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Current and Voltage Measurement Transformers for Settlement Metering of the 33 kV, 66 kV 132 kV, 275 kV and 400 kV Systems

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CURRENT AND VOLTAGE MEASUREMENT TRANSFORMERS FOR SETTLEMENT METERING OF THE 33 kV, 66 kV, 132 kV, 275 kV AND 400 kV SYSTEMS

FOREWORD

This Specification defines the functional requirements for measurement transformers of maximum voltage rating 36, 72.5, 145, 300 and 420 kV connected to the National Grid Company (NGC) Transmission System, for use in settlement metering applications. It supports the more general conditions defined in the companion documents NGTS 1 and NGTS 2.2.

1 SCOPE

This is a functional specification for current and voltage measurement transformers for settlement metering applications.

2 REFERENCES

This Specification makes reference to or must be read in conjunction with:

IEC 44-3	Instrument Transformers Part 3: Combined Transformers
IEC 185	Current Transformers
IEC 186	Voltage Transformers
IEC 694	Specification for Common Requirements for High Voltage Switchgear and Controlgear Standards
BS 3938	Specification for Current Transformers
BS 3941	Specification for Voltage Transformers
NGTS 1	Overview, National Grid System
NGTS 2.1	Substations
NGTS 2.2	Switchgear for the National Grid System
NGTS 3.2.4	Current Transformers
NGTS 3.2.5	Voltage Transformers
Electricity Pool of England & Wales Metering Code of Practice 4	Calibration, Testing and Commissioning Requirements for Metering Equipment Registered with the Pooling and Settlements Administrator

3 GENERAL REQUIREMENTS

In addition to the requirements of NGTS 1 and NGTS 2.2 the following clauses apply:

3.1 All Settlement Metering Measurement Transformers

3.1.1 All current and voltage measurement transformers shall be designed for a minimum service life of 40 years as detailed in NGTS 2.2 clause 3.1.1.

3.1.2 Post-type current and voltage measurement transformers for settlement metering shall be of the combined VT/CT type or individual current/electromagnetic voltage transformer type.

3.1.3 External porcelain insulation and insulation co-ordination shall meet the requirements of NGTS 2.2.

3.1.4 An insulation test tap shall be provided for the purpose of performing capacitance and dielectric loss (tan *) measurements on the internal insulation during routine maintenance.

3.1.5 A single secondary terminal box shall be mounted on each transformer to accommodate necessary alarm equipment, secondary terminal connections, fuses and links. Each secondary wire to the terminal block shall be identified in accordance with IEC 185 or IEC 186 (BS 3938 or BS 3941). Facilities shall be provided to enable the box to be locked and for the application of a wire security seal. Secondary terminals and connections shall be suitable for their required purpose.

3.2 Combined Transformers (VT/CT)

3.2.1 Combined transformers shall be in accordance with IEC 44-3.

3.2.2 Combined transformers shall comprise two current transformer secondary cores and one voltage transformer comprising two secondary windings, each being of rating and accuracy class defined in section 4.

3.2.3 Secondary terminals shall be provided for the purpose of earthing the neutral connection of the VT primary winding and test tap connections.

3.2.4 Both ends of the VT secondary windings shall be earth free and be brought out to permit connection to links external to the VT.

3.2.5 Each VT secondary winding shall be protected by a fuse or an MCB of suitable type situated in the secondary terminal box. Where secondary fuses are supplied as part of the equipment the fuse rating shall be 10A and the type of fuse carrier used shall provide a reliable low resistance connection.

3.2.6 Oil-filled combined transformers shall be fitted with a gas detection device which shall be subject to NGC approval. Requirements for gas detection devices are detailed in NGTS 3.2.5 Appendix B.

3.3 Post-Type and GIS Voltage Transformers

3.3.1 Post-type and GIS voltage transformers shall be in accordance with NGTS 3.2.5 but shall comprise two secondary windings of rating and accuracy class as detailed in section 4.

3.3.2 Voltage transformer secondary windings and terminals shall be provided in accordance with clauses 3.2.3, 3.2.4 and 3.2.5.

3.3.3 Oil-filled voltage transformers shall be fitted with a gas detection device which shall be subject to NGC approval. Requirements for gas detection devices are detailed in NGTS 3.2.5 Appendix B.

3.3.4 Resin impregnated post-type voltage transformers shall be provided with an effective means of protecting the primary winding.

3.4 Post-Type and GIS Current Transformers

3.4.1 Post-type current transformers using oil, gas or gas/solid insulation systems and GIS current transformers shall be in accordance with NGTS 3.2.4 but shall comprise two secondary cores, each of rating, transformation ratio and accuracy class as detailed in section 4.

4 PERFORMANCE REQUIREMENTS

4.1 Combined Transformers (VT/CT)

4.1.1 All combined transformers shall comply with the general requirements of IEC 44-3 for the primary ratings detailed in NGTS 1 and NGTS 2.2.

4.1.2 The voltage transformer and current transformer parts of the combined instrument transformer shall meet the further rating and accuracy requirements selected from IEC 186 and IEC 185 as detailed in Schedules 1 and 2 respectively.

4.2 Post-Type and GIS Voltage Transformers

4.2.1 All post-type and GIS voltage transformers shall comply with the general requirements of NGTS 3.2.5 for the primary ratings detailed in NGTS 1 and NGTS 2.2.

4.2.2 The voltage transformer shall meet the further rating and accuracy requirements selected from IEC 186 as detailed in Schedule 1.

4.3 Post-Type and GIS Current Transformers

4.3.1 All post-type and GIS current transformers shall comply with the general requirements of NGTS 3.2.4 for the primary ratings detailed in NGTS 1 and NGTS 2.2.

4.3.2 The current transformer shall meet the further rating and accuracy requirements selected from IEC 185 as detailed in Schedule 2.

Primary System Voltage	400 kV	275 kV	132 kV	66 kV	33 kV
Accuracy Class (see note 1) $ 100 MW	0.2	0.2	0.2	0.2	0.2
< 100 MW	0.5	0.5	0.5	0.5	0.5
Rated Secondary Output per Winding (VA) (see note 2)	15	15	15	15	15
Actual Transformation Ratio (V/V)	228600/63.5	158750/63.5	76200/63.5	38100/63.5	19050/63.5
Voltage Factor, pu (IEC 186 cl 7)	1.5, 30 secs	1.5, 30 secs	1.5, 30 secs	1.9, 30 secs	1.9, 30 secs

Note 1 : Accuracy of the voltage transformer to comply with the appropriate classification of IEC 186 at burden power factors of 0.8 lag and unity, and over the range from 25 % to 100 % of rated burden.
For applications where the transformer is to be used for metering of primary circuits of rated capacity 100 MW and above, the required accuracy is class 0.2.
For primary circuits of less than 100 MW rated capacity, the required accuracy is class 0.5.

Note 2 : This burden excludes the burden of any gas detection equipment.

SCHEDULE 1 - VOLTAGE TRANSFORMER PERFORMANCE REQUIREMENTS

Primary System Voltage	400 kV	275 kV	132 kV	66 kV	33 kV
Accuracy Class (see note 1)	0.2S	0.2S	0.2S	0.2S	0.2S
Rated Output Per Secondary Winding on all tappings at unity power factor (VA)	7.5	7.5	7.5	7.5	7.5
Rated Secondary Current (A)	1	1	1	1	1
Rated Continuous Secondary Current, Thermal, all Tappings (A)	1	1	1.5	1.5	1.5
Extended Secondary Current, Accuracy (A)	2.5	2.5	1.5	1.5	1.5
Rated Transformation Ratios (Tappings) (Any deviations from these rated transformation ratios will be specified in the contract)	4000/3000/ 2000/1500/ 1000 : 1	3000/2500/ 2000/1500/ 1000/500: 1	1600/1200/ 1000/800/ 600/500 : 1	1600/1200/ 1000/800/ 600/500/400 : 1	2000/1600/ 1200/1000/ 800/600/ 500 : 1
Maximum Rated Continuous Thermal Primary Current (A) (see note 2)	4000	2500	2000	2000	2500
Rated Primary Thermal Currents (A)					
- 6 hrs 10EC ambient	-	-	-	2100	2750
- 30 min 10EC ambient (see note 3)	-	-	-	2400	3150

SCHEDULE 2 - CURRENT TRANSFORMER PERFORMANCE REQUIREMENTS

Schedule 2 - Notes

Note 1 : Accuracy of the current transformer to be demonstrated at burden power factor of unity over the range 1.0 VA to 7.5 VA and also at 7.5 VA (0.8 lag power factor) as detailed in Appendix B of this Specification.

Note 2 : For all ratios, the maximum rated continuous thermal primary current shall be defined as :-

Rated continuous secondary current (thermal) x Rated transformation ratio

Note 3 : The supplier shall demonstrate, by test, that the specified rated short duration primary thermal currents can be withstood, within the permissible temperature rise limits, following the steady state operation of the instrument transformer at rated continuous primary current at an ambient temperature of 10EC.

5 TESTING REQUIREMENTS

5.1 Test Standards

Transformers for settlement metering applications shall be tested in accordance with the following standards. Test requirements for gas detection devices are detailed in NGTS 3.2.5 Appendix B.

Combined Instrument Transformers : IEC 44-3

Current Transformers : IEC 185

Voltage Transformers : IEC 186

5.2 Type Test Requirements Additional To Those Detailed in the Above Standards

5.2.1 All Equipment

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

(ii) Radio Interference - RIV tests in accordance with IEC 694.

(iii) Accuracy - Tests in accordance with Appendix B shall be performed to conform with the requirements of Metering Code of Practice 4. Information required by this Code of Practice for the purpose of the Settlement System Administrator shall be provided to NGC at the tender stage. During the accuracy testing of VTs, any electronic gas detection device which derives its supply from the VT secondary winding shall be connected and functional.

(iv) Leakage Test on Oil System - For transformers using an oil insulation system, the supplier shall demonstrate leak-free performance of the transformer.

(v) Leakage Test on Gas System - For transformers using a gas insulation system, the supplier shall demonstrate compliance with clause 4.7.3 of NGTS 2.2.

Routine tests shall be performed before and after all type tests. No significant changes between these results shall occur.

5.3 Routine Test Requirements Additional to Those Detailed In the Above Standards

5.3.1 All Equipment

(i) Capacitance / Dielectric loss (tan *) measurements over the voltage range 10 kV to rated voltage.

(ii) Accuracy - Tests in accordance with Appendix B shall be performed.

5.3.2 Additional Tests for Combined Transformers (VT/CT)

(i) Measurement of the CT primary and secondary winding resistances.

(ii) Measurement of the VT primary winding resistance.

5.3.3 Additional Tests for Current Transformers

(i) Measurement of the primary and secondary winding resistances.

5.3.4 Additional Tests for Voltage Transformers

(i) Measurement of the primary winding resistance.

6 APPROVAL PROCEDURE

Requirements for the approval of measurement transformers for settlement metering are as detailed in NGTS 2.2. Where required, Appendix A of this document shall be completed by the supplier in support of approval.

APPENDIX A

INFORMATION TO BE SUPPLIED BY THE TENDERER

A1 GENERAL DETAILS

1	Manufacturer	
2	Type of measurement transformer (combined VT/CT, CT or VT) Type reference Drawing reference (s)	
3	Production commencement date	
4	Type test report number (s)	
5	Test specification (s)	
6	Category and date of approval	

A2 GENERAL TECHNICAL DATA (All Equipment)

1	Rated primary voltage Maximum operating voltage	kV kV	
2	Capacitance / dielectric loss	pF	
3	Power frequency withstand voltage (dry/wet) Lightning impulse withstand voltage (dry) Switching impulse withstand voltage (dry/wet)	kV kV kV	

4	Primary insulation details :- (a) Insulating medium (b) Quantity (c) Type of insulating oil (if applicable) (d) Gas insulation (if applicable) :- (i) Maximum operating pressure (ii) Minimum operating pressure (iii) Normal operating pressure (iv) Leakage rate (v) Maximum permissible dew point temperature	 m^3 MPa MPa MPa torr l/s EC	
5	Admissible static load (primary terminals) Admissible dynamic load (primary terminals) Cantilever test load (primary terminals) Declared porcelain breaking strength	kN kN kN kNm	
6	Insulation test tap (Yes/No) Porcelain insulator creepage distance Porcelain insulator arcing distance	 mm mm	
7	Total weight	kg	

A3 CURRENT TRANSFORMER DETAILS (including CT part of combined transformers)

1	Rated primary current	A	
2	Rated short-time current, thermal (1 second) Rated short-time current, dynamic (peak)	kA kA	

Secondary winding details :-

WINDING NUMBER	1	2
Ratio		
Secondary current (A)		
Rated burden (VA)		
Accuracy class		
Extended current rating (A)		

A4 VOLTAGE TRANSFORMER DETAILS (including VT part of combined transformers)

1	Rated voltage factor / time Thermal current rating	pu/sec A	
2	Gas detection device (a) Electrical or mechanical (b) Contact rating (trip) (c) Contact rating (alarm)	 A A	

Secondary details :-

WINDING NUMBER	1	2
Rated secondary voltage (V)		
Rated secondary burden (VA)		
Accuracy class		

APPENDIX B

ACCURACY TYPE AND ROUTINE TEST REQUIREMENTS FOR MEASUREMENT TRANSFORMERS FOR SETTLEMENT METERING APPLICATIONS

B1 TYPE TEST REQUIREMENTS FOR VOLTAGE TRANSFORMERS OR THE VOLTAGE TRANSFORMER PART OF THE COMBINED TRANSFORMER

The following accuracy type tests are applicable to each winding of the voltage transformer or each winding of the voltage transformer part of the combined measurement transformer. A total of 16 tests are to be performed per winding.

Measured Winding	Non-measured Winding
15 VA, upf	15 VA, upf 15 VA, 0.8 lag 3.75 VA, upf 3.75 VA, 0.8 lag
15 VA, 0.8 lag	15 VA, upf 15 VA, 0.8 lag 3.75 VA, upf 3.75 VA, 0.8 lag
3.75 VA, upf	15 VA, upf 15 VA, 0.8 lag 3.75 VA, upf 3.75 VA, 0.8 lag
3.75 VA, 0.8 lag	15 VA, upf 15 VA, 0.8 lag 3.75 VA, upf 3.75 VA, 0.8 lag

The above tests are to be performed at the following primary voltages :-

Equipment Rated Voltage, kV	Primary Test Voltages, kV
420	182.9, 228.6, 274.3
300	127, 158.8, 190.5
145	61, 76.2, 91.4
72.5	30.5, 38.1, 45.7
36	15.2, 19.1, 22.9

B2 ROUTINE TEST REQUIREMENTS FOR VOLTAGE TRANSFORMERS OR THE VOLTAGE TRANSFORMER PART OF THE COMBINED TRANSFORMER

The following routine accuracy tests shall be performed at primary voltages as specified for the type tests:

(a) Accuracy tests at 15 VA (upf) on each winding.

(b) Accuracy tests at 3.75 VA (upf) on each winding.

B3 TYPE TEST REQUIREMENTS FOR THE CURRENT TRANSFORMER OR CURRENT TRANSFORMER PART OF THE COMBINED TRANSFORMER

For the transformation ratios detailed in schedule 2, tests shall be performed with burdens of 1 VA (upf), 4 VA (upf), 7.5 VA (upf) and 7.5 VA (0.8 lag) at the currents detailed below :-

Equipment Rating, kV	**Currents At Which Accuracy Tests Shall Be Performed (as a percentage of rated secondary current)**
420	1, 5, 10, 20, 100, 120, 200 and 250%
300	1, 5, 10, 20, 100, 120, 200 and 250%
145	1, 5, 10, 20, 100 and 120 %
72.5	1, 5, 10, 20, 100 and 120 %
36	1, 5, 10, 20, 100 and 120 %

B4 ROUTINE TEST REQUIREMENTS FOR THE CURRENT TRANSFORMER OR CURRENT TRANSFORMER PART OF THE COMBINED TRANSFORMER

For the transformation ratios detailed in schedule 2, tests shall be performed at 1 VA (upf) and 7.5 VA (upf) at the currents specified for the type tests above.