electricity north west

Bringing energy to your door

Electricity Specification 350

Issue 4 August 2025

Neutral Earthing Resistors at BSP and Primary Substations

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 4	Document converted into new template only.
August 2025	Prepared by: Simon Rushton Approved by: Policy Approval Panel and signed on its behalf by Paul Turner, PAP Chairperson

Contents

1 Scope

This specification details the general requirements for the design, manufacture, testing at works, supply and delivery to site of 6.6kV, 11kV, and 33kV dry and liquid type neutral earthing resistors. These are for use with system highest voltages of 7.2, 12.6 and 36kV with rated currents and rated times as stated herein.

The normal operating voltages are 6.6, 11 and 33kV respectively.

2 Definitions

Approval	Sanction by the Electricity North West Limited Protection Systems Manager that specified criteria have been satisfied.
Contract	The agreement between Electricity North West Limited and the Contractor for the execution of the Works including therein all documents to which reference may properly be made in order to ascertain the rights and obligations of the parties under the said agreement.
Contractor	The person or person's firm or company, including personal representatives, successors and permitted assigns, who's Tender has been accepted by Electricity North West Limited.
High Voltage (HV)	A voltage exceeding Low Voltage (LV).
Low Voltage (LV)	A voltage exceeding 50V ac but not exceeding 1000V ac or a voltage exceeding 120V dc but not exceeding 1500V dc
Specification	The Specifications and schedules (if any) agreed by the parties for the purpose of the Contract.
Sub-Contractor	Any person (other than the Contractor) named in the Contract for any part of the Works or any person to whom any part of the Contract has been sub-let with the consent in writing of the Electricity North West Limited Protection Systems Manager, and the legal representatives, successors and assigns of such person.
Supplier	Any person or person's firm or company who supplies goods to Electricity North West Limited or to its Contractor.
Tender	An offer in writing to execute work or supply goods at a fixed price.
Tenderer	The person or person's firm or company, including personal representatives, successors and permitted assigns, invited by Electricity North West Limited to submit a Tender.
Words	Words importing persons shall include firms and corporations; words importing the singular only, also include the plural, and vice versa where the context requires.
Work	All materials, labour and actions required to be provided or performed by the Contractor under the Contract.

Writing	Any manuscript, typewritten or printed statement under seal or hand as the case may be.
ENA TS	Electricity Networks Association Technical Specification

3 General Requirements for Approvals and Testing

3.1 Product not to be Changed

No change in the product, packaging or labelling shall be made after Approval has been granted without prior notice to the Electricity North West Limited Protection Systems Manager, and receipt of a written agreement to the proposed change from the Electricity North West Limited Protection Systems Manager.

3.2 Electricity North West Technical Approval

The Tenderer shall submit, with this Tender, proposals for testing which will demonstrate, to the satisfaction of the Electricity North West Protection Systems Manager, compliance with this Specification. Such tests shall be carried out without expense to Electricity North West Limited.

Alternatively, technical reports and other data may be submitted that the Tenderer considers will demonstrate, to the satisfaction of the Electricity North West Protection Systems Manager, compliance with this Specification. Acceptance of this evidence shall be at the discretion of the Electricity North West Limited Protection Systems Manager but will not be unreasonably withheld.

Approval shall be 'factory specific' and is not transferable to another factory without the written Approval of the Electricity North West Limited Protection Systems Manager.

The supplier and product shall comply with all the relevant requirements of Electricity North West Limited document CP311.

The Tenderer shall complete the conformance declaration sheet in Appendix C.

3.3 Quality Assurance

The Tenderer shall confirm whether or not Approval is held in accordance with a quality assurance scheme accredited under BS EN ISO 9001. If not, the Tenderer shall submit a statement of the quality assurance procedures employed to control the quality of the product, including the performance of Suppliers and Sub-Contractors.

The right is reserved for the repeat of such tests, from time to time, that the Electricity North West Limited Protection Systems Manager may deem to be reasonably necessary to demonstrate continued compliance with the Specification.

The Tenderer shall submit, with the Tender, a list of tests and inspections which are carried out on the product prior to despatch which shall demonstrate, to the satisfaction of the Electricity North West Limited Protection Systems Manager, fitness for installation and service.

The Tenderer shall provide free of charge to Electricity North West such samples as may, in the opinion of the Electricity North West Limited Protection Systems Manager, be reasonably required for inspection and/or retention as quality control samples. The Electricity North West Limited Protection Systems Manager will confirm the requirement for samples at the time of Tendering.

The right is reserved for inspections to be made of Tenderer's facilities, from time to time, as deemed reasonably necessary by the Electricity North West Limited Protection Systems Manager to ensure compliance with this Specification and any Contract of which it forms a part.

