Electricity Distribution

nationalgrid

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 174/0

145kV Outdoor Structure Mounted Instrument Transformers

Policy Summary

Specification for the purchase of 145kV structure mounted instrument transformers for use on the NGED 132kV network.

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Implementation Date: **October 2023**

Approved by:

Carl Ketley-Lowe
Engineering Policy Manager

Date: **9th October 2023**

Target Staff Group	**Primary System Design, Engineering Design and Purchasing**
Impact of Change	**Green – No impact on current working practices**
Planned Assurance Checks	**Engineering Policy Team to work with Purchasing to ensure compliance.**

IMPLEMENTATION PLAN

Introduction

This document specifies the requirements for 145kV outdoor structure mounted instrument transformers. These include current transformers, capacitor voltage transformers, and inductive voltage transformers.

Combined transformers and resistor capacitor voltage transformers (RCVT) will be added at a later date as required.

Main Changes

This is a new document replacing the parts of EE SPEC: 7 covering 145kV instrument transformers. A separate EE SPEC document covers the NGED requirements for 72.5kV instrument transformers.

Impact of Changes

EE SPEC: 7 shall no longer apply to 145kV instrument transformers supplied for use on the NGED 132kV network.

Implementation Actions

This new EESPEC has been prepared to enable the tender of call-off contracts for 145kV instrument transformers.

Procurement Team to use this specification for new Tenders.

Implementation Timetable

A tender process will be run using EE SPEC: 174 so as to put in place a call-off contract for 145kV structure mounted instrument transformers.

ICPs will be expected to comply with this new specification within 6months of its issue.

Items currently on order/under active quotation by an ICP, to the existing specification shall continue to be acceptable to NGED, but new orders, after the 6 months have elapsed will need to comply with this specification.

Exceptions to this may be made by NGED Engineering Policy team upon formal request.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
October 2023	• This is a new document.	Andrew Reynolds / Stephen Hennell

Contents

1.0 INTRODUCTION

1.1 This Technical Specification sets out National Grid Electricity Distribution (NGED) requirements for 145kV outdoor structure mounted instrument transformers.

1.2 Where this NGED Technical Specification is being used for Tender purposes then unless otherwise specified in writing at time of Tender, all equipment offered against this Technical Specification shall be compliant with this Technical Specification.

1.3 Any selection of options or changes to this specification by NGED shall be made in writing.

1.4 Manufacturers and suppliers shall satisfy the requirements of BS EN ISO 9000 and BS EN ISO 9001 for all items supplied.

1.5 NGED has a distinct preference for equipment which holds an Energy Networks Association (ENA) Notice of Conformity (NoC) to the current version or a previous version of an ENA Technical Specification (TS). Where equipment does not have an ENA NoC then the following preferences apply in order:-

- Equipment from a design where other ratings have an ENA NoC;
- Equipment manufactured in a facility where other equipment having an ENA NoC is manufactured;
- Other non ENA Assessed equipment.

2.0 REFERENCES

2.1 Primary references are listed below in Table 1. Secondary references not listed but referenced in other standards shall be used as required.

2.2 Users of all standards and technical specifications shall ensure they are applying the most recent editions together with any amendments.

2.3 Where the IEC base document is listed for information, the prime document that shall take priority is the British Standard enacting the European Standard (EN) or European Harmonisation Document (HD).

BS No.	Title	IEC / ISO base
BSEN 61869-1	Instrument transformers – General requirements	IEC 61869-1
BSEN 61869-2	Instrument transformers – Additional requirements for current transformers	IEC 61869-2
BSEN 61869-3	Instrument transformers – Additional requirements for inductive voltage transformers	IEC 61869-3
BSEN 61869-4	Instrument transformers – Additional requirements for combined transformers	IEC 61869-4
BSEN 61869-5	Instrument transformers – Additional requirements for capacitive voltage transformers	IEC 61869-5
BSHD 60269	Cartridge fuses for voltages up to and including 1000V ac and 1500V dc	IEC 60269
ENA TS 48-5	Environmental Test Requirements for Protection and Control Equipment and Systems	

Table 1 References

3.0 GENERAL

3.1 Normal service conditions

3.1.1 The instrument transformer shall be suitable for use with an ambient air temperature in the range -25degC to +40degC. [BSEN 61869-1; 4.2.1]

3.1.2 The altitude does not exceed 1000m. [BSEN 61869-1; 4.2.2]

3.1.3 Other service conditions shall be as BSEN 61869-1 clause 4.2.5:-

- the average value of the ambient air temperature, measured over a period of 24 h, does not exceed 35 °C;
- solar radiation up to a level of 1 000 W/m2 (on a clear day at noon) should be considered;
- the ambient air may be polluted by dust, smoke, corrosive gases, vapours or salt. The pollution does not exceed the pollution levels given in IEC 60815;
- the wind pressure does not exceed 700 Pa (corresponding to a 34 m/s wind speed);
- the presence of condensation or precipitation should be taken into account;
- the ice coating does not exceed 10 mm.

3.2 The system on which these instrument transformers are to be used may utilise:

- A solidly earthed system.

3.3 The rated primary insulation levels for the instrument transformer primary terminals are:-

- Highest voltage for equipment (U_m) 145kV
- Rated power-frequency withstand voltage 275kV
- Rated lightning impulse withstand voltage (peak) 650kV

3.4 Partial discharge levels shall not exceed those in Table 2 below. The test procedure is given in BSEN 61869-1.

Instrument transformer type	PD Test Voltage (rms) kV	Maximum permissible PD level	
CT and earthed VT	U_m $1.2U_m/\sqrt{3}$	10 5	50 20
Unearthed VT	$1.2U_m$	5	20

Table 2 Partial Discharge Levels

3.5 The rated power-frequency withstand voltage for secondary insulation shall be 3kV. [BSEN 61869-1; 5.3.5]

A class PX current transformer having a rated knee point emf $E_k \geq 2$kV shall be capable of withstanding a rated power-frequency withstand voltage of 5kV rms for 60s. [BSEN 61869-2; 5.3.5]

3.6 The rated frequency is 50Hz.

3.7 Where the equipment design uses liquids then the requirements of BSEN61869-1 clause 6.1 shall apply.

3.8 NGED does not require / will not accept equipment that is gas filled.

3.9 The requirements for temperature rise of parts of the equipment shall be as BSEN 61869-1 clause 6.4.

3.10 Equipment earthing requirements

3.10.1 The frame of each equipment device, if intended to be earthed, shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions. The connecting point shall be marked with the “earth” symbol as indicated by symbol No 5019 of IEC 60417. [BSEN 61869-1; 6.5.1]

3.10.2 The earthing terminal connecting point shall be suitable for either termination of copper tape and/or accepting a lugged cable end using an M12 bolted connection. Clamp type arrangements are not acceptable to NGED. Where a bolt or stud is provided then plain and spring washers are also to be provided.

