



Engineering Specification ES350

Issue 2 March 2000

Specification for Neutral Earthing Resistors at BSP and Primary Substations

Contents

- 1 Scope
- 2 Approved Components and Quality Assurance
- 3 Type and Design
- 4 Current and Time Ratings
- 5 Delivery
- 6 Erection
- 7 Surface Finish
- 8 Documents Referenced
- 9 *Keywords*

**Approved for issue by the
Technical Policy Panel**

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NEUTRAL EARTHING RESISTORS

1. SCOPE

This specification covers the general requirements for the design, manufacture, testing at works, supply and delivery to site of 6.6kV and 11kV dry type, and 33kV 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. APPROVED COMPONENTS AND QUALITY ASSURANCE

When submitting his tender the Contractor shall give an undertaking that all the equipment offered complies with the requirements of this specification. If he is unable to give this undertaking the Contractor shall supply with his offer full technical details to Electricity North West, and conditions 2.1, 2.2 and 2.3 below shall apply:-

- 2.1 Where the Contractor proposes to supply an item not previously approved, Electricity North West will consider giving approval to alternatives on an individual Contract basis only and subject to specific agreement for that Contract.
- 2.2 Such apparatus shall preferably be of a design which has undergone type tests by a recognised authority and full details of such testing and approval shall be submitted together with a written guarantee that the apparatus offered will be identical.
- 2.3 Where such independent testing and approval has not taken place, the Contractor shall provide full details of any evaluation and environmental testing to which the item has been subjected.

3. TYPE AND DESIGN

- 3.1 Neutral earthing resistors for normal operating voltages of 6.6 and 11kV shall be of the metallic strip type. Neutral earthing resistors for 33kV shall be of the liquid type. As there is no British Standard covering earthing resistors this specification is based on American standard IEEE 32, except as modified in this document.
- 3.2 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.

4. CURRENT AND TIME RATINGS

- 4.1 Unless otherwise specified the nominal current rating at normal system voltage shall be 1000A for all resistors.
- 4.2 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.
- 4.3 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. DELIVERY

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

6. ERECTION

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

7. SURFACE FINISH

7.1 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 BS729. Thereafter paint finish shall be to Electricity North West Specification ES363 for outer surfaces. 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.

7.2 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.

8. DOCUMENTS REFERENCED

- 8.1 BS EN 60137 - Insulated Bushings for alternating voltages greater than 1kV
- 8.2 BS EN 60529 - Degrees of Protection Provided by Enclosures
- 8.3 IEEE 32 - Standard Requirements Terminology and Test Procedures for Neutral Grounding Devices
- 8.4 BS1224 – Specification for electroplated coatings of nickel and chromium
- 8.5 Engineering Specification ES363 - Common Plant Clauses.
- 8.6 BS729 - Specification for hot dip galvanised coatings on iron and steel articles.

9. KEYWORDS

Neutral; Earthing; Resistor;

APPENDIX A

LIQUID NEUTRAL EARTHING RESISTORS FOR 33KV

1. TYPE AND DESIGN

- 1.1 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.
- 1.2 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.
- 1.3 The heater and thermostat pockets shall be mounted below a protective grid which shall carry any current from the bottom of the electrode.
- 1.4 The tank shall be adequately ventilated, the user providing means to limit evaporation which will normally be by a surface film of mineral oil.
- 1.5 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.
- 1.6 An indicator shall be provided visible from ground level and clearly and permanently marked to indicate the correct liquid level.
- 1.7 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.
- 1.8 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.
- 1.9 The skirt shall have access holes of a size to readily permit cleaning and repainting of the underside.

2. HEATING

- 2.1 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.
- 2.2 No on-off switch shall be provided.

- 2.3 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. PVC SWAPVC 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.

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

- 1.1 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.
- 1.2 The preferred dimensions and layouts shall be in accordance with this document and as shown in Electricity North West General Arrangement Drawing Number 900160/010 from Grid and Primary Systems.
- 1.3 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.
- 1.4 The current transformer mounting plate shall be fixed below the cable box and shall have approximate dimensions of 300mm(w) x 420mm(h).
- 1.5 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

- 2.1 The preferred design is that resistor elements shall be manufactured from continuous strips of non-corrodible chrome aluminium steel alloy wound edgewise as an elliptical coil supported by ceramic insulators mounted on stainless steel centre supports. Alternative designs may be acceptable.
- 2.2 Terminations should be made by welded stainless steel terminals at each end of the individual resistor assembly.
- 2.3 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.
- 2.4 All inter-element connections should be dull nickel plated to BS1224.
- 2.5 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.

- 3.1 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.
- 3.2 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.
- 3.3 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.

4. EARTH CONNECTIONS

- 4.1 The low voltage end of the resistor shall be taken to a separate external bushing.
- 4.2 A minimum of two enclosure earthing studs shall be provided, diagonally opposite.
- 4.3 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

- 5.1 Current transformers will be provided on a separate contract.
- 5.2 Provision shall be made for mounting outdoor pattern slip over current transformers around the vertical run of incoming neutral cable beneath the cablebox
- 5.3 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.