The Tenderer shall submit, with the Tender, such details of product packaging disposal, as will enable Electricity North West to comply with the requirements of BS EN ISO 14001 - Environmental Management Systems.

3.4 Formulation

The Tenderer shall submit, with the Tender, such details of the formulation and use of the product and associated substances as will enable Electricity North West Limited to comply with the obligations of the Health and Safety at Work Act 1974 and the Control of Substances Hazardous to Health Regulations 2002, in the use, storage and disposal of the product. The Tenderer may stipulate, prior to submission of such information, that it is to remain confidential, and the Electricity North West Limited Protection Systems Manager will, if requested, confirm agreement to this prior to receipt of the information.

3.5 Identification Markings

The Tenderer shall submit, with the Tender, details of markings which it is proposed to apply to the product or packaging to identify manufacturing batches or items. The forms and content of such markings shall be subject to the Approval of the Electricity North West Limited Protection Systems Manager and shall in all cases include the Electricity North West Limited approved description and commodity code number.

The Tenderer shall submit, with the Tender, such details of marking gross weight on components, assemblies and packages, as will enable Electricity North West to comply with the Health and Safety Manual Handling Operation Regulations 1992, for components, assemblies and packages supplied with a gross weight over 1kg. The forms and content of such markings shall be subject to the Approval of the Electricity North West Limited Protection Systems Manager.

3.6 Minimum Life Expectancy

The minimum life expectancy of all products covered by this Specification is 40 years.

3.7 Product Conformity

Preference will be given to those Suppliers who can provide suitable product conformity certification to a recognised or specified standard, or an equivalent certification.

4 Requirements for Type and Routine Testing

The Electricity North West Limited Protection Systems Manager shall set out the requirement of the following tests to be carried out by the Supplier at the Supplier's cost.

4.1 Requirement for Type Tests at Suppliers Premises

These are a series of one-off type tests, which are carried out to ensure the satisfactory performance of the product design, under extremes of operating stresses, and of endurance, as may be appropriate, to be determined by the Electricity North West Limited Protection Systems Manager.

These may or may not be destructive tests.

4.2 Requirement for Routine Tests at the Supplier's Premises

These tests may be required to be carried out on every individual unit or component, as specified, or at some regular frequency to be determined by the Electricity North West Limited Protection Systems Manager.

The results of these tests may be required to be supplied to Electricity North West Limited with each unit purchased or retained for inspection, at a period to be determined by the Electricity North West Limited Protection Systems Manager.

5 Technical Requirements

5.1 Type and Design

Neutral earthing resistors for normal operating voltages of 6.6, 11kV and 33kV shall be either of the metallic strip type or the liquid type. As there is no British Standard covering earthing resistors this specification is based on American standard IEEE C57.32, except as modified in this document.

This specification includes Appendix A dealing with liquid type resistors and Appendix B dealing with metallic strip type resistors together with the clauses common to both in this general section.

5.2 Current and Time Ratings

Unless otherwise specified the nominal current rating at normal system voltage shall be 1000A for all resistors.

Metallic strip type resistors shall be designed to carry the rated current for 10s repeated within 30 minutes without the elements having a temperature rise in excess of 760°C.

Liquid type resistors shall be rated for 30s to achieve a temperature rise of the liquid not exceeding 50°C, the current being maintained at the nominal rated value. The electrode shall be of cylindrical shape with rounded ends and the bushing connection shall fall within the cylinder to avoid concentrations of current. The surface area of the exterior of the electrode shall be such that the surface current density at rated current is not more than 750A/sq m.

5.3 Delivery

Delivery shall be to a prepared plinth. For liquid type resistors the empty tank shall be delivered with the central electrode packed separately.

5.4 Erection

The tenderer shall be responsible for completion of erection on site but not for filling and adjustment of liquid type resistors.

5.5 Surface Finish

Liquid filled resistors shall be shot blast cleaned and on the same day without outdoor exposure, hot-dipped galvanised. After the completion of all drilling or other work the tank and top-plate and all steel parts shall be thoroughly cleaned by shot blasting and galvanised by the hot dip process to BS EN ISO 1461. Inner surfaces do not require a paint finish. No component shall introduce the possibility of bimetallic corrosion. This particularly applies to thermostat and heater pockets, bushing stems and nuts.

Metallic resistors shall be housed in a ventilated enclosure, in accordance with BS EN 60529 (IP23 as a minimum), manufactured from grade 304 stainless steel with no other protective coating.

6 Protection, packaging and delivery

The Contractor shall ensure that each item is suitably protected and packaged to maintain it fit for service prior to installation.

The Tenderer shall submit, with the Tender, details of the proposed packaging arrangements and identification markings.

Tenderers shall state on the price schedules the lead times offered. Deliveries shall be specified with the order and may be to any stores or specific site within Electricity North West's area.

7 Documents Referenced

DOCUMENTS REFERENCED	
Health and Safety at Work etc Act 1974	
Control of Substances Hazardous to Health Regulations 2002	
Manual Handling Operations Regulations 1992 (as amended)	
BS EN ISO 9001: 2015+A1:2024	**Quality Management Systems. Requirements**
BS EN ISO 14001: 2015	**Environmental Management Systems. Requirements**
BS EN 60137: 2017	**Insulated Bushings for alternating voltages greater than 1kV**
BS EN 60529:1992+A2:2013	**Degrees of Protection Provided by Enclosures (IP Code)**

IEEE C57.32-2015	**IEEE Standard for Requirements, Terminology, and Test Procedures for Neutral Grounding Devices**
BS EN ISO 1456:2009	**Metallic and other inorganic coatings. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium**
BS EN ISO 1461:2022	**Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods**
CP311 Issue 3	**Approval of Equipment**

8 Keywords

Neutral; Earthing; Resistor;

Appendix A – Liquid Neutral Earthing Resistors

1 Type and Design

The resistor shall be designed for outdoor mounting on a simple flat square plinth and for filling with a dilute solution of sodium carbonate in water.

The electrolyte shall be totally enclosed in a tank of mild steel. The top plate shall be designed to prevent the collection of rain water on any part. The tank shall be supported on a ventilated skirt to prevent corrosion.

The heater and thermostat pockets shall be mounted below a protective grid which shall carry any current from the bottom of the electrode.

The tank shall be adequately ventilated, the user providing means to limit evaporation which will normally be by a surface film of mineral oil.

Where a hinged inspection lid is provided the lid shall not reduce the clearance to earth of live conductors in any position of the lid. Where the lid is free to lift as a means of venting internal pressure the movement shall be limited such that the lid is self-closing and that any spray emission is directed away from live conductors.

An indicator shall be provided visible from ground level and clearly and permanently marked to indicate the correct liquid level.

A valve shall be provided for draining the tank mounted within the skirt so as to avoid freezing of the unheated length of pipework. The valve shall be connected to a pipe passing to the outside of the skirt and terminating in a flange suitable for drain hose connection which shall be provided with a blanking plate.

Fittings shall include jacking points, main lifting eyes and lifting eyes for the lid. Temporary labels shall be fitted at delivery indicating that the lifting provision of the lid must be used for the lid only and that the main lifting eyes are to be used only for an empty resistor.

The skirt shall have access holes of a size to readily permit cleaning and repainting of the underside.

2. Heating

The resistor shall be provided with pockets to allow replacement of the heater(s) and thermostats without draining the main tank. An indicating thermometer is not required. Two thermostats are required either of the long reach differential expansion type or the vapour pressure type operating mechanical contacts with a maximum differential of 2°C between closing contacts on falling temperature and opening contacts on a rising temperature. The setting range shall be 0-10°C to permit an open scale but the device shall withstand the maximum temperature of the resistor following a full duty cycle. One thermostat shall control the heater(s) direct and the other will be connected to Electricity North West's remote alarm system. The heaters shall be adequate to prevent freezing at an ambient temperature of minus 25°C.

No on-off switch shall be provided.

Connections external to the pockets shall be within a weatherproof box including a terminal block for connection of the incoming supply and alarm cable which will be a 4 core 7/0.67mm. PVCSWAPVC cable supplied and connected under a separate contact. The gland plate shall be not less than 450 mm above plinth level.

3. Terminal Arrangements

The 33kV terminal shall be the outer end of the electrode support bushing. It shall be of the porcelain through type with a voltage rating of 44kV and a short term current rating to match the resistor and complying with BS EN 60137. The earthed flange of the bushing shall be not less than 2.9m above plinth level. The bushing shall have mechanical protection to prevent damage.

4. Provision for Current Transformers

Current transformers shall be provided under a separate contract. Current transformers of outdoor pattern will be supported on a separate structure.

Appendix B – Metallic Type Neutral Earthing Resistors

1 Enclosure

The preferred main body dimensions for 6.6 and 11kV resistors shall not exceed 1100mm(w) x 820mm(d). The height for 6.6 and 11kV resistors shall be subject to the approval of Electricity North West.

The preferred main body dimensions for 33kV resistors shall not exceed 1500mm(w) x 1300mm(d). The height for 33kV resistors shall be subject to the approval of Electricity North West.

6.6 and 11kV resistors shall be cable connected. The cable box attached to the main body shall have approximate dimensions of 450mm(w) x 325mm(d) x 800mm(h). The cable box shall be fitted with a gland plate pre-drilled to accept an 85mm gland. The preferred height of the gland plate above ground level is a minimum of 600mm.

