

ADDENDUM

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ORIGINAL DOCUMENT DETAILS

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ADDENDUM DETAILS

The above document shall be read in conjunction with the following amendments:

Check appropriate boxes below

Addition	<input checked="" type="checkbox"/>	Replacement	<input type="checkbox"/>	Deletion	<input type="checkbox"/>
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5.5 Electric and Magnetic Fields (EMFs)

Occupational exposure

In normal operational conditions when the equipment is operating at nominal voltage and within any continuous ratings, it shall not be necessary for staff to enter any area where the limits given for occupational exposure in the Table 9 for time-varying fields can be exceeded. This restriction applies to continuous current ratings.

The design of the equipment shall be such that it is not possible for staff to enter any such area, without the addition of barriers or access controls specific to EMFs.

Note: If, exceptionally, it appears that barriers or access controls specific to EMFs are required, the Supplier should provide proposals for any such barriers to National Grid.

The Supplier shall provide, if stated in the lower tier TS for that particular technology, plans showing areas (if any) where the occupational exposure limit for the magnetic field is exceeded for the continuous current rating. These assessments shall normally consider the 50 Hz component of the fields only unless the operating condition that produces the highest fields involves significant fields at other frequencies, in which case the Supplier shall agree an assessment method with National Grid.

Occupational exposure – staff at particular risk

To enable National Grid to assess the impact for staff at particular risk, e.g. staff with active implanted medical devices, the Supplier shall provide plans that show the areas where the relevant values in the table below may be exceeded. **This is not a requirement when reutilising existing overhead lines.**

Note: These are not a limit that should be applied to the design.

Public exposure

In normal operational conditions, it shall not be possible for members of the public to enter any area where the public exposure limits given in the table below for time-varying fields are exceeded. If operational constraints or significant additional costs would be incurred to achieve this, the supplier shall notify National Grid.

	Occupational exposure limits	Values used to assess impact on staff at particular risk	Public Exposure Limits
50 Hz Magnetic field	6000 μ T	100 μ T	360 μ T
50 Hz Electric field	20 kV/m	5 kV/m	9 kV/m

Table 9 – Exposure limits for time varying electric and magnetic fields

RATINGS AND GENERAL REQUIREMENTS FOR PLANT, EQUIPMENT AND APPARATUS FOR THE NATIONAL GRID SYSTEM

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PURPOSE AND SCOPE

This document is the highest level specification in a three tier structure. Each successive level provides greater detail in a specific discipline and, collectively, these documents define National Grid's technical requirements for plant, equipment and apparatus for use on its electricity transmission system. These documents translate the actual operating characteristics of the National Grid electricity transmission system (National Grid System) into standardised values that assure safe & reliable operation. As far as possible, ratings and requirements are selected from values given in appropriate international standards. Deviations from these standards relate to particular requirements of National Grid network configurations or operational & safety procedures.

Greater detail regarding the actual operating characteristics of the National Grid System are detailed in CI 01 "Technical and Operational Characteristics of the National Grid Transmission System". Suppliers of plant, equipment and apparatus for use on the National Grid System should be familiar with CI 01.

The requirements of this document apply to all plant, equipment and apparatus which is part of the National Grid System. Requirements contained herein may be modified on a more specific basis by lower level specification however, unless such modifications are explicitly detailed, the requirements of this document apply.

Ratings are specified explicitly for plant with nominal voltages of 66kV and above and 13kV transformer tertiary connections. Rating for other nominal voltages are specified in TS 2.29.

Derogation from the requirements of the TS suite will normally be permitted only where it can be demonstrated that the proposed derogation is not detrimental to the safety, reliability and availability of the National Grid System.

PART 1 – TECHNICAL REQUIREMENTS

1 ENVIRONMENTAL SERVICE CONDITIONS

1.1 General

Plant, equipment and apparatus shall be suitable for operation under the normal service conditions defined in IEC 61936-1 with the following additions/modifications.

Equipment housed outdoors in association with high voltage plant shall have a degree of protection of at least IP54 as defined in BS EN 60529.

1.2 Normal Service Conditions

1.2.1 Indoor

The temperature class shall be “-5 indoor”.

1.2.2 Outdoor

The temperature class shall be “-25 outdoor”.

The ice coating classification shall be “class 10” (10mm).

The environmental pollution level shall be “Class III – Heavy” as defined in Table 1 of 60071-2.

1.3 Special service conditions

1.3.1 Indoor

Equipment intended to be sited within a closely controlled environment shall be suitable for operation in the temperature range +18⁰C to +27⁰C and within the relative humidity range 20% to 75% (Class A1 of BSEN 60654-1). Critical functionality shall be maintained in the event of failure of the environmental controls i.e. under the Normal Service Conditions defined above.

1.3.2 Outdoor

For particular locations, which may be subject to severe coastal/industrial pollution, the environmental pollution level shall be “Class IV – Very Heavy” as defined in Table 1 of 60071-2.

Informative: Further details regarding external insulation requirements for substations in polluted environments can be found in PS(T)023.

2 ELECTRICAL REQUIREMENTS

2.1 System Voltage

Plant and Equipment shall satisfy their specified functional and performance requirements over the appropriate range of primary voltages given in Table 1.

Plant and equipment for use on the 400kV system shall also operate safely and without any degradation in performance when operated in the range 420kV to 440kV for not longer than 15 minutes.

Plant and equipment shall satisfy their specified functional and performance requirements with phase voltage unbalance up to a maximum of 1%.

Informative: Phase voltage unbalance up to 2%, on an infrequent, short duration basis, may be specified at some sites.

Plant and equipment shall satisfy their specified functional and performance requirements when exposed to harmonic distortion levels in the voltage waveform up to the compatibility levels specified in Appendix A of ER G5/4.

Nominal System voltage	400 kV	275 kV	132 kV	66kV	13 kV tertiary
Rated voltage of plant	420 kV	300 kV	145 kV	72.5kV	17.5 kV
Maximum continuous System voltage	420 kV	303 kV	145 kV	70kV	16.9 kV
Minimum continuous System voltage	360 kV	247 kV	119 kV	62kV	10.4 kV

Table 1 - System Voltage

2.2 Rated Insulation Level and Protective Gap Settings

Plant shall meet the requirements of Table 3 with regard to its rated insulation level.

Table 4 details protective gap settings commonly used by National Grid which should be taken into account.

Informative: Current practice is to protect transformers and reactors with surge arresters as detailed in PS(T)021.

2.3 System Frequency

Plant and Equipment shall satisfy their specified functional and performance requirements over the range of frequencies given in Table 2.

Plant and equipment shall also operate safely and without any degradation in performance within the following frequency ranges:

- a) 47Hz to 47.5Hz for at least 20 seconds
- b) 50.5Hz to 52 Hz continuous

Rated frequency	50 Hz
Maximum continuous frequency	50.5 Hz
Minimum continuous frequency	47.5 Hz

Table 2 - System Frequency

Nominal voltage (kV)	Rated voltage (kