

CURRENT TRANSFORMERS FOR PROTECTION AND GENERAL USE

This document is for internal and contract specific use only.

Disclaimer

NGG and NGET or their agents, servants or contractors do not accept any liability for any losses arising under or in connection with this information. This limit on liability applies to all and any claims in contract, tort (including negligence), misrepresentation (excluding fraudulent misrepresentation), breach of statutory duty or otherwise. This limit on liability does not exclude or restrict liability where prohibited by the law nor does it supersede the express terms of any related agreements."

TABLE OF CONTENTS

PURPOSE AND SCOPE.....	1
PART 1 – PROCEDURAL	1
1 GENERAL REQUIREMENTS	1
2 PERFORMANCE REQUIREMENTS.....	4
3 TESTING REQUIREMENTS	4
4 FORMS AND RECORDS	7
PART 2 - DEFINITIONS AND DOCUMENT HISTORY	7
5 DEFINITIONS	7
6 AMENDMENTS RECORD	7
7 IMPLEMENTATION.....	8
PART 3 - GUIDANCE NOTES AND APPENDICES	8
8 REFERENCES	8
APPENDIX A CURRENT TRANSFORMER (CT) ACCOMMODATION.....	10
APPENDIX B TABLE OF PARTICULARS FOR 420KV, 300KV, 145KV AND LOWER VOLTAGE CURRENT TRANSFORMERS	13
APPENDIX C TABLE OF PARTICULARS FOR ASSET REPLACEMENT OF 420 KV, 300 KV AND 145 KV CURRENT TRANSFORMERS IN ASSOCIATION WITH SCHEMES 15822, 30671 & 32382 AND STRATEGIC SPARES ONLY	16
APPENDIX D FEEDER CIRCUITS 400KV AND 275KV	17
APPENDIX E 13KV TERTIARY EQUIPMENT	20
APPENDIX F SERIES REACTORS	23
APPENDIX G SHUNT REACTORS	25
APPENDIX H BUS SECTIONS AND BUS COUPLERS, ALSO OTHER USER CT'S AT CONNECTION POINTS AND ASSOCIATED WITH NGC BUSBAR PROTECTION.....	28
APPENDIX I AUTO TRANSFORMER CIRCUITS	29
APPENDIX J TRANSFORMER NEUTRAL AND NEUTRAL END CURRENT TRANSFORMER UNITS FOR USE WITH SUPERGRID AUTO TRANSFORMERS	31
APPENDIX K SECONDARY RATINGS AND RATED TRANSFORMATION RATIOS FOR DOUBLE WOUND TRANSFORMER CURRENT TRANSFORMER CIRCUITS.....	35

PURPOSE AND SCOPE

This document defines the functional and performance requirements for current transformers (CTs) for protection and general use on the National Grid (NGET) Electricity Transmission System UK. It supports the more general requirements defined in TS 1, TS 2.1 and TS 2.2.

For CTs used in Settlement Metering applications reference should be made to TS 3.2.6.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

Current transformers shall comply with TS 1, TS 2.1, TS 2.2, BS EN 61869-1 and BS EN 61869-2. In addition, the following clauses apply:

1.1 General Requirements for all Current Transformers

Secondary ratings, transformation ratios and characteristics shall be selected from the attached Appendices.

Requirements for protection Class PX cores are given in BS EN 61869-2

A single secondary terminal box shall be mounted on the transformer to accommodate the necessary secondary terminal connections.

Current transformer secondary terminals shall be of stud type and allow the application of shorting/earthing links or wiring for maintenance purposes. Separately, a terminal for earthing purposes shall be provided within the terminal box and shall be clearly marked.

Secondary terminals and connections shall be suitable for their required purpose regarding rating, reliability and the effects of environmental conditions, corrosion and vibration, and shall meet the requirements of TS 2.19.

Cable entries shall be in accordance with the requirements of TS 2.19 and shall be constructed of suitable material considering the effects of environmental conditions and corrosion.

Secondary terminal boxes shall have a degree of protection of at least IP54 as defined in BS EN 60529 as required by TS 1. Suitable materials shall be chosen for the construction of the terminal boxes considering the effects of environmental conditions and corrosion.

Primary and secondary terminal markings, and rating plate markings shall be in accordance with BS EN 61869-1 with the additional requirements given in BS EN 61869-2.

The rated continuous primary current of the current transformer shall be chosen to exceed the maximum continuous rating of the associated circuit and shall be selected from the standard values detailed in BS EN 61869-2.

A thermal short-time current rating (I_{th}) shall be assigned to all current transformers in accordance with BS EN 61869-2. The value of I_{th} shall not be less than the corresponding value for the associated switchgear or transformer primary plant.

For all oil filled CTs the supplier shall declare the type of insulating oil being used.

For oil-filled equipment fitted with an external oil expansion system, means shall be provided to give a permanent visual indication of the volume of the oil. The status of the indicator should be visible from ground level.

For oil filled CTs where the oil expansion system is wholly internal ie gas cushion or flexible diaphragm, the CT shall be fitted with a permanent internal pressure indicator. The status of the indicator shall be visible from ground level.

All oil filled CTs shall be fitted with an oil sample valve suitable for taking oil samples for Dissolved Gas Analysis (DGA) in accordance with BS EN 60567. The sample valve shall be situated on the earthed base tank of the CT. Valves where the oil is extracted by using a hypodermic needle or other specialist equipment are not acceptable. The CT design shall have sufficient oil capacity to allow 1 litre of oil to be extracted over the lifetime of the CT for dissolved gas analysis purposes.

Both ends of the CT secondary windings shall be earth free.

1.2 Additional Requirements for Post-Type Current Transformers

The core configurations preferred order is detailed in Appendix A

External insulation shall comply with TS 3.1.7.

An insulation test terminal (test tap) shall be provided for the purpose of performing capacitance and dielectric loss (tan delta) measurements of the primary insulation during routine maintenance. The test terminals shall be suitably identified.

The CT shall be provided with a suitable connection point for earthing the CT to the substation main earthing system. The point of connection shall be on the base of the CT and positioned as low as possible to permit removal and reconnection without infringement of the electrical safety clearances as defined in TS 2.1.

The CT shall be capable of withstanding the static and dynamic withstand loads in accordance with the Load Class II requirement of BS EN 61869-1.

The deflection at the primary terminals shall not exceed 50mm with the static withstand load applied.

The CT shall provide minimum Class I internal arc fault protection in accordance with BS EN 61869-1.

1.3 Additional Requirements for Current Transformers for GIS Application

The core configuration shall be in accordance with Appendix A

Current transformers may be mounted internally or externally to the GIS enclosure.

Adequate protection against adverse environmental conditions shall be provided for externally mounted CTs as required in TS 1

1.4 Additional Requirements for Ring-Type Current Transformers

The core configurations preferred order is detailed in Appendix A

Current transformers mounted internally to power transformers shall be capable of operating in an environment as detailed in TS 2.3.

Current transformers supplied as loose equipment for power transformer application shall be equipped with secondary terminals or shall be supplied with leads of suitable length for this application. Such leads shall be capable of satisfying the power frequency test requirement detailed in clause 3.3.

Current transformers supplied with through wall bushings can be mounted internally or externally to the bushing. Current transformers mounted internally shall be capable of operating within that environment. Current transformers mounted externally shall be suitably protected against the effects of adverse environmental conditions as required by TS 1.

1.5 Additional Requirements for Measurement/Protection and Class PX Protective Current Transformers

Measurement/Protection and class PX protective current transformers with a rated primary current of 2500 A or below and with untapped secondary windings shall have a rated secondary current of 1 A (as selected from BS EN 61869-2). The rated secondary current for current transformers of this primary rating with tapped secondary windings shall be 1 A corresponding to the highest transformation ratio.

Measurement/Protection and class PX protective current transformers with a rated primary current in excess of 2500 A shall have a rated secondary current selected from the values stated in BS EN 61869-2.

2 PERFORMANCE REQUIREMENTS

2.1 General

All current transformers shall comply with the performance requirements of BS EN 61869-1 and BS EN 61869-2 for the primary ratings detailed in TS 1, TS 2.1 and TS 2.2.

All CTs shall meet the rated continuous thermal current and short time overload ratings specified in the appendices.

The following requirements shall also apply as appropriate:

2.2 Protection Type PX-A Current Transformers

Protection type PX-A current transformers shall meet the requirements given in BS EN 61869-2 providing accurate transformation up to the maximum fault current rating of the associated main plant. This performance shall be maintained under both fault and steady-state conditions without saturation

Type PX-A current transformers shall also meet the performance requirements of Appendix B of this Specification.

2.3 Protection Type PX-B Current Transformers

Protection type PX-B current transformers shall meet the requirements given in BS EN 61869-2 providing accurate steady-state transformation up to the maximum fault current rating of the associated main plant.

Type PX-B current transformers shall also meet the performance requirements of Appendix B of this Specification.

2.4 Dual Purpose Measurement/Protection Current Transformers

Current transformers intended for the dual purpose of measurement and protection shall meet the performance requirements of BS EN 61869-2 and Appendix B of this Specification.

2.5 Interposing Current Transformers

Short duration overload capabilities assigned to the main current transformers and the associated interposing current transformers shall be capable of carrying the corresponding current.

3 TESTING REQUIREMENTS

3.1 Type Tests

All current transformers shall be tested in accordance with the Type and Special test requirements of BS EN 61869-2. Current transformers using a gas insulation system, a leakage test on the gas system shall be performed by the supplier to demonstrate compliance with TS 3.2.14

Testing requirements for protection Class

PX cores are given in BS EN 61869-2.

Radio interference voltage tests to BS EN 62271-1 are to be performed on open-terminal current transformers.

Mechanical tests – The test load shall be to Class II of BS EN 61869-1.

All oil filled current transformers rated at 72.5kV and above, shall be subject to a 600 chopped negative polarity impulse test in accordance with the special test requirements of BS EN 61869-1 in addition to the following requirements. The test level shall be 60% of the rated BIL level for that equipment. The time to chop shall be between 2 to 5 μ s. A full set of routine electrical tests shall be performed before and after the test. Oil samples for dissolved gas analysis shall be taken both before and 3 days after this test.

The three criteria that must all be satisfied for the current transformer to pass the test are:

- a) The results of the electrical tests, performed before and after the chopped impulse test, are the same within the error specification of the test field.
- b) No evidence of degradation is found when the current transformer is dismantled and examined after the test
- c) Any increases in the dissolved gas analysis levels are within the limits listed in Table 1.

Dissolved gas	Allowable increase after 3 days (ppm)
Hydrogen (H ₂)	5
Methane (CH ₄)	3
Ethane (C ₂ H ₆)	3
Ethylene (C ₂ H ₄)	2
Acetylene (C ₂ H ₂)	No detectable increase

Table 1 – Allowable Change in Dissolved Gas Concentrations for Multichopped Impulse Test

Temperature Rise - The thermal time constant of all equipment shall be determined on both rising and falling temperature.

Internal arc fault – the arc inception shall be located where the voltage gradient is highest. The containment area shall be as specified in BS EN 61869-1 cl. 7.4.6.

For oil filled equipment oil samples for DGA shall be taken before and after the dielectric type tests and shall comply with 3.4.

Accuracy at Short-Term Continuous Current Levels – All measurement/protection CTs shall meet the short term overload ratings given in Table1 of TS 2.1. The maximum short term continuous current shall be withstood for a period of 3 minutes. Current transformers which have a 5P10/5P20 classification shall have their composite errors determined by a direct test method.

Routine tests shall be performed before and after all tests.

3.2 Routine Tests

All current transformers shall be routine tested in accordance with:

BS EN 61869-2 (routine tests)

Requirements for protection class PX transformers are given in BS EN 61869-2.

3.3 Additional Routine Tests

Accuracy Tests shall be performed in a laboratory having traceability to National/International standards. The overall accuracy and uncertainty of the measurement shall be demonstrated prior to testing and shall be commensurate with the accuracy class of the transformer under test. Full accuracy routine tests shall be performed to BS EN 61869-2.

Capacitance and dielectric loss angle ($\tan \delta$) measurements of the primary insulation over the voltage range 10 kV to rated voltage shall be performed.

Leads for loose current transformers as detailed in clause 1.4 shall withstand a power frequency test voltage of 5 kV (peak). For PXA application, the test levels shall be determined by tests in BS EN 61869-2.

An oil sample for DGA shall be taken as described in 3.4 from all oil filled CTs. The sample shall be taken at least 24 hours after the final routine electrical testing has been performed. The results shall be included in the routine test report as detailed in Clause 3.4.

3.4 Routine Test Reports

Routine test reports shall be provided with the equipment and shall include details of all routine measurements made in accordance with this specification. The information regarding the overall accuracy and uncertainty of the accuracy measurements shall be recorded for all ratios. A certificate of conformity shall also be provided which is endorsed by the manufacturer to attest that the equipment supplied conforms to specification and is fit for purpose.

During the partial discharge (PD) test, the value of measured PD at the specified test voltage shall be recorded together with the value of the PD extinction voltage. Extinction voltage is defined as the voltage level at which measurable PD is completely extinguished upon decreasing test voltage. The background PD level at the time of the test should also be recorded in the report.

Where oil samples are taken for Dissolved Gas Analysis (DGA) the report shall contain the following information:

- (a) Name and Address of the laboratory where the analysis was performed
- (b) The Accuracy, Precision and Detection Limits for the individual gas measurement expressed in either parts per million (ppm) or percentage by volume.
- (c) The Sampling Procedure (stating the Standard Method BS EN 60567 if applicable).
- (d) The Gas Extraction Method used (stating the Standard Method BS EN 60567 if applicable).
- (e) Calibration Procedure adopted by the laboratory, including details of the number of points used over the range and the gases used.
- (f) Accreditation Status of the laboratory for the purposes of DGA testing.
- (g) Date Sampled and Analysed.
- (h) Report the following:

Measurement	Units	No. Decimal Places
Oil Volume Tested	mls	0
Total Gas Content	%	2
Hydrogen	ppm	0
Methane	ppm	0
Ethane	ppm	0
Ethylene	ppm	0

Acetylene	ppm	1
Carbon monoxide	ppm	0
Carbon dioxide	ppm	0
Oxygen	ppm	0
Nitrogen	ppm	0
Moisture	mg/l	0

4 FORMS AND RECORDS

Schedule of General and Technical Details (Current Transformers) – Schedule A

Schedule of Type Tests (Current Transformers) – Schedule B

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

5 DEFINITIONS

The definitions used in TS 1 and TS 2.2 apply to this document.

6 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
4	December 1999	Major revision to incorporate requirements placed on the Users (Other Users) of the NGC system at the Connection Points to that system. Changes associated with the move from Type Approval to Type Registration. Incorporation of Site Commissioning Test Sheets.	Francis Waite Substations and Cables	John Scott General Manager Engineering and Technology
5	December 2003	Editorial changes.	Tony Westmorland Policy	Mike Dean Asset Strategy Manager
6	December 2015	Document reformatted and renumbered Addendums 1-3 incorporated Performance and test requirements for internal arc fault protection class added External insulation requirements and deflection limits added Alignment of document to IEC 61869 Core order arrangement added as Appendix A	Martin Carpenter Policy Development Engineer	EEPIG

7 IMPLEMENTATION

7.1 Audience Awareness

Audience	Purpose Compliance (C) / Awareness (A)	Notification Method Memo / letter / fax / email / team brief / other (specify)
ETAM, Capital Delivery	A	Email/Intranet
Suppliers, Delivery Vehicles	C	Email/Extranet

7.2 Training Requirements

Training Needs N/A / Informal / Workshop / Formal Course	Training Target Date	Implementation Manager
N/A	N/A	N/A

7.3 Compliance

Compliance with this specification will be verified by Asset Policy through the Type Registration process.

7.4 Procedure Review Date

5 years from publication date.

PART 3 - GUIDANCE NOTES AND APPENDICES

8 REFERENCES

8.1 International, European and British National Documentation

This document makes reference to or should be read in conjunction with the documents listed below. Where a Standard has been harmonised into a Euronorm, only this latter reference is given. The issue and date of the documents detailed below shall be that applicable at the time of issue of this specification unless a specific issue date is given

BS EN 61869-1	Instrument transformers – Part 1 : General requirements
BS EN 61869-2	Instrument transformers – Part 2 : Additional requirements for current transformers
BS EN 60529	Degrees of Protection Provided by Enclosures (IP Code)
BS EN 62271-1	High-voltage switchgear and controlgear – Part 1: Common specifications
BS EN 60567	Oil-filled electrical equipment – Sampling of gases and analysis of free and dissolved gases - Guidance

8.2 National Grid Technical Specifications

The following NGTS documentation is relevant to current transformers and should be read in conjunction with this document.

TS 1	Ratings and General Requirements for Plant, Equipment and Apparatus for the National Grid System
TS 2.1	Substations
TS 2.2	Switchgear
TS 2.3	Power Transformers and Reactors
TS 2.19	Ancillary Light Current Equipment
TS 3.1.7	Substation Polymeric and Ceramic Insulation
TS 3.2.14	Gas Insulated Switchgear

8.3 National Grid Transmission Procedures

UKBP/TP183 Type Registered Equipment Procedural Requirements

APPENDIX A CURRENT TRANSFORMER (CT) ACCOMMODATION

The current transformer accommodation normally available for use is as detailed in A1 to A6 below with the housing core 1 being positioned nearest to the P1 terminal.

A1 POST TYPE CURRENT TRANSFORMERS AND THROUGH WALL AIR/AIR BUSHINGS

All 420,300 and 145 kV post type measurement/protection CTs and through wall air/air bushings shall have accommodation for a minimum of five current transformer cores using one of the arrangements listed below.

The following standard configurations of CT cores are commonly used by National Grid. Alternative configurations may be accepted or specified on a project basis:

A1.1 Five Core Arrangement

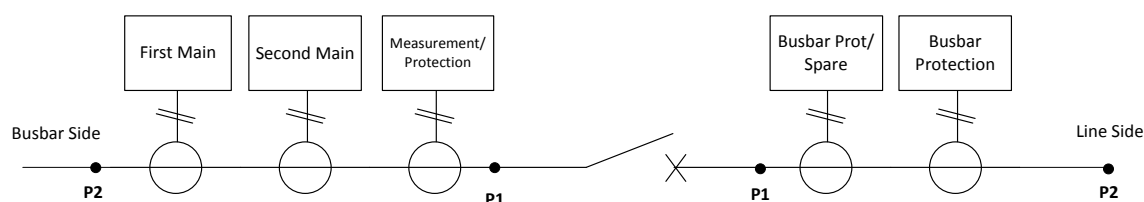
A full complement of five secondary windings as follows:

Core 1	Protection Type A
Core 2	Protection Type A
Core 3	Measurement/Protection
Core 4	Protection Type B
Core 5	Protection Type B

This arrangement will be required where older types of high-burden protection/instrumentation are installed

A2 AIS DEAD-TANK AND GIS CIRCUIT BREAKERS

Where a circuit breaker has Current Transformer chambers on both sides of the circuit breaker, as part of the standard equipment, the preferred accommodation of the current transformers is with overlapping protection across the interrupter.



P2 (Busbar side)	CT Class	Function
Core 1	PX-A	Feeder First Main
Core 2	PX-A	Feeder Second Main
Core 3	Measurement/Protection	Backup protection
P1 (CB side)		
Dead-Tank Circuit Breaker interrupter		
P1 (CB side)		
Core 4	PX-B	Spare (BBP – Discrim Zone if High Impedance)
Core 5	PX-B	Busbar Protection (Check zone if High Impedance)
P2 (Line side)		

For Bus Coupler and Bus Section applications CT accommodation shall be provided on each side of the circuit breaker with accomdation for a mimimum of three current transformers, as detailed in Appendix H.

A3 GIS BACK PARTS

In switchgear making up a mesh or single switch substation additional accommodation is required for five current transformers in each feeder circuit connection, the arrangement being as A1.1.

A4 TRANSFORMER AND SHUNT REACTOR BUSHING TURRETS

The accommodation available in the turrets of bushings shall allow for a maximum of five CT windings, excluding those which may be required for winding temperature indicators, as follows:

Core 1	Protection Type A
Core 2	Protection Type A
Core 3	Measurement/Protection
Core 4	Protection Type B
Core 5	Protection Type B

The allocation of CT cores to particular transformers will depend upon the protection requirements of the local primary systems to which the transformer is connected.