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Low Voltage Installations Earthing

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The technical content of this document has been approved by the relevant ARTC engineering authority and has also been endorsed by the ARTC Safety Committee.

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About This Standard

This document details the earthing and bonding requirements of various types of low voltage installations located on the 'railway corridor' and 'near 1500 V track' (refer to Specification PDS 03 - "Low Voltage Distribution and Installations Earthing References and Definitions" for the definitions of these terms). Except for section 5 on Signalling Supplies, the practices used at each installation are independent of the source, that is, whether supply is from the ARTC high voltage network or is taken from a local Electricity Distributor. The requirements of the Distributor's supply is contained in Specification PDS 07 - "Low Voltage Distribution Earthing".

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1 General

The low voltage installations covered in this document are to be earthed in accordance with AS 3000 - 1991 clause 5.10.2(b). Figure 1, represents the relationship between the ARTC low voltage distribution system and the two general types of low voltage installations that may be connected. Diagrams representing the ARTC distribution system covering a supply originating from the ARTC high voltage network and from a local Electricity Distributor are contained in Voltage Distribution Earthing”.

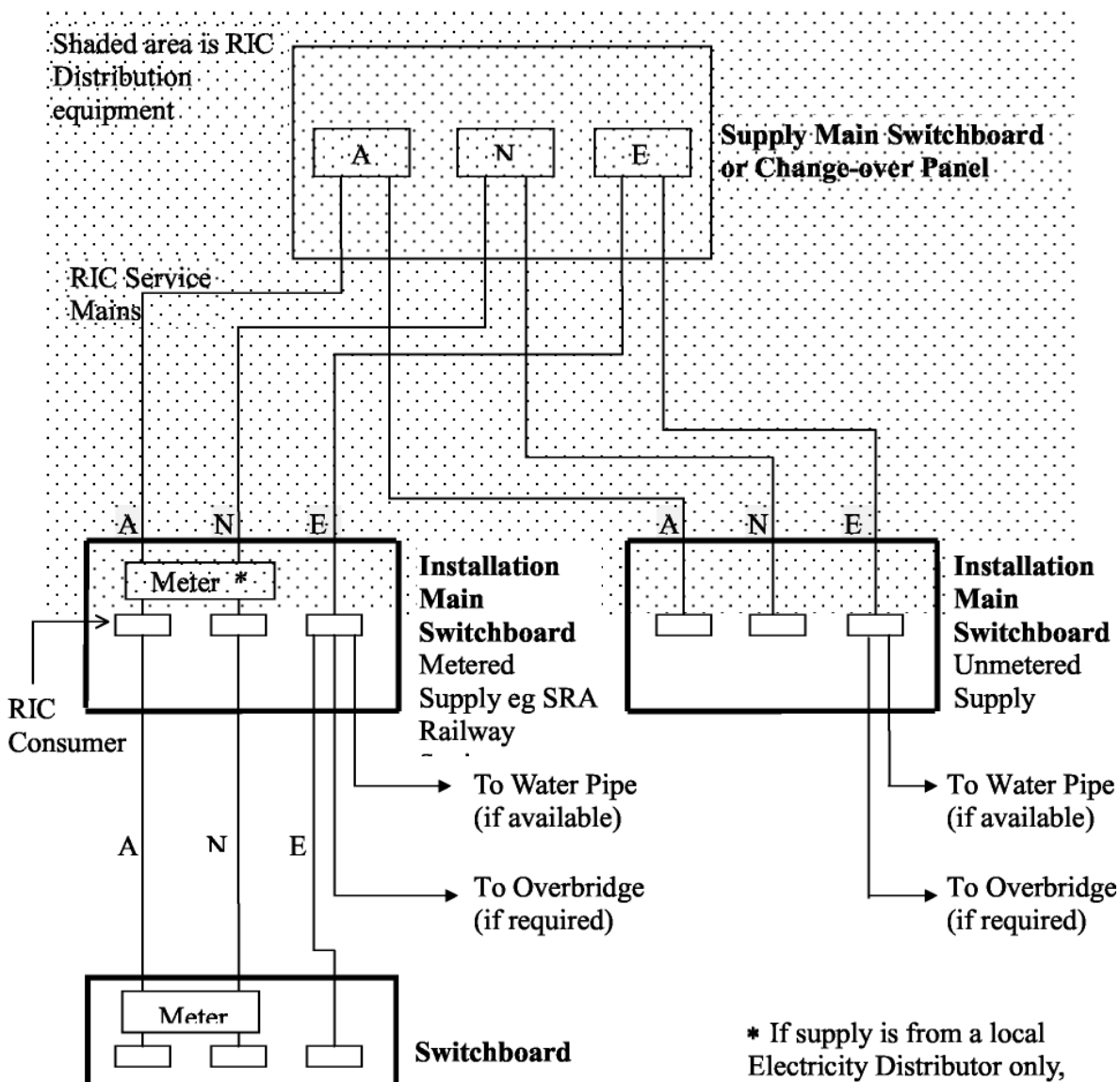


Figure 1 Connection of Installation Main Switchboards

1.1 Clearances from 1500 V Structures and Other Earthed Metalwork

A 2 m distance shall be maintained between the earthing system of the low voltage installation, including earthed metalwork for example fences, vending machines and

telephone cabinets, and any overhead wiring structures which are not bonded to the same earthing system or metalwork connected to a separate earthing system.

1.2 Switchboards

An earthing conductor of not less than 16 mm² copper shall be used for linking the earth bars of any two switchboards, including the sub-mains extending from the installation main switchboard to the earth bar of any other switchboard.

When there is a substantial metallic water pipe in the vicinity refer to section 1.4.

1.3 Earthing Conductors with Final Sub-circuits

Each final sub-circuit shall contain an earthing conductor as prescribed by AS 3000.

1.4 Water Pipe Equipotential Bonding

The earth bar of a switchboard shall be connected to the nearest substantial metallic water pipe (on the railway station side of the water pipe isolating joint, refer to section 1.8) with a bond of the same size as the incoming submain earthing conductor, to a maximum size of 70 mm² copper. The bond conductor is to be effectively protected from mechanical damage as detailed in section 1.5.

There shall only be one connection between a waterpipe and a switchboard for each low voltage installation. The location of the water pipe connection is to be clearly labelled on the switchboard from which the equipotential bond originates.

1.5 Mechanical Protection of Earthing Conductors

In situations where an earthing conductor may be exposed to mechanical damage, the conductor shall be effectively protected from ground level to a height of 2.4 m. This protection shall be in the form of a galvanised metallic conduit or by installing the conductor in PVC conduit and protecting the PVC by a galvanised steel sleeve to the full height of 2.4 m.

1.6 Lineside Metal Fencing or Signal Troughing

A 2 m clearance must be maintained between any metal connected to the railway stations low voltage earth and any continuous metal structure, such as a fence or signal troughing, that is not intentionally connected to the earthing system. Where the 2 m clearance cannot be obtained, a suitable approved method such as installing two isolating breaks 2 m apart in the continuous metal structure shall be used. Alternatively the situation can be proved safe by calculation and testing for dangerous touch voltages in accordance with the ESAA Substation Earthing Guide.

1.7 Metallic Conduits

In general metallic conduits are not permitted to be installed underground or in concrete within the electrified area due to the presence of stray 1500 V dc leakage currents. However, in practice short lengths should not present a problem, therefore, if a situation arises where a short length of buried metallic conduit is the preferred method then the definition of appreciable dc leakage current from Specification PDS 03 - "Low Voltage Distribution and Installations Earthing References and Definitions" can be applied.

1.8 Metallic Pipes

All underground metallic pipes entering railway land in the 1500 V electrified area shall be electrically isolated by the permanent installation of an approved isolating joint one metre outside the boundary, as shown on drawing D/89147. Isolation is to provide protection against stray 1500 V dc leakage currents.

An approved sign, as shown on drawing D/89147, is to be secured to the fence directly above the pipe.

2 Overbridge having 1500 V Overhead Wiring and Low Voltage Wiring Attached

2.1 Connection to Electrode

An overbridge at any railway station in the electrified area having low voltage cables in contact with the bridge will require the bridge to be connected to a 6 m electrode using a 70 mm² copper conductor, refer to section 2.1.1. The electrode is to be located as close as possible to the bridge and installed as detailed in sections 2.1.2 and 2.1.3. The 70 mm² conductor shall be protected against mechanical damage as detailed in section 1.5 and be secured to the over bridge by no lesser security than a crimped closed lug, lock-nutted onto a stud of minimum size 12 mm.

2.1.1 Standard Electrode

The standard electrode for an overbridge is a 6 m length of thick copper tube (14.29 mm outside diameter, 11.03 mm inside diameter, this internal dimension will allow a 70 mm² conductor to be a close fit for a crimped joint). A driven electrode may be used.

2.1.2 Installation of Electrode

The electrode may be driven where conditions are suitable, otherwise use a drilled hole (50 mm diameter) back filled with a conducting medium mixture, for example bentonite, gypsum and sodium sulphate (50%, 45% and 5% by weight respectively) mixed to AS 2239 - Cathodic Protection, or similar. The top of each electrode is to finish 200 mm below ground level.

The earth electrode is to have a collar installed with the inside of the collar backfilled with earth. A lid is to be placed over the collar.

2.1.3 Electrode Connection

The earthing conductor is to be connected to the electrode by crimping. The earth conductor will need 75 mm of insulation removed, the 75 mm of bare 70 mm² conductor inserted inside the copper tube electrode and either of the following crimp methods used:

Hydraulic crimp: 2 crimps with a 70 mm² die over the 75 mm of insert. Hand crimp: 5 crimps over the 75 mm of insert.

2.2 Connection to Switchboard

Where the low voltage earthing system is in contact with a 1500 V structure, eg overbridge, the 1500 V structure is to be bonded to the switchboard earth bar from

which the low voltage installation circuits originate.

The earth bar of the switchboard required to be bonded to the station overbridge is connected by a bonding conductor equivalent to the incoming submain earthing conductor up to a maximum size of 70 mm² copper (minimum size is 16 mm²). The same requirements for mechanical protection as for the main earthing conductor apply to this bonding conductor, refer to section 1.5.

The bonding conductor shall be secured by means of not lesser security than a crimped closed lug, lock-nutted onto a stud of minimum size 12 mm. The location of the point of connection of the bonding connection to the overbridge shall be indicated at the switchboard where the overbridge is connected to the earth bar.

The incoming earthing conductor and the overbridge bonding conductor are to be terminated adjacent to each other at one end of the switchboard earth bar. Clear labelling is to be provided to identify each conductor, such as overbridge bond, or earth conductor.

Reference can be made to drawing C87115.

2.3 Connection to Waterpipe

At a railway station, the overbridge shall be bonded to the railway station internal water pipe (the station side of the water pipe isolating joint, refer to section 1.8) by means of a 70 mm² copper bonding conductor. The location of both the water pipe and overbridge connections shall be clearly labelled on the switchboard where the overbridge is connected to the earth bar. The water pipe bond conductor is to be effectively protected from mechanical damage as detailed in section 1.5.

2.4 Other Metalwork

Refer to Specification EP08000014SP - "Services Erected Above OHW".

2.5 Spark Gap

The overbridge must have an approved spark gap fitted, refer to RailCorp publication EP12200001 SP - "Bonding of Overhead Wiring Structures to Rail" contained in Volume 1.

If two, or more, 1500 V overhead wiring structures are electrically connected by a low voltage earthing system then the structures shall be bonded together by a minimum 70 mm² copper conductor and only one spark gap shall be provided.

3 Railway Station Interfaces

Where a railway station adjoins with another building or structure, such as a bus rail interchange or a footbridge that connects a railway station with a shopping centre, the design shall not allow the extension of the ARTC low voltage earthing system beyond the railway corridor. This includes all metallic structures and services, such as awnings, fences, pipes and electrical wiring and conduits. The interface should be well defined and easily observable and where any doubt exists the situation shall be proved safe by calculation and testing for dangerous touch voltages in accordance with the ESAA Substation Earthing Guide.

The metalwork of the structure that has been isolated from the station may be

connected to an MEN earthing system.

4 Single Point Trackside Supplies

Where a local Electricity Distributor provides a supply to a small single load such as the lighting of a billboard or a sign near the 1500 V track then an isolating transformer will not be required as a single footing encased in concrete is not likely to pick-up appreciable dc leakage current, refer to Specification PDS 03 - "Low Voltage Distribution and Installations Earthing References and Definitions" for definition.

No other supplies are allowed from the same service equipment. There shall also be no other metallic services such as water pipes in close proximity to the supply point. If there is any doubt the supply or service can be tested for appreciable dc leakage current as described in Specification PDS 03 - "Low Voltage Distribution and Installations Earthing References and Definitions".

5 Signalling Supplies

The 120 V signalling supply is considered to be unearthed for the purposes of this document. The earthing of the Signalling system, that is the electrical installation at 120 V and below, is covered in the appropriate Signalling documents.

Where supply is provided from a ARTC 415 V or 240 V source or a local Electricity Distributor, the active and neutral conductors from the main supply switchboard, or service equipment, shall be double insulated to the 415/120 V or 240/120 V isolating transformer. The metal screen shall be connected to earth using a method that will maintain the double insulation of the transformer. Depending on the connection details for a particular transformer this may involve over sleeving the earth conductor for the section internal to the transformer and taping the connection. The connection shall be mechanically secure. Double insulated active and neutral conductors shall be run from the isolating transformer to the signal hut switchboard. Any switches in the circuit shall switch both the active and neutral conductors simultaneously.

Where supply is from a ARTC high voltage location stepped down directly to 120 V, double insulated active and neutral conductors shall be run from the transformer to the supply main switchboard and on to the signalling location switchboard. Any switches shall switch both active and neutral conductors simultaneously. The metal screen of the transformer shall be connected to the high voltage earth.

Refer to Specification PDS 07 - "Low Voltage Distribution Earthing" for more information on isolating transformers.

6 Train Maintenance Centres

6.1 General

Buildings containing 1500 V overhead wiring, such as Train Maintenance Centres, usually have two different types of supplies. There is a "normal" supply for general lighting and power for the building and any additional special equipment such as cranes, this is covered in section 6.2. There is also a "train shore" supply which is available for the connection of auxiliary power to trains, this is covered in section 6.3.

6.2 Buildings Containing 1500 V Overhead Wiring

The neutral of the low voltage winding of the transformer of the normal supply must be bonded to the earth bar at the supply main switchboard with a 70 mm² copper conductor. The earth bars of any other switchboards shall also be bonded to the earth bar of the supply main switchboard. The steelwork of all buildings supplied from the same transformer shall all be bonded to the earth bar of the main supply switchboard.

The frame of the building shall be connected to a minimum of one earth electrode by 70 mm² copper conductors. The frame of the building shall also be spark gapped to rail to provide a path for any dc fault currents resulting from the failure of an insulator supporting overhead wiring off the steel structure of the building.

Any 240 V power outlet installed for use by staff to plug in a portable electric tool when working on a train, must be supplied from its own individual isolating transformer. Neither the screen nor the case of the isolating transformer are to be earthed.

Reference can be made to drawings A/88097, D/87155 and B/82693.

6.3 Train Shore Supply

The train shore supply shall not have its neutral earthed. The neutral is connected to the running rails. The train shore supply must be isolated from the normal supply earthing system, including the building frame and pipes.

An isolating transformer shall be used to supply a "Train Supply Switchboard" which shall have a neutral/rail bondbar. The neutral of the secondary winding of the isolating transformer and all rails shall be connected to the neutral/rail bondbar using a minimum 120 mm² copper conductor insulated with black pvc. The train will be at rail potential, the rail is not at earth potential.

Any 120 V_{dc} train supply must also be supplied from its own individual isolating transformer. Neither the screen or the case of the isolating transformer are to be earthed.

Refer to drawings D/87155, D/86812 and B/82693 for further clarification.

6.4 Lifting Shops

A minimum 120 mm² copper conductor insulated with black pvc shall be used to bond the following to the earth bar of the lifting shop switchboard:

- the railway tracks that pass through the lifting shop,
- the contact and catenary anchors on the face of the lifting shop,
- the lifting shop structure,
- the earth bar of supply main switchboard for the transformer supplying the location.

The number of 120 mm² cables required in each case shall be calculated for individual locations.

Insulated joints shall be inserted in both rails on both sides of the lifting shop. A sign shall be installed on both sides of the lifting shop adjacent to the track at an appropriate distance to warn train drivers not to stable their train across the insulating joint.

Refer to drawings D/87155 and B/82693.

7 Lighting Mounted on 1500 V Structures

Where light fittings are mounted on a 1500 V overhead wiring structure the lighting circuit shall be supplied from an isolating transformer. The earth terminals of the light fittings shall be connected to the neutral of the transformer. The neutral of the transformer shall be bonded to the overhead wiring structure.

Where lighting, supplied from a common switchboard, is mounted on more than one 1500 V overhead wire structure an individual isolating transformer shall be mounted on each overhead wiring structure.

The active and neutral conductors used to connect the supply side of the isolating transformers shall be double insulated. There shall be no earth conductor on the supply side of the transformers.

If double insulated light fittings are used then only one isolating transformer may be used. In this situation double insulated active and neutral conductors shall be used to connect the light fittings to the isolating transformer and there shall be no earth connections and the neutral shall not be connected to the overhead wiring structure.

Each individual 1500 V overhead wiring structure with lighting mounted on it must have a spark gap installed, refer to RailCorp publication EP12200001 SP - "Bonding of Overhead Wiring Structures to Rail" contained in Volume 1.

8 Permanent Standby Generators

The earthing system employed for a 415 V or 240 V permanent standby generator shall follow the same principles set out in this document and Specification EP12100020SP - "Low Voltage Distribution Earthing".

The earthing system employed for a 120 V permanent standby generator for a signalling supply is covered in the appropriate Signalling documents.

9 Telecommunication and Protection Equipment

Standard requirements for this configuration have not yet been determined.

10 Train Radio Aerial Masts and Equipment

Standard requirements for this configuration have not yet been determined.

11 Welding Machines

Standard requirements for this configuration have not yet been determined.

Reference can be made to drawing D/77535.