3.10.3 The electrical continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stresses caused by the current they may have to carry. For the interconnection of enclosure, frames, etc, fastening (eg bolting or welding) is acceptable for providing electrical continuity. [BSEN 61869-1; 6.5.3]

3.11 Corrosion protection

3.11.1 All exposed hardware shall be stainless steel.

3.11.2 Any aluminum castings shall be anodized.

3.11.3 Other exposed metal parts shall be shot blasted and spray galvanized. This shall be followed by two coats of zinc rich primer and two coats of polyurethane based paint. The preferred paint colour is Dark Admiralty Grey (BS381C 632), however other colours may be acceptable (eg RAL 7033).

3.12 Requirements for the external insulation

3.12.1 The creepage distances shall be as given Table 3 below:-

Site Pollution Severity Class	**Minimum mm/kV**	**Ratio = creepage distance divided by arcing distance**
IEC/TS 60815:2008 e	Unified specific creepage distance 53.7	≤4.0
IEC/TR 60815:1986 IV Very Heavy	Specific creepage distance 31	

Table 3 Creepage distances [IEC/TR60815 & IEC/TS60815]

3.12.2 NGED requires insulators for Site Pollution Severity Class e (IEC/TR 60815:1986) or Class IV (IEC/TR 60815:1986); however there are some substation locations where Class d or Class III may be acceptable (eg >50km from coast) in the event that Class e or Class IV are not technically possible.

3.12.3 Insulators having an alternating shed profile are preferred.

3.13 NGED prefers units that have been tested and perform to Class II of Clause 6.9 BSEN 61869-1 in the event of an internal arc.

Where this is not possible then manufacturers shall provide data on how their equipment performs in the event of an internal arc, and any specific requirements to help mitigate adverse effects (eg the use of composite insulators).

3.14 Auxiliary enclosures

3.14.1 The degree of protection for low-voltage and/or auxiliary enclosures shall be at least IP44 according to BSEN60529.

3.14.2 Shall be fabricated of stainless steel and painted.

3.14.3 Shall be provided with a securing and locking device that provides security against unauthorized access. The locking arrangement shall be robust and accommodate a padlock with 41mm square body and with a 4mm to 7mm diameter shackle having a clear inside width of 21mm and an inside length of 16mm to 45mm. The holes provided for the shackle shall not be less than 8mm diameter.

3.14.4 Where an auxiliary enclosure (eg. terminal box) is fitted it shall be placed so that work can be carried out on this box with the equipment after the equipment is installed and cables terminated.

3.14.5 Auxiliary enclosures shall be suitable for the termination of armoured multicore cables using cable glands. Insulated cable glands, where specified and requested by NGED, shall be insulated to 4kVac for 1 minute.

3.14.6 Adequate terminal blocks shall be provided to terminate all the cores of all multicore cables as detailed in the Summary of Technical Parameters for the instrument transformer.

3.15 Markings

3.15.1 All instrument transformers shall carry at least the following markings:-

a) the manufacturer’s name or other mark by which he may be readily identified;

b) the year of manufacture, a type designation and a serial number,

c) rated frequency;

d) highest voltage of equipment;

e) rated insulation level;

f) temperature category;

g) mass in kg

h) class of insulation if different from Class A;

[NOTE If several classes of insulating material are used, the one, which limits the temperature rise of the windings, should be indicated.]

i) On transformers with more than one secondary winding, the use of each winding and its corresponding terminals should be indicated.

j) all indications relative to the measuring characteristics (see specific standard);

k) type of the insulating fluid;

3.15.2 All information shall be marked in an indelible manner on the instrument transformer itself or on a stainless steel rating plate with engraved text securely attached to the transformer.

3.16 Equipment shall be subject to a series of tests as detailed in BSEN 61869-1 clause 7. The minimum tests required by NGED are detailed in Table 4 below:-

T e s t s	**Subclause**
Type tests	**7.2**
Temperature-rise test	7.2.2
Impulse voltage test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Test for accuracy	See specific requirements standard
Verification of the degree of protection by enclosures	7.2.7
Enclosure tightness test at ambient temperature	7.2.8
Routine tests	**7.3**
Power-frequency voltage withstand tests on primary terminals	7.3.1
Partial discharge measurement	7.3.2
Power-frequency voltage withstand tests between sections	7.3.3
Power-frequency voltage withstand tests on secondary terminals	7.3.4
Test for accuracy	7.3.5
Verification of markings	7.3.6
Enclosure tightness test at ambient temperature	7.3.7

Table 4 – Type and Routine Tests

3.17 Clearances for overhead conductor connected equipment

3.17.1 Minimum clearance from ground level of a fixed access platform to exposed live conductors shall be basic electrical clearance (as defined in BSEN61936) plus 300mm plus personal reach. Clearance to support insulation shall be 300mm plus personal reach.

3.17.2 For the purposes of this specification personal reach is 2.25m.

3.17.3 Support structures will be supplied separately by NGED or others unless specifically requested and agreed in writing by NGED.

3.18 Small wiring and terminals

3.18.1 Small wiring and terminals shall comply with ENA TS 41-36 with the following additions:

- The application of small wiring, ancillary electrical equipment and protection shall in general follow the principles in Engineering Recommendation S15.
- Secondary wiring shall comprise of:
  - AC wiring: 2.5mm^2 (minimum) copper stranded cable with PVC insulation to BS6231 Type BR, or equivalent tri-rated cable complying with BS6231.
- The insulation of AC wiring shall be coloured white in all circuits, except earthing which shall be coloured green/yellow.
- A.C. wiring shall be terminated with crimped connections in accordance with ENA TS 50-18.
- Terminal blocks used for protection, alarm and control circuits shall be screw clamp with spring type, in accordance with ENATS 50-18 Type B. Sufficient space shall be allowed so that connections can be tightened or un-tightened and wires removed and re-inserted.
- An earth terminal shall be included at one end of a row with the terminal blocks provided. This shall be connected to a suitable earth point on the equipment.

3.19 Fuses and Links

3.19.1 Secondary fuselinks, links and fuse carriers shall be in accordance with ENATS 50- 18 and BS HD 60269-2 reference A.

3.19.2 Fuses and fuse holders up to 20A rating shall be in accordance with BS HD 60269-2 reference A1.

3.19.3 The fuse holders and bases shall be coloured as follows:

- 2A, 4A, 6A, 10A fuselink ratings: Black
- 16A fuselink rating: Green
- Solid links: White

2A, 4A and 10A fuse holders and bases shall have supplementary markings applied to denote the fuse rating. These markings shall be applied using permanent self-adhesive coloured vinyl tapes as follows:

- 2A Purple
- 4A Blue
- 10A Grey

[See example photo right.]

3.19.4 Eaton Bussmann (previously GE Power Controls) or Mersen Red Spot fuse holders shall be provided unless otherwise agreed at the time of tender.

3.19.5 All fuses and links shall be mounted vertically, grouped logically and consistently in the panel and shall be clearly labelled. The label shall show the function of the fuses/links and include the fuse/link number as specified on the schematic drawings.

3.19.6 Fuse terminals shall be suitably shrouded to minimise electric shock hazards. The incoming (supply) side of each circuit shall be connected on the bottom terminal of the fuse/link.

3.20 All equipment and systems shall satisfy requirements of the EMC directive. EMC emissions and immunity requirements shall, as a minimum, satisfy the requirements of the generic emission and immunity standards for industrial environments BSEN 61000-6-2 and BSEN 61000-6-4 and also all relevant EMC product standards.

3.21 The manufacturer shall provide information regarding any environmental aspects of the instrument transformer during service life, dismantling and disposal.

3.22 It is essential that the transport, storage and installation of instrument transformers, as well as their operation and maintenance in service, be performed in accordance with instructions given by the manufacturer. Consequently, the manufacturer should provide on time instructions for the transport, storage, installation, operation and maintenance of instrument transformers.

3.23 For each type of instrument transformer the installation instructions provided by the manufacturer should at least include the items listed below:-

- Required information for unpacking and lifting safely.

- Where the instrument transformer is not fully assembled for transport then all transport units should be clearly marked. Drawings showing assembly of these parts should be provided with the instrument transformer.

- Instructions for the mounting of instrument transformers, operating devices and auxiliary equipment should include sufficient details of locations and foundations to enable site preparation to be completed.

- Instructions on connections shall include information on:

    a) connection of conductors, comprising the necessary advice to prevent overheating and unnecessary strain on the instrument transformers and to provide adequate clearance distances;

    b) connection of auxiliary circuits;

    c) connection for earthing;

- Instruction shall be provided for inspection and test which should be made after the instrument transformer has been installed and all connections have been completed. These instructions should include:-

    a) a schedule of recommended site tests to establish correct operation;

    b) procedures for carrying out any adjustment that may be necessary to obtain correct operation;

c) recommendations for any relevant measurements that should be made and recorded to help with future maintenance decisions;

d) instructions for final inspection and putting into service.

3.24 The manufacturer shall issue a maintenance manual including the following information:-

- maintenance frequency and active time;
- detailed description of the maintenance work;
  - recommended place for the maintenance work (indoor, outdoor, in factory, on site, etc.);
  - procedures for inspection, diagnostic tests, examination, overhaul, check of functionality (limits of values and tolerances, for example, opto-electrical component operating efficiency);
  - reference to drawings;
  - reference to part numbers (when applicable);
  - use of special equipment or tools (cleaning and degreasing agents);
  - precautions to be observed (e.g; cleanliness).
- Comprehensive drawings of the details of the instrument transformers important for maintenance, with clear identification (part number and description) of assemblies, sub -assemblies and significant parts.
- List of recommended spare-parts (description, reference number, quantities, etc.) and advice for storage.
- Estimate of active scheduled maintenance time.
- How to proceed with the equipment at the end of its operating life, taking into consideration environmental requirements.

3.25 The manufacturer should be responsible for ensuring the continued availability of spare parts required for maintenance for a period not less than 10 years from the date of the final manufacture of the instrument transformer.

3.26 The manufacturer of the equipment covered by this specification shall provide a guarantee for that equipment. The guarantee period that the manufacturer warrants will be a minimum of five (5) years from the date of completion of commissioning of the relevant plant / equipment.

3.27 Drawings

3.27.1 The manufacturer shall provide the following drawings for approval within one month of the commencement date of the contract or by mutually agreed date at the placement of the order:

- General Arrangement of each instrument transformer
- Schematic Diagram for each instrument transformer
- Wiring diagram for each instrument transformer

3.27.2 Once approval has been obtained an additional copy of the drawings shall be provided.

3.27.3 All drawings shall be provided electronically in .dwg CAD and .pdf format.

3.28 Facility to install power quality monitoring sensors shall be provided for fitting in the factory or at site. As per IEC 61000-4

3.28.1 Sensors shall where required be fitted to each unit.

3.28.2 Wiring shall be suitable to and long enough to reach the sensor and the marshalling box and have suitable mechanical protection and be of SWA construction.

3.28.3 Wring diagrams shall be provided for NGED approval

3.28.4 Installation methods shall be provided to NGED for approval including testing procedures

3.28.5 PQ sensor specification

- Input signal from measurement unit in CVT earth connections
- Output Signal 63.5V at nominal voltage
- Output signal (optional) 16mA into 75R (1.2V) at nominal voltage
- Output signal gain error <0.2% at nominal frequency
- Temp range -20 to +55 degrees C
- Supply Voltage 110, 220Vac ($\pm$10%), 85-260Vdc
- IP rating 65
- Harmonic Measurement error <3% to 2.5kHz: <5%to 5kHz
- Frequency response 5Hz to 6kHz
- Phase angle error <6degrees

3.28.6 Test certificates are required

3.29 Test Certificates

The manufacturer shall supply copies of the instrument transformer test certificates in PDF format by electronic mail to the NGED project manager in advance of delivery.

A hard copy of the test certificates shall accompany each instrument transformer.

4.0 CURRENT TRANSFORMERS

4.1 Terminal Connections

4.1.1 Terminal palms size 2 to clause 3.1.2 and Figure 1 of ENATS 41-16 are required.

4.1.2 Where these cannot be provided the Tenderer shall specify what is offered.

4.2 CT secondary windings shall be supplied with a removable factory fitted short in the terminal box.

4.3 All connections from secondary windings shall be brought out and taken to an accessible terminal board to permit testing of individual CTs.

4.4 Current transformer secondary windings shall have a bare wire diameter (copper) of not less than 0.8mm.

4.5 Rated short-time withstand current

The rated short-time withstand current (ENATS 41-36 cl 1.4.5) shall be a minimum of 31.5kA with 40kA preferred. The value of rated duration of short circuit shall be 3s.

4.6 Rated insulation levels

4.6.1 The insulation requirements for secondary terminals shall be to clause 5.3.5 of IEC 61869-1:2007 with the addition that the secondary winding insulation of class PX and class PXR current transformers having a rated knee point emf Ek ≥ 2 kV shall be capable of withstanding a rated power frequency withstand voltage of 5 kV r.m.s. for 60 s.

4.6.2 The rated withstand voltage for inter-turn insulation shall be 4.5 kV peak. For class PX and class PXR current transformers having a rated knee point emf of greater than 450 V, the rated withstand voltage for the inter-turn insulation shall be a peak voltage of 10 times the r.m.s. value of the specified knee point emf, or 10 kV peak, whichever is the lower.

4.7 Rated output

The rated output shall be 30VA.

4.8 Rated primary current

The rated primary current shall be 2000A or, 1250A to match the full current rating of the primary conductor or an adjacent circuit breaker (whichever is the higher). This will be specified at time of order.

4.9 Rated secondary current

The rated secondary current shall be 1A.

4.10 Rated continuous thermal current (I_{cth})

For measuring CTs the rated continuous thermal current shall be 120% of the rated primary current (I_{pr}) of the CT.

4.11 Ratio

4.11.1 The customary protection current transformer turns ratios are 1000/1 and 500/1.

4.11.2 Alternative ratios, VA ratings and Class may be required for some CTs to match those at existing substations for specific protection scheme requirements and these will be specified at time of order.

4.11.3 Where dual ratio CTs are specified the required class, accuracy and VA rating applies to both ratios, unless otherwise stated.

4.12 Additional current transformers for dedicated indication use.

4.12.1 Where additional current transformers are required for dedicated indication purposes they shall be Class 0.5S.

4.12.2 Their ratio shall be 1000/1.

4.12.3 Their rated burden shall be 15VA.

4.13 Additional current transformers for customer Import/Export limitation Schemes and/or G99 monitoring systems

4.13.1 Where current transformers are required for use with customer Import/Export Limitation Schemes and/or monitoring systems required by Engineering Recommendation G99 “Requirements for the connection of generation equipment in parallel with public distribution networks”, then these should meet the requirements of both measurement Class 0.2 and protection class 5P20.

4.13.2 Their ratio shall be 1000/1.

4.13.3 Their rated burden shall be 15VA.

4.14 Additional protection current transformers for customer sole use
Where a customer requires specific current transformers as part of their equipment protection scheme (eg. transformer protection) then these may be provided to customer specification and at customer cost.

4.15 Where additional current transformers as in 4.12, 4.13 and/or 4.14 above are required, then their provision can only be accomplished provided that it does not compromise the specific current transformer ratios, class and ratings etc required for NGED use.

4.16 CT requirements are summarised in Schedule A.

4.17 Class P secondary winding

The rated accuracy of the current transformer shall be 5P20.

4.18 Class PX secondary winding

4.18.1 The minimum knee point requirements for CT’s with a 1A secondary rating are specified below, where:

VK = Knee point voltage

RCT = DC secondary resistance of the CT

N = Ratio of the CT (i.e. primary current / rated secondary current)

4.18.2 CT’s for Current Differential Protection, Distance Protection or High Impedance Busbar Protection:

$VK \geq (286000 + 193000Rct)/N$ [for 25kA or 31.5kA rated short-time withstand current]

$VK \geq (326000 + 220000Rct)/N$ [for 40kA rated short-time withstand current]

4.18.3 CT’s for Transformer Bias Differential or Transformer Restricted Earth Fault Protection

$VK \geq (38000 + 26000Rct)/N$ [for 25kA, 31.5kA & 40kA rated short-time withstand current]

4.18.4 For CT's with an alternative secondary rating, the minimum knee point requirement shall be calculated in accordance with the protection relay manufacturer's recommendations.

4.18.5 Where multi-ratio CT's are specified the knee point requirements shall be satisfied on each CT ratio.

4.18.6 In addition to the knee point requirements, the magnetising current for each CT shall be less than 50mA at the CT's knee point voltage. This requirement must be satisfied for each CT ratio.

4.19 Metering Current Transformers

4.19.1 Metering current transformers shall have independent cores and secondary windings from those provided for protection purposes.

4.19.2 Where dual ratio CTs are specified the required class, accuracy and VA rating applies to both ratios, unless otherwise stated.

4.19.3 For rated circuit capacities up to 100 MVA, one dedicated winding for settlement metering is required.

4.19.4 For rated circuit capacities of more than 100 MVA two windings for metering are required:

a) Dedicated winding for Main meter

b) Check meter winding which can also be used for other purposes, provided overall accuracy is met and the burden of the additional load is known. (The additional burden must not be changed without the approval of the Settlement System Administrator).

4.19.5 All metering current transformers shall be to Class 0.2S rated at 15 VA unless otherwise specified.

4.19.6 The following metering CT ratios shall be available for selection as required:

200/100/1

300/150/1

400/200/1

600/300/1

800/400/1

2000/1200/1

4.19.7 Metering current transformers shall be tested to confirm compliance with BSEN 60044-1 but shall also be error tested on each ratio at 7.5VA 0.9 power factor lagging burden at 5%, 20%, 100% and 120% test load points.

4.19.8 Electronic copies of the of test certificates in PDF format, including any error tests used as the basis of the calculations described above, shall be provided in advance of delivery for each metering current transformer. These shall be sent to the NGED project engineer by electronic mail.

A hard copy of the test certificate/s shall accompany any instrument transformer in which a metering current winding is installed.

4.20 Markings

4.20.1 The terminal markings shall identify the:

a) primary and secondary windings;

b) winding sections, if any;

c) relative polarities of windings and winding sections;

d) intermediate taps, if any.

4.20.2 The marking shall consist of letters followed, or preceded where necessary, by numbers. The letters shall be in block capitals. [BSEN 61869-2; 6.13.201]

4.20.3 The markings shall be as indicated in Table 208 of BSEN 61869-2 clause 6.13.201.3.

4.21 Rating plate markings

4.21.1 In addition to those markings defined in BSEN 61869-1 Clause 6.13, all current transformers shall carry the general rating plate markings as defined in this clause.

a) the rated primary and secondary current (e.g. 100/1 A);

b) the rated short-time thermal current (Ith), (e.g. Ith = 40 kA);

c) the rated dynamic current (Idyn) if it differs from 2,5 × Ith (e.g. Idyn = 85 kA);

d) on current transformers with two or more secondary windings, the use of each winding and its corresponding terminals;

e) the rated continuous thermal current if different from the rated primary current.

4.21.2 A current transformer satisfying the requirements of several combinations of output and accuracy class may be marked according to all of them.

4.21.3 Equipment shall be subject to a series of tests as detailed in BSEN 61869-2 clause 7. The minimum tests required by NGED are detailed in Table 5 below:-

T e s t s	**Subclause**
Type tests	**7.2**
Temperature-rise test	7.2.2
Impulse voltage test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Test for accuracy	7.2.6
Verification of the degree of protection by enclosures	7.2.7
Enclosure tightness test at ambient temperature	7.2.8
Short-time current tests	7.2.201
Routine tests	**7.3**
Power-frequency voltage withstand tests on primary terminals	7.3.1
Partial discharge measurement	7.3.2

Tests	Subclause
Power-frequency voltage withstand tests between sections	7.3.3
Power-frequency voltage withstand tests on secondary terminals	7.3.4
Test for accuracy	7.3.5
Verification of markings	7.3.6
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Table 5 Type and Routine Tests for Current Transformers

5.0 CAPACITOR VOLTAGE TRANSFORMERS

5.1 General

This section covers single phase oil insulated outdoor capacitor voltage transformers used for protection purposes.

5.2 Secondary Connections

5.2.1 Voltage transformer secondary fuses and links shall be contained in a separate box, so placed as to permit changing of fuses with equipment alive. Both secondary terminals shall be insulated for a 2kV withstand test.

5.2.2 Where voltage transformers are fitted on two or three phases of a circuit, a single terminal box per circuit is required to facilitate single point earthing of secondary circuits. This shall be wired in accordance with Engineering Recommendation S15, and shall be padlockable.

5.2.3 Both ends of all secondary windings shall be brought out through fuses and links situated in the single terminal box per circuit.

5.2.4 Where individual phases have been provided with their own terminal box in addition to the above single terminal box, isolation links only shall be provided.

5.2.5 The secondary windings shall be connected to the appropriate circuits through fuses and links, labelled to indicate their functions and phase colour to be marked in accordance with BS EN 60445

5.3 Ratings

5.3.1 Rated Output

100VA at a power factor of 0.8 lagging.

5.3.2 Rated Accuracy Class

The rated accuracy class shall be Class 1/3P.

5.3.3 Rated Primary Voltage

132,000V

5.3.4 Rated Secondary Voltages

110V

5.3.5 Rated Secondary Voltage for Residual Voltage Windings

63.5V

5.4 All windings shall be rated for a voltage factor of 1.5 for 30 seconds.

5.5 Voltage transformers shall have their rated transformation ratios and voltages shown on drawings, diagrams and rating plates as shown in Table 6.

System Voltage	Primary Winding	Secondary Windings		
		Protection	Metering	Residual[1]
	Voltage (Upn)	Voltage (Usn)	Voltage (Usn)	Voltage (Usn)
132kV	132,000/√3	110/√3	110/√3	110/3

Table 6 VT Ratios

Note 1: Residual voltage windings shall be connected to form a broken delta that will provide an output voltage from the broken delta winding of 3 x 110/3 (i.e. 110 volts for a solid single phase earth fault close to the voltage transformer).

5.6 Secondary windings used for protection purposes shall be fused at 6A. VT residual windings shall be connected through removable links.

5.7 Terminal Connections

5.7.1 Terminal palms size 2 to clause 3.1.2 and Figure 1 of ENATS 41-16 are required.

5.7.2 Where these cannot be provided the Tenderer shall specify what is offered

5.8 Terminal Markings

Primary winding terminals shall be marked in capital letters A, B, C and N (denoting a terminal intended to be earthed) and a, b, c, n denoting the corresponding secondary terminals.

Terminals intended to supply a residual voltage shall be marked da and dn.

[As indicated in Figures 502, 503, 504 and 505 of BSEN 61869-5.]

5.9 Rating Plate Markings

In addition to those markings stated in BSEN 61869-1, the voltage transformer shall carry the following markings:

- Rated primary and secondary voltage;
- Rated output and the corresponding accuracy class for each separate secondary winding;
- Rated voltage factor and time.

5.10 Test

Equipment shall be subject to a series of tests as detailed in BSEN 61869-5 clause 7.

The minimum tests required by NGED are detailed in Table 7 below:-

T e s t s	**Subclause**
Type tests	**7.2**
Temperature-rise test	7.2.2
Impulse voltage test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Test for accuracy	7.2.6
Verification of the degree of protection by enclosures	7.2.7
Enclosure tightness test at ambient temperature	7.2.8
Short-time current tests	7.2.201
Pressure test for the enclosure	7.2.9
Short-circuit withstand capability test	7.2.301
Routine tests	**7.3**
Power-frequency voltage withstand tests on primary terminals	7.3.1
Partial discharge measurement	7.3.2
Power-frequency voltage withstand tests between sections	7.3.3
Power-frequency voltage withstand tests on secondary terminals	7.3.4
Test for accuracy	7.3.5
Verification of markings	7.3.6
Enclosure tightness test at ambient temperature	7.3.7
Pressure test for the enclosure	7.3.8
Special Tests	
Chopped impulse voltage withstand test on primary terminals	7.4.1
Multiple chopped impulse test on primary terminals	7.4.2
Measurement of capacitance and dielectric dissipation factor	7.4.3
Transmitted overvoltage test	7.4.4
Mechanical tests	7.4.5
Internal arc fault test	7.4.6

Table 7 Type and Routine Tests for Capacitive Voltage Transformers

6.0 INDUCTIVE VOLTAGE TRANSFORMERS

6.1 General

This section covers single phase oil insulated outdoor inductive voltage transformers used for protection and metering purposes.

6.2 Voltage Transformers for Metering Purposes

6.2.1 Inductive type voltage transformers shall be used for settlement metering purposes.

6.2.2 For circuit capacities between 10MVA and 100MVA shall be to Class 0.5 and have two windings, either

a) 1 dedicated winding for Main and Check metering with other burdens on the second winding, or

b) 1 dedicated winding for Main and a second for Check, which may be shared with other burdens providing overall accuracy is met. (The additional burden must not be changed without the approval of the Settlement System Administrator).

6.2.3 For circuit capacities above 100MVA shall be to Class 0.2 and have two windings:

a) Dedicated winding for Main meter

b) Check meter winding which can also be used for other purposes, provided the overall accuracy is met and the burden of the additional load is known. (The additional burden must not be changed without the approval of the Settlement System Administrator).

6.3 Secondary Connections

6.3.1 Voltage transformer secondary fuses and links shall be contained in a separate box, so placed as to permit changing of fuses with equipment alive. Both secondary terminals shall be insulated for a 2kV withstand test.

6.3.2 Where voltage transformers are fitted on two or three phases of a circuit, a single terminal box per circuit is required to facilitate single point earthing of secondary circuits. This shall be wired in accordance with Engineering Recommendation S15, and shall be padlockable.

6.3.3 Both ends of all secondary windings shall be brought out through fuses and links situated in the single terminal box per circuit.

6.3.4 Where individual phases have been provided with their own terminal box in addition to the above single terminal box, isolation links only shall be provided.

6.3.5 The secondary windings shall be connected to the appropriate circuits through fuses and links, labelled to indicate their functions and phase colour to be marked in accordance with BS EN 60445.

6.3.6 Separate fusing shall be provided for:

a) Main meter

b) Check meter

c) Any additional burden

These fuses must be as close as practical to the VT and must be readily accessible with the VT in service.

6.4 Ratings

6.4.1 Rated Output

100VA at a power factor of 0.8 lagging.

Residual voltage winding – 50VA at unity power factor.

6.4.2 Rated Accuracy Class

All Star connected windings shall satisfy the rated accuracy class requirements for both Class 3P and Class 0.5 irrespective of their intended use.

Residual voltage windings connected to form a broken delta shall be Class 3P but are not required to satisfy Class 0.5

6.4.3 Rated Primary Voltage

132,000V

6.4.4 Rated Secondary Voltages

110V

6.4.5 Rated Secondary Voltage for Residual Voltage Windings

63.5V

6.5 All windings shall be rated for a voltage factor of 1.5 for 30 seconds.

6.6 Voltage transformers shall have their rated transformation ratios and voltages shown on drawings, diagrams and rating plates as shown in Table 8.

System Voltage	Primary Winding	Secondary Windings		
		Protection	Metering	Residual[1]
	Voltage (Upn)	Voltage (Usn)	Voltage (Usn)	Voltage (Usn)
132kV	132,000/√3	110/√3	110/√3	110/3

Table 8 VT Ratios

Note 1: Residual voltage windings shall be connected to form a broken delta that will provide an output voltage from the broken delta winding of 3 x 110/3 (i.e. 110 volts for a solid single phase earth fault close to the voltage transformer).

6.7 Secondary windings used for protection and metering purposes shall be fused at 6A. VT residual windings shall be connected through removable links.

6.8 Metering VTs

6.8.1 Voltage transformers used for settlement metering purposes.

6.8.2 Metering VTs shall be error tested by the manufacturer. In all cases individual test certificates shall be provided.

6.8.3 All metering VT test certificates shall include tests to confirm compliance with BSEN 61869-3.

6.8.4 In addition, VT errors shall be supplied on brown/black (L1/L2) and black/grey (L2/L3) phases at 10VA 0.5 power factor lagging burden. These additional VT errors shall either be separately tested or alternatively calculated from other error test results.

6.8.5 Electronic copies of the of test certificates in PDF format, including any error tests used as the basis of the calculations described above, shall be provided in advance of delivery for each metering voltage transformer. These shall be sent to the NGED project engineer by electronic mail.

6.8.6 A hardcopy of the test certificates shall also be dispatched with the voltage transformer.

6.9 Terminal Connections

6.9.1 Terminal palms size 2 to clause 3.1.2 and Figure 1 of ENATS 41-16 80mm are required.

6.9.2 Where these cannot be provided the Tenderer shall specify what is offered

6.10 Terminal Markings

Primary winding terminals shall be marked in capital letters A, B, C and N (denoting a terminal intended to be earthed) and a, b, c, n denoting the corresponding secondary terminals.

Terminals intended to supply a residual voltage shall be marked da and dn.

[As indicated in Figures 301, 304, 306, 308 and 309 of BSEN 61869-3.]

6.11 Rating Plate Markings

In addition to those markings stated in BSEN 61869-1, the voltage transformer shall carry the following markings:

- Rated primary and secondary voltage;
- Rated output and the corresponding accuracy class for each separate secondary winding;
- Rated voltage factor and time.

6.12 Test

Equipment shall be subject to a series of tests as detailed in BSEN 61869-3 clause 7.

The minimum tests required by NGED are detailed in Table 9 below:-

T e s t s	Subclause
Type tests	**7.2**
Temperature-rise test	7.2.2
Impulse voltage test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Test for accuracy	7.2.6
Verification of the degree of protection by enclosures	7.2.7
Enclosure tightness test at ambient temperature	7.2.8
Short-time current tests	7.2.201
Pressure test for the enclosure	7.2.9
Short-circuit withstand capability test	7.2.301
Routine tests	**7.3**
Power-frequency voltage withstand tests on primary terminals	7.3.1
Partial discharge measurement	7.3.2
Power-frequency voltage withstand tests between sections	7.3.3
Power-frequency voltage withstand tests on secondary terminals	7.3.4
Test for accuracy	7.3.5
Verification of markings	7.3.6
Enclosure tightness test at ambient temperature	7.3.7
Pressure test for the enclosure	7.3.8
Special Tests	
Chopped impulse voltage withstand test on primary terminals	7.4.1
Multiple chopped impulse test on primary terminals	7.4.2
Measurement of capacitance and dielectric dissipation factor	7.4.3
Transmitted overvoltage test	7.4.4
Mechanical tests	7.4.5
Internal arc fault test	7.4.6

Table 9 Type and Routine Tests for Inductive Voltage Transformers

7.0 COMBINED UNIT INSTRUMENT TRANSFORMERS

7.1 This type of instrument transformer contains both inductive voltage transformer and current transformer elements in a single unit.

7.2 They are normally used for high accuracy boundary metering purposes between adjoining licence areas or at connections to the National Grid electricity transmission network.

7.3 These units will not be used for general customer metering purposes with a separate inductive VT and dead tank circuit breaker being the required NGED option.

7.4 Combined unit instrument transformers shall follow the requirements of Section 4 and Section 6 in this document above.

7.5 High accuracy metering voltage transformers shall maintain the accuracy classes and burdens as for inductive voltage transformers above, in addition to providing a metering accuracy of Class 0.2 at 15VA.

8.0 RESISTOR CAPACITOR VOLTAGE TRANSFORMERS

8.1 Resistor Capacitor Voltage Transformers (RCVT) can be used to provide accurate power quality measurements up to a high frequency, typically 0Hz to 1MHz, with a high level of accuracy (+/- 0.2%) in the range 15Hz to 10kHz. They may sometimes be referred to as Voltage Dividers.

For comparison the harmonic measurement range of inductive voltage transformers is typically 20Hz to 1.5kHz at varying levels of accuracy which reduces significantly as the frequency increases away from the fundamental frequency.. Capacitor voltage transformers are only accurate at their fundamental frequency ie 50Hz. Capacitor voltage transformers (CVT) equipped with a PQ-Sensor module have a measurement limit of 5kHz and a typical accuracy of <3% up to 2.5kHz and then <5% up to 5kHz.

[*Note: Voltage dividers based on resistance only will not provide accurate harmonic measurement and shall not be used as an alternative to an RCVT device.]*

8.2 RCVT have low burden values (typically 0VA to 3VA) so that load applied needs to have a high impedance typically in the very high kΩ range. They are therefore not suitable for protection applications.

8.3 Some voltage dividers and RCVT may have to be calibrated to a certain test instrument and connecting lead; however there are types available that may allow for some re-adjustment on site.

8.4 This section of the EESPEC will be further developed and issued when a need for these devices is identified within NGED.

Extract from BS EN 61000-4-30 Annex 3

A.3.3 Frequency response of transducers

A.3.3.1 Frequency and phase response of voltage transducers
In general, transformer-type electromagnetic voltage transducers have frequency and transient responses suitable up to typically 1 kHz; but the frequency range may sometimes be limited to well below 1 kHz, and sometimes may extend to a few kilohertz.

Simple capacitor dividers can have frequency and phase responses that are suitable up to hundreds of kilohertz or even higher; however, in many applications, a resonant circuit is intentionally added, making the frequency response of the capacitive divider unsuitable for measurements at any frequency other than the fundamental.

Resistive voltage dividers may have frequency and phase response suitable up to hundreds of kilohertz. However, they may introduce other problems, for example, the capacitive load of the measurement instrument can influence the frequency and phase response of the resistive voltage dividers.

A.3.3.2 Frequency and phase response of current transducers
As current transformers are wound electromagnetic devices, the frequency response varies according to the uncertainty class, type (manufacturer), turns ratio, core material and cross-section, and the secondary circuit load.

Usually, the cut-off frequency of a current transducer ranges from 1 kHz to a few kilohertz, and the phase response degrades as the cut-off frequency is approached.

ASSUMPTIONS FOR MINIMUM KNEE POINT CALCULATIONS FOR CLASS PX CURRENT TRANSFORMERS

The Class PX current transformer minimum knee-point calculations are based on the following assumptions:

- A maximum multicore length 100m (of 2.5mm2 copper multicore).

  [*Note:- Longer multicore lengths can be accommodated by increasing the cross-section or by doubling up on the cores*.]

- The current transformer secondary resistance (for individual current transformers) is up to 5 ohms.

- The fault level at the circuit breaker is equal to the circuit breaker rated short-circuit breaking current (40kA or 31.5kA) with a network X/R ratio of 10.

  [*Note:- The impact of higher X/R ratios are mitigated to some extent by the assumed minimum circuit impedance*.]

- Operating at nominal voltage.

- The minimum circuit impedance for feeder protection (e.g. at end of Zone 1 reach = 0.5 ohms at 65°C).

- The maximum through fault current (referred to HV side of transformer) for a transformer bias differential protection and transformer restricted earth fault protection (REF) is based on ENA TS 48-3 (i.e. 16x transformer rating).

APPENDIX B

SUPERSEDED DOCUMENTATION

This is a new specification that supersedes relevant sections in EE SPEC: 7.

EESPEC 7 will be withdrawn once all sections are covered by new EE SPECs.

APPENDIX C

RECORD OF COMMENTS DURING CONSULTATION

Comments – EE SPEC: 174/0

APPENDIX D

ASSOCIATED DOCUMENTATION

ENA TS 41-37 Part 1	Switchgear for use on 66kV and 132kV distribution systems – Common clauses.
ENA TS 41-37 Part 5	Switchgear for use on 66kV and 132kV distribution systems – Inductive voltage transformers, capacitor voltage transformers, combined unit transformers and current transformers.
ENA TS 41-24	Guidelines for design, installation, testing and maintenance of main earthing systems in substations
ENA TS 41-38	Power installations exceeding 1kVac – Design of high-voltage open-terminal stations
ENA TS 50-18	Application of ancillary electrical equipment
EE SPEC: 136	Ancillary Electrical Equipment for Use in Conjunction with Switchgear and Protection/Control Panels

APPENDIX E

KEY WORDS

Instrument Transformer, Current Transformer, Voltage Transformer, Resistor Capacitor Voltage Transformer, Structure Mounted, CT, VT, RCVT, IT.

SCHEDULE A

CURRENT TRANSFORMER – SUMMARY OF TECHNICAL PARAMETERS

Information	
Particulars of System	
Voltage(kV)	132
Frequency (Hz)	50
Number of phases	3
Neutral earthing	Solid
Current Transformer Characteristics	
Class	Outdoor -25ºC +40ºC
Nominal Voltage U_n (kV)	132
Rated Voltage U_m (kV)	145
Rated frequency (Hz)	50
Rated power frequency withstand voltage U_d (kV)	275
Rated lightning impulse withstand voltage (peak) (kV)	650
Rated Normal current (A)	1250 or 2000
Rated continuous thermal current (A)	To match values above
Rated short-time withstand current (kA)	40
Rated duration of short circuit (sec)	3
Site pollution severity class	e or IV Very Heavy

Other NGED Requirements	
Number of multicore cables to be terminated	
Number of secondary terminals required to terminate multicore cable cores	

Supplier To Declare	
Terminal connections	
Insulation medium	
Mass of complete unit (kg)	
Maximum dynamic floor/support loading(s) (kN)	
Maximum terminal loadings (kg)	
Dimensions (m)	
Insulator material	
Insulator shed arrangement	

Typical Protection CT Winding Arrangements for Post CTs

	Protection Application			
	Bus Section	Transformer	Feeder – Unit	Feeder - Distance
P1	PX 500/1	PX 500/1	PX 500/1	PX 500/1
	5P20 1000/1	5P20 1000/1	5P20 1000/1	5P20 1000/1
	5P20 1000/1	5P20 1000/1	5P20 1000/1	5P20 1000/1
			PX 500/1	PX 500/1
P2				

SCHEDULE B

CAPACITIVE VOLTAGE TRANSFORMER – SUMMARY OF TECHNICAL PARAMETERS

Information	
Particulars of System	
Voltage(kV)	132
Frequency (Hz)	50
Number of phases	3
Neutral earthing	Solid
Voltage Transformer Characteristics	
Class	Outdoor -25ºC +40ºC
Nominal Voltage U_n (kV)	132
Rated Voltage U_m (kV)	145
Rated frequency (Hz)	50
Rated power frequency withstand voltage U_d (kV)	275
Rated lightning impulse withstand voltage (peak) (kV)	650
Voltage Factor	1.5 for 30 seconds
Site pollution severity class	e or IV Very Heavy
Altitude	<1000m

Other NGED Requirements	
Number of multicore cables to be terminated	
Number of secondary terminals required to terminate multicore cable cores	

Supplier To Declare	
Terminal connections	
Insulation medium	
Mass of complete unit (kg)	
Maximum dynamic floor/support loading(s) (kN)	
Maximum terminal loadings (kg)	
Dimensions (m)	
Insulator material	
Insulator shed arrangement	

Typical CVT Protection Requirements

	Primary Winding	Secondary Windings	Class	VA Rating
	Voltage (Upn)	Voltage (Usn)		
	132,000/√3	**110/√3**	**1/3 P**	**100**

SCHEDULE C

INDUCTIVE VOLTAGE TRANSFORMER – SUMMARY OF TECHNICAL PARAMETERS

Information	
Particulars of System	
Voltage(kV)	132
Frequency (Hz)	50
Number of phases	3
Neutral earthing	Solid
Voltage Transformer Characteristics	
Class	Outdoor -25ºC +40ºC
Nominal Voltage U_n (kV)	132
Rated Voltage U_m (kV)	145
Rated frequency (Hz)	50
Rated power frequency withstand voltage U_d (kV)	275
Rated lightning impulse withstand voltage (peak) (kV)	650
Voltage Factor	1.5 for 30 Seconds
Site pollution severity class	e or IV Very Heavy
Altitude	<1000m

Other NGED Requirements	
Number of multicore cables to be terminated	
Number of secondary terminals required to terminate multicore cable cores	

Supplier To Declare	
Terminal connections	
Insulation medium	
Mass of complete unit (kg)	
Maximum dynamic floor/support loading(s) (kN)	
Maximum terminal loadings (kg)	
Dimensions (m)	
Insulator material	
Insulator shed arrangement	

Typical Inductive VT Requirements

Metering (circuit capacity 10MVA to 100MVA)

Option 1

Application	**Primary Winding Voltage (Upn)**	Secondary Windings Voltage (Usn)	Class	VA Rating
Main & Check Metering	132,000/√3	**110/√3**	**0.5**	**100**
Other	132,000/√3	**110/√3**	**0.5**	**100**

Option 2

Application	**Primary Winding Voltage (Upn)**	Secondary Windings Voltage (Usn)	Class	VA Rating
Main Metering	132,000/√3	**110/√3**	**0.5**	**100**
Check Metering & Other	132,000/√3	**110/√3**	**0.5**	**100**

Metering (circuit capacity above 100MVA)

Application	**Primary Winding Voltage (Upn)**	Secondary Windings Voltage (Usn)	Class	VA Rating
Main Metering	132,000/√3	**110/√3**	**0.2**	**100**
Check Metering & Other	132,000/√3	**110/√3**	**0.2**	**100**

SCHEDULE D

RESISTOR CAPACITOR VOLTAGE TRANSFORMER – SUMMARY OF TECHNICAL PARAMETERS

Information	
Particulars of System	
Voltage(kV)	132
Frequency (Hz)	50
Number of phases	3
Neutral earthing	Solid
Voltage Transformer Characteristics	
Class	Outdoor -25ºC +40ºC
Nominal Voltage U_n (kV)	132
Rated Voltage U_m (kV)	145
Rated frequency F_n (Hz)	50
Rated power frequency withstand voltage U_d (kV)	275
Rated lightning impulse withstand voltage (peak) (kV)	650
Voltage Factor	1.5 for 30 seconds
Site pollution severity class	e or IV Very Heavy
Insulator material	Composite
Insulator shed arrangement	Alternating
Altitude	<1000m
Accuracy	0.1% at F_n / 0.2% in extended frequency band
Expanded frequency band (Hz)	15 - 10000
Burden	R or R//C
Burden range	≥ 100kΩ
Primary voltage	132,000/√3
Secondary voltage	110/√3
Nominal cable length (m)	60

Other NGED Requirements	
Number of multicore cables to be terminated	
Number of secondary terminals required to terminate multicore cable cores	

Supplier To Declare	
Terminal connections	
Insulation medium	
Mass of complete unit (kg)	
Maximum dynamic floor/support loading(s) (kN)	
Maximum terminal loadings (kg)	
Dimensions (m)	