2. 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 effect 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.

### 5.3. 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.

Newer surge protection devices will be expected to include a form of 'health check' indication that may be able to be remotely monitored or alarmed if the device is no longer able to carry out its protective function.

### 5.4. 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.

### 5.5. 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 of Earth resistance provided for surge protection for electrical equipment to be protected shall equal to or better than that nominated in the following table.

**Table 2 – Equipment Earth Resistance**

<b>Equipment Type</b>	<b>Earth Resistance</b>
Electronic Equipment installed inside locations	5 ohm
Electro-mechanical equipment installed inside locations	10 ohm
Electronic Equipment installed external to locations	75 ohm
Electro-mechanical equipment installed external to locations	150 ohm

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 25 kHz to 50 kHz.

If an Earth Leakage detector 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.

A concession may be given if more than 6, 4 m earth stakes are required to achieve the required earth resistance.

## **5.6. Earth Potential Rise (EPR)**

Potential differences between various earth points at a location due to a Category C surge pulse shall be typically less than 430 volts.

Earth potential rise due to surges at adjacent locations or on different earth's shall be limited by the use of equi-potential bonding or transient earth clamp between the surge protection earth and the other earth. The DC clamping voltage shall be 430 volts.

A transient earth clamp shall be used to connect earths provided for different purposes unless the owners of both earths agree to equi-potential bonding of their earth.

The test earth for an Earth Leakage Detector is not bonded to the protection earth.

Low voltage power earths shall be bonded to the protection earth using a transient earth clamp.

## **5.7. Earthing Co-ordination**

The earthing arrangements provided for the signalling surge protection must be implemented as part of the whole of the railway infrastructure.

CRN Signals Specification "Signalling Power Systems" CRN SC 003 details the requirements for the co-ordination of the earthing arrangements.

## **5.8. 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’.

## 5.9. 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 the Section 5.8 Surges 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.

A normally accepted “Rated Impulse voltage” for equipment insulation to earth is 10 times the maximum rated working voltage. The common mode surge voltages to earth shall not exceed the Rated Impulse voltage to earth for the equipment.

### 5.9.1. 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”.

The voltage or current appearing at the interface to an item of electronic equipment shall not exceed the rated voltage or current for the interface for more than the values given for the durations shown in the following table.

**Table 3 – Interface Limits for Electronic Equipment**

<b>Interface</b>	<b>≤&lt;1 mS</b>	<b>&gt;1 mS</b>	<b>&gt;10 mS</b>
Power supply	300%	200%	150%
Communications	1000%	400%	150%
All other	1000%	400%	150%

## 5.9.2. 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.

The voltage or current appearing at the interface to an item of electro-mechanical equipment shall not exceed the rated voltage or current for the interface for more than the values given for the durations shown in the following table.

**Table 4 – Interface Limits for Electro-mechanical Equipment**

Interface	≤1 mS	>1 mS	>10 mS
Power supply	500%	200%	150%
All other	1000%	400%	150%

## 5.10. Cables

Buried cables shall be provided with the means to mitigate the effects of ground surge currents.

Mitigation of ground surge current effects has two purposes. Firstly, to protect the cables from damage, and secondly to reduce the level of surge that may be induced in the cable.

Conduits and Galvanised Steel Troughing (GST) are accepted methods of protecting cables from these effects.

In non-electrified area another established means of mitigating the effect of ground surge currents is the provision of an earthed stainless steel drain wire 300 mm below ground level, and 300 mm above the cables. However careful consideration is required to ensure that this does not create problems due to High Voltage power supply EPR faults being transferred to other locations via the stainless steel wire.

## 5.11. 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.

The surge protection equipment's Mean Time to Repair for failures shall be 10 minutes or less for one person and 95% of all failure repair tasks shall be completed in less than 20 minutes. These times do not include travelling time but do include fault diagnosis time.

Preventative maintenance required to maintain correct performance of the surge protection equipment shall not increase the maintainer's workload by more than 10%.

Replacement of cartridge protection units in mains protection units shall not interfere with the normal operation of the mains system it is protecting.

## 5.12. Segregation

Surge protected wiring shall be segregated from non-surge protected wiring to prevent coupling of surges between the wiring. Earth wire is to be considered as non-surge protected wiring. The amount of segregation shall be suitable for the expected level of surge on the non-protected wiring. CRN's Signalling Surge Protection installation guidelines detail accepted separation distances.

## 6. Proof of Performance

The supplier 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 the CRN'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 aspects or equipment aspects.

Surge protection equipment and its usage shall be approved as part of CRN's Type Approval process.

# A.1. Appendix A - Earthing

## General

Earthing systems are installed in accordance with CRN's Signalling Surge Protection installation guidelines.

## Measurement of Earth Resistance

- The earth resistance shall be measured at the SE Main Earth Busbar or each separate Earth system using an approved earth resistance meter. Each local earth system is to be tested independently. (i.e., all interconnecting trench cable route Earths disconnected.)
- The Earth probes on the earth resistance meter shall be connected such that a line drawn between them is at right angles to the railway line.
- Where (b) cannot be achieved due to physical limitations of a site, unusual earth potential voltages or due to any other difficulty arising, approval shall be obtained for an alternate method of determining the earth resistance.

## Procedure for Installation of the Signalling Earth

- Take measurements of Earth resistivity at the site.
  - (refer Measurement of Earth Resistivity)
- Determine the number of Earth stakes 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 stakes.

**Table 5 – Earthing Arrangements (Number of Earth Stakes)**

Earth Resistivity Range	R=5 ohms Length of Earth Stake 2 m	R=5 ohms Length of Earth Stake 4 m	R=5 ohms Length of Earth Stake 6 m	R=10 ohms Length of Earth Stake 2 m	R=10 ohms Length of Earth Stake 4 m	R=10 ohms Length of Earth Stake 6 m
(Ohm.cm)	1	NR	NR	1	NR	NR
0000 to 1000	2	1	NR	1	NR	NR
1701 to 2000	2	2	1	1	NR	NR
2001 to 2300	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

Earth Resistivity Range	R=5 ohms Length of Earth Stake 2 m	R=5 ohms Length of Earth Stake 4 m	R=5 ohms Length of Earth Stake 6 m	R=10 ohms Length of Earth Stake 2 m	R=10 ohms Length of Earth Stake 4 m	R=10 ohms Length of Earth Stake 6 m
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 CRN's Representative.

However, Earth stakes shall not be installed exceeding or less than the following limits.

**Table 6 – Earth Stake Limits**

	Location	Earth Resistance (ohms)	Required Number Minimum	Required Number Maximum
1	Track-side units at Matching/Tuning Units	50	Use Post	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 stakes the minimum separation between Earth stakes shall be twice the length of the longer Earth stake.

Where the maximum number of earth stakes does not achieve the required value for earth resistance, consult CRN's Representative.

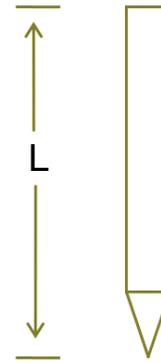
### Measurement of Earth Resistivity

Earth Resistivity shall be measured as outlined in AS 1768: Lightning Protection.

Some Earth Resistance meters provide the facility to measure earth resistivity directly.

If only the earth resistance measurement facility is available, the following relationship may be applied to calculate the earth resistivity.

$$R = \frac{\rho}{2.75 L} \log_{10} \frac{4 L}{d}$$



Where:

- R - Earth Resistance in ohms
- $\rho$  - Earth Resistivity (Ohm-metre)
- L - Depth of the electrode inside soil in metres
- D = 0.014 m
- d - Diameter of electrode in metres

### **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.

## A.2. Appendix B - Expected Exposure of Equipment Interfaces

**Table 7 – Expected Exposure of Equipment Interfaces**

<b>Surge Category</b>	<b>Discharge Pulse</b>	<b>Equipment interface</b>
Category C	70 kA, 8/20 us or 10/350 us	Tall communication antennas in heavy lightning area close to signalling equipment locations.
	70 kA, 8/20us	Some power supply entry points in hilly open areas that have a history of serious lightning damage, and critical installations.
	60 kA, 8/20us	Power supply entry points 240 VAC 50 Hz,
	40 kA, 8/20us	Power supply entry points (locations) 120 VAC 50 Hz
	20 kA, 8/20 us or 20 kA, 10/350 us	Open Wire Line, lines
	20 kA, 8/20 us	Some field equipment
	20 kA, 8/20 us	Track circuit input cables at track-side locations
	60 kA, 8/20 us	Power supply entry point (Council 240 VAC)
	40 kA, 8/20 us	Power supply distribution to field locations (120/240/415 V, etc)
	20 kA, 8/20 us	SSI Data Links through LDT, external communication circuits
Category B	3 kA, 8/20 us or 6 kV, 1.2/50	Sub circuits. Field equipment
	3kA, 8/20us or 6kV, 1.2/50	SSI Data Links (installations not exposed to lightning)
	3 kA, 8/20 us or 6 kV, 1.2/50	Low Voltage control circuits
Category A	6 kV, 200 A	Final equipment or devices, Sub-circuits

### A.3. Appendix C - Lightning Protection for Railway Signalling

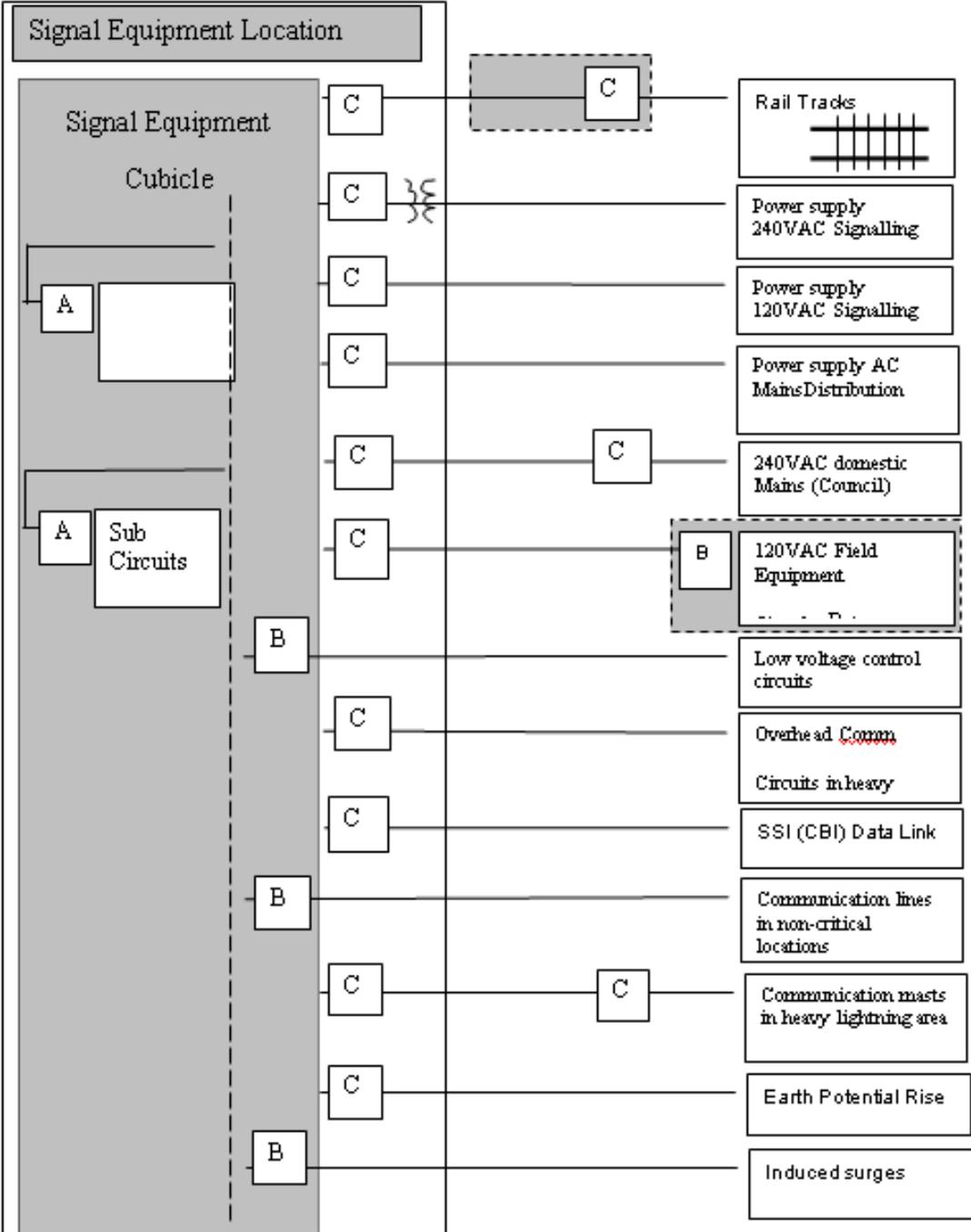


Figure 2 – Lightning protection equipment suitable for protection against the nominated Category of surge as detailed in AS 1768

## A.4. Appendix D - Lightning / Surge Protection Equipment

All the designs of surge protection systems or equipment other than the ones specified require type approval. The let through voltage of surge protection equipment for each item of equipment to be protected shall be taken into consideration. Refer to the Schedule of Type Approved signalling equipment for a current list of approved equipment.

### Types of Equipment

The following types of surge protection equipment are permitted to be installed as applicable. Alternate devices shall meet the application requirements in terms of the performance requirements and must be Type Approved.

### Arrestors & Arrestor Holders

#### Two Terminal Arrestors

The two terminal arrestor shall be the Type #1 Arrestor as specified in Appendix-F with breakdown voltage of 350 Vrms.

Arrestor holder for above shall be "Sankosha" type Arrestor holder or an approved equivalent type.

#### Three Terminal Arrestors

The three terminal arrestors shall be as follows:

- Type #2 - with breakdown voltage of 290 Vrms
- Type #3 - with breakdown voltage of 700 Vrms

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.

### Varistors

Suitable varistors approved for the application considering the signal application voltage and surge current capability.

### Inductor/Varistor/Arrestor Panel (IVAP)

This provides primary protection for the power. The IVAP shall be as specified in Specification CRN SC 023.

Current ratings of IVAP panels shall be selected for

- The continuous rating of the supply transformer (on the supply side of the switchboard), or

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

If 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 CRN's Representative.

### **Varistor/Arrestor Panel (VAP)**

This provides secondary protection on power supply feeders. The VAP shall be as specified in Specification CRN SE 024.

### **Earthing Equipment**

The following components are approved for use in Earthing and surge protection systems.

**Table 8 - Approved Components for Earthing and Surge Protection Systems**

	<b>Item</b>	<b>Type No./(part#)</b>	<b>Manufacturer/ Supplier</b>
1	Earth Electrode Clad 14 mm dia. length 2 m	Stainless steel grade 316; Type STE1420	Electrical Equipment Ltd ALM Division
2	Earth Electrode Clamp	Type: EP 01	- " -
3	Earth Electrode Coupling	Type: SCT 15	- " -
4	Earth Electrode Driving Head	Type: DHT 15	- " -
5	Earth Electrode Star Driving Point	Type SDP 15T	- " -
6	Earth Enhancing Compound	Earth Rite Compound	- " -
7	Cable untinned PVC insulated annealed copper conductor	Single core 7/0.85 or larger, Yellow/Green	- " -
8	Earth Cable stainless steel, 2 mm dia. solid conductor single strand	Grade 304	Atlas Steel (Aust) P/L

## A.5. Appendix E - System Protection

CRN's Signalling Surge Protection installation guidelines details accepted methods for installation of the surge protection equipment.

### **120 Volts 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 VAP is required, between the main terminals and the location equipment.

### **Outgoing 50 Volts DC Supply - Main Locations**

The same level of protection shall be provided as in the section on 120 Volts.

A reverse direction diode is fitted across the 50 V external IVAP at feed locations to prevent false tripping of 50 VDC external circuit breakers due to Earth Potential Rises. The diode must be at least rated at 6 A continuous forward current, and 1000 V Peak Inverse Voltage.

### **120 V Signalling and 50 VDC 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.

The VAP shall be grounded to the Signalling Earth.

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

### **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 proposed for approval.

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.

## **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 2 x 2 m 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.

Earthing of Motor/Alternator sets, rated other than 120 VAC, shall be done in accordance with AS 3000 and CRN standards.

## **Protection of Equipment Operating on 240 VAC 50 Hz (Unprotected Supplies)**

Whenever there is a necessity to operate equipment on 240 VAC 50 Hz at signal equipment locations, it is necessary to make sure the 240 VAC supply is protected against lightning/surge protection. A commercially available, approved surge suppression/filter shall be installed in the switchboard between Phase and Neutral to meet the expected level of surge.

## A.6. 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 & Arrestor "Sankosha" GT type, "Omron" PF083A or Equivalent	
6.	Cable, 7/0.85 PVC Green & Yellow	meter
7.	Cable, Stainless Steel 2 mm (Approx. 3036M)	75 kg 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 Point	
13.	Earth Enhancing Compound (Earth-rite compound or an equivalent)	
14.	Panel Diverter (DP-240 V)	
15.	Panel, Inductor/Varistor/Arrestor Panel (IVAP-50 A)	
16.	Panel, Inductor/Varistor/Arrestor Panel (IVAP-100 A)	
17.	Panel, Varistor/Arrestor (VAP)	
18.	Varistor, Siemens SIOV B32K150 or "National" ERZC32EK241 (20kA, for 120V bus)	
19.	Varistor, SIOV S20K17(5 kA, for 12 V bus)	
20.	Varistor, SIOV S20K30 (5 kA for 24 V bus)	
21.	Varistor, SIOV B32K75 (20 kA for 50 V bus)	
22.	Varistor SIOV B60K150 (60 kA for 120 V bus)	
	<b>Test Equipment</b>	
23.	Earth Tester type YEW 3235 or equivalent	
24.	Lightning Arrestor/Varistor Tester	

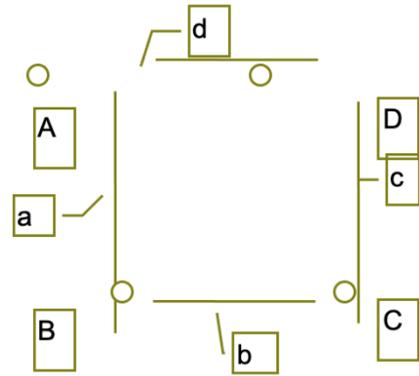
# A.7. Appendix G - Surge Protection Installation Test Report

Area/District: \_\_\_\_\_ Location: \_\_\_\_\_ km: \_\_\_\_\_

Project: \_\_\_\_\_

## Earthing Arrangement

Earth Stake Length	Earth Leads (2 mm SS or 7/1.7Cu)
A =	a =
B =	b =
C =	c =
D =	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	= Ohm
Earth Resistance (2)	=
Earth Resistance at main earth busbar (with all earths connected)	= Ohm
Remarks (material, practices, specification deviations, etc.):	
Name of Supplier:	Signature:
Representative:	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 (verified or witness tested)	(Y/N)

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