6.6 and 11kV resistors shall have a current transformer mounting plate fixed below the cable box and shall have approximate dimensions of 300mm(w) x 420mm(h).

The enclosure shall be vermin proof. No part of the enclosure shall reach a temperature that may cause injury if touched immediately following a full duty cycle.

2. Resistance Elements

The preferred design is that resistor elements shall be manufactured from continuous strips of non-corrodible chrome aluminium steel alloy wound edgewise as elliptical coil supported by ceramic insulators mounted on stainless steel centre supports. Alternative designs may be acceptable.

For maintenance purposes inter-element and interbank connections should be made by bolted copper links with a minimum of two bolts per joint, allowing individual elements to be replaced if required.

All inter-element connections should be dull nickel plated to BS EN ISO 1456.

Resistor elements shall have a low temperature co-efficient of resistance (less than 3% per 100°C rise) to limit the increase in resistance over the rated time of the unit.

3. Terminals

The 11/6.6kV system neutral earth terminal should consist of the following.

An IP54 cable box with a terminal arrangement suitable for cable connection. The 11/6.6kV terminal shall be of the through bushing type leading from the main resistor enclosure into the cable termination enclosure which shall be suitable for a 400mm2 SC XLPE cable having up to 50mm2 earth screen. The cable shall enter vertically from below. The entry to the enclosure shall support the cable and provide insulation from the metalwork. The cable termination shall be substantially vertical and connected by a removable test link to the resistor terminal. Suitable arrangements shall be made to terminate the screen of the cable within the enclosure and to transfer the screen connection by means of an M12 5kV insulated through stud from the interior to the exterior of the enclosure to be continued through the current transformers to an earth connection.

The through bushing shall have a voltage rating of 22kV and the short term current rating shall match that of the resistor. Pending the provision of an ESI Standard the cable termination enclosure shall be to the approval of Electricity North West.

The cable termination enclosure shall be ventilated but weather and vermin proof and mounted to allow the ct mounting plate to fit in with previous dimensional requirements.

For 33kV resistors, the 33kV terminal shall be the outer end of the electrode support bushing. It shall be of the porcelain through type with a voltage rating of 44kV and a short term current rating to match the resistor and complying with BS EN 60137. The earthed flange of the bushing shall be not less than 2.9m above plinth level. The bushing shall have mechanical protection to prevent damage.

4. Earth Connections

The low voltage end of the resistor shall be taken to a separate external bushing.

A minimum of two enclosure earthing studs shall be provided, diagonally opposite.

The cablebox shall be fitted with a M12 through stud with 5kV insulation for the purpose of connecting the cable screens to the main substation earth system using an earth connection passing through the current transformer orifice. Cable screens are not connected to earth within the cablebox.

5. Provision for Current Transformers

Current transformers will be provided on a separate contract.

Provision shall be made for mounting outdoor pattern slip over current transformers around the vertical run of incoming neutral cable beneath the cablebox

Details of the current transformers from all suppliers will be provided and it will be necessary to confirm the mounting and drilling details prior to the first delivery of any resistor by the successful tenderer. The detailed arrangements will be subject to the approval of Electricity North West.

Appendix C – Conformance Declaration

SECTION-BY-SECTION CONFORMANCE WITH SPECIFICATION

The Tenderer shall declare conformance or otherwise for each product/service or range of products/services, section-by-section, using the following Conformance Declaration Codes.

Conformance Declaration Codes:

N/A =	Clause is not applicable/appropriate to the product/service.
C1 =	The product/service conforms fully with the requirements of this clause.
C2 =	The product/service conforms partially with the requirements of this clause.
C3 =	The product/service does not conform to the requirements of this clause.
C4 =	The product/service does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Manufacturer:

Product/Service Description:

Product/Service Reference:

Name:

Company:

Signature:

SECTION-BY-SECTION CONFORMANCE			
Section	**Section Topic**	**Conformance Declaration Code**	**Remarks * (must be completed if code is not C1)**
3.1	**Product not to be Changed**		
3.2	**Electricity North West Technical Approval**		
3.3	**Quality Assurance**		
3.4	**Formulation**		
3.5	**Identification Markings**		
3.6	**Minimum Life Expectancy**		
3.7	**Product Conformity**		
4.1	**Requirements for Type Tests at Suppliers Premises**		
4.2	**Requirements for Routine Tests at Suppliers Premises**		
5.1	**Type and Design**		
5.2	**Current and Time Ratings**		
5.3	**Delivery**		
5.4	**Erection**		
5.5	**Surface Finish**		
6	**Protection, Packaging and Delivery**		
Appendix A	**Liquid Type Neutral Earthing Resistors**		

Appendix B	**Metallic Type Neutral Earthing Resistors**		

Additional Notes: