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DRY-TYPE REACTORS FOR AC SYSTEMS

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PURPOSE AND SCOPE

This document forms part of a suite of documents which define National Grid's functional and performance requirements for new plant and equipment.

This Specification states the functional and performance requirements for dry – type reactors that will form an intrinsic part of a 'Subsystem' (see Section 6 for definitions) to be connected to the National Grid UK Transmission System (Electricity) or Third Party Networks.

Note that the reactor rating methodology is specified in the National Grid Technical Specification(s) that relate(s) to the specific Subsystem into which the reactor is to be incorporated.

Reference is made to TS 1 in respect of the general applicability of the requirements of this and other (NG)TS specifications to non National Grid connected Users of the Transmission System.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENTS

1.1 Overall

Reactors shall comply with the requirements of this specification, other (NG)TS documents referred to in this specification and BS EN 60076-6. Where conflict between these standards exists, the requirement of this specification shall take precedence. The equipment shall be designed and manufactured for a minimum operating life of 40 years, unless the Enquiry Document states otherwise. All maintenance required to achieve this life (e.g. washing, re-application of external anti-tracking finishes) shall be stated in the Tender Submission. See Appendix D.

1.2 Outdoor Use

Unless otherwise specified in the Enquiry Document all equipment shall be suitable for outdoor use.

The outer surfaces shall be treated with an anti-tracking finish and preventative measures shall be provided as necessary to prevent deterioration due to atmospheric pollution in order to achieve the lifetime requirements specified in this document. All reactors supplied for outdoor use (and comprising more than one cylinder) shall be equipped with both bird barriers and top hats or similar protective measures even when sound shields are not required. Furthermore the use of Mylar as an insulation material for reactors specifically intended for outdoor use (irrespective of whether a sound shield is provided) is not permitted.

1.3 Insulators

Mounting and supporting insulators shall be in accordance with the provisions of NGTS 3.2.9.

1.4 Clearances

Electrical and safety clearances shall be in accordance with TS 2.1.

2 PERFORMANCE REQUIREMENTS

2.1 Mechanical Adequacy

Calculations shall be provided in accordance with TS 2.1 to demonstrate the mechanical adequacy of the reactor together with its support structure/insulators for at least the following loading effects (electrical and mechanical) :-

- a) mechanical loads during operation and installation
- b) electromagnetic forces including those arising from any fault / short time loading conditions
- c) wind, ice and seismic loading
- d) forces due to expansion and contraction due to both ambient temperature and load variation

2.2 Ratings, Losses And Tolerances

All ratings, losses and tolerances shall apply to the complete reactor, its support assembly and any ancillary equipment (e.g. pollution shield, noise shield) erected as for service.

2.3 Temperature Rise

The temperature rise of supporting structures shall not exceed 30 K if they are accessible during normal operation, or 50 K otherwise (BS EN 60694).

2.4 Temperature Rise of Palm Type Terminations

The temperature rise of palm type terminations shall not exceed that specified in TS 2.1 for busbar connections under the worst loading situation. Bushing type terminations, if used, shall comply with NGTS 3.2.7.

2.5 Voltage Performance

There shall be no visible corona at maximum rated voltage for the reactor.

2.6 Mutual Coupling

Where poly-phase reactors are used, a calculation of mutual coupling effects on the ratings and losses is required. Zero sequence and mutual reactances must be stated in Appendix C.

2.7 Magnetic Fields and Clearances

The following magnetic field clearances, both above / below the reactor and radially from the centre of the reactor shall be declared. The clearances shall be for the complete reactor and support assembly erected as for service and at the maximum continuous rated current (including where relevant all harmonic currents):-

- e) to other reactors
- f) to small metallic objects
- g) to metallic parts forming closed loops
- h) for a 0.1mT field strength

2.8 Total Sound Power

Calculations of the guaranteed maximum total sound power for a single and three phase reactor set including any support assembly, erected as for service, shall be provided. The calculations shall take full account of the maximum continuous rated fundamental and harmonic currents as specified in the relevant schedule.

2.9 Availability

The reactor shall be designed to have an availability of greater than 98%, including planned maintenance outages unless the Enquiry Document states otherwise.

3 TEST REQUIREMENTS

3.1 General

Note: any statements or evidence submitted to support Routine or Type tests shall relate to the reactor, support assembly and insulators as a single entity

Tests shall be carried out in accordance with the relevant clauses of BS EN 60076-6 appropriate to the type of reactor (except as modified in this specification) and the general requirements for testing given in TS 2.3.

3.2 Routine Tests

Accuracy tests shall be performed in a laboratory with equipment, methods and processes that are traceable to National/International standards. Routine test reports shall include details of all Routine measurements made in accordance with this specification. In all cases the following Routine tests shall be performed as defined by the relevant clause, appropriate to that design of reactor in BS EN 60076-6.

- 3.2.1 Measurement of impedance and loss.
- 3.2.2 Winding resistance.
- 3.2.3 Dielectric tests.

- 3.2.4 A reactance measurement shall be performed for shunt reactors (including thyristor controlled reactors).
- 3.2.5 A separate source voltage withstand test shall be carried out for current limiting/damping and MSCDN / filter (including thyristor switched capacitor (TSC)) reactors.
- 3.2.6 An induced overvoltage withstand test (turn to turn across reactor) shall be carried out for current limiting/damping and MSCDN / ac harmonic filter (including thyristor switched capacitor (TSC)) reactors. The method of test and choice of test voltage shall be submitted for agreement 4 weeks prior to testing. Alternatively and depending on the specified impulse level across the reactor and / or limitations of the test facility, this test may be replaced by agreement with a (routine) lightning impulse test.
- 3.2.7 Routine tests for the measurement of Q factor and inductance shall be made for filter (including TSC) reactors at both fundamental and where applicable the specified harmonic frequencies.

3.3 Type Tests

- 3.3.1 Unless otherwise agreed, the unit to be Type tested shall first have withstood satisfactorily a complete set of Routine tests. After a successful Type test, the unit shall be subjected to another complete set of Routine tests. Although there is no requirement to perform all the Type tests on the same unit, all units subjected to a Type test are required to be fully initially, and repeat, Routine tested.
- 3.3.2 Type test reports shall include details of all measurements made in accordance with this specification.
- 3.3.3 The minimum test voltages for reactors for use in HV-connected SVCs shall be as specified in the insulation co-ordination section of TS 2.11.
- 3.3.4 The minimum test voltages for reactors for use in tertiary-connected SVCs shall be as specified in the insulation co-ordination section of NGTS 2.18.
- 3.3.5 The minimum test voltages for reactors for use in 400 kV/275 kV mechanically switched capacitor banks and damping networks shall be as specified in the relevant section of TS 2.21.
- 3.3.6 The minimum test voltages for reactors for use in 132 kV mechanically switched capacitor banks and mechanically switched capacitor damping networks shall be as specified in the relevant section of TS 2.26.
- 3.3.7 The minimum test voltages for reactors connected to a transformer tertiary winding shall be as specified for the tertiary winding itself in TS 2.3 (Power Transformers and Reactors).
- 3.3.8 The minimum test voltages for reactors for use in all other applications shall be as specified in the relevant (National Grid) Technical Specification.
- 3.3.9 The lightning impulse-voltage withstand test shall consist of 1 reduced wave (50-75% of full wave) and 5 full waves of both polarities. These tests shall be performed from both reactor main terminals to the earthed support framework, and across the reactor. For tapped reactors the impulse test shall be performed at the maximum tap position only. Whilst it is acknowledged that an impulse-voltage test may be carried out as a routine test in lieu of an induced overvoltage test (see 4.2.6 above), each reactor design requiring type testing shall be submitted to the above impulse test procedure.

Informative: Where it is not practicable to perform the lightning impulse-voltage tests with the standard wave-shape, the Tenderer shall state the wave-shape achievable on test and the test method for the inter-turn over-voltage test.

- 3.3.10 A short-time current test as specified in BS EN 60076-6 is generally required as a Type test. However this test may be waived if the manufacturer produces satisfactory relevant supporting evidence.
- 3.3.11 Measurements of acoustic sound pressure level, sound power and vibration according to BS EN 60076-6 (and BS EN 60551) are required as a Type test. The manufacturer shall submit full details of the proposed method of testing, including calculations of the equivalent test currents both at fundamental and the relevant harmonic frequencies to be applied for agreement 4 weeks prior to testing. Furthermore where the fundamental frequency of the supply at the test plant is not 50Hz, the manufacturer shall also submit calculations of the equivalent test current to be applied for agreement 4 weeks prior to testing.
- 3.3.12 The temperature rise Type test (including determination of the maximum hot spot temperature) is to be performed at the maximum continuous rated current including all harmonics with full allowance made for the variation of reactor resistance with frequency. The temperature rise test shall be performed with the reactor erected as for service including the installation of top hats and any further ancillary equipment (e.g. pollution and noise shields). The manufacturer shall submit details of the method of measuring the absolute temperature of each reactor cylinder (package) and justify the positioning of each temperature transducer. The manufacturer shall also submit calculations of the test current to be applied for agreement 4 weeks prior to testing. Where the test current is not the same as the specified maximum continuous rated current (but is nonetheless not less than 0.9 times the equivalent current at power frequency, refer also to BS EN 60076-6) or where the fundamental frequency of the supply at the test plant is not 50 Hz, the manufacturer shall also submit calculations of the equivalent test current to be applied for agreement 4 weeks prior to testing. The manufacturer shall also submit details of the calculation method used in determining temperature rise and maximum hot spot temperature when the test is not performed at maximum specified ambient temperature.
- 3.3.13 Radio interference voltage tests to BS EN 60694 are to be performed on open terminal reactors.

4 CONTRACT SPECIFIC REQUIREMENTS

- 4.1 Audible noise limits may be requested on a contract specific basis, refer to the Enquiry Document for further details.

5 FORMS AND RECORDS

The Tenderer shall provide the following technical details with the tender submission:-

Form TS 3.03.02_A1	Self Certification Check Sheet
Form TS 3.03.02_B1	Additional Information Required with Tender Submission
Form TS 3.03.02_C1	Plant Performance
Form TS 3.03.02_D1	Maintenance and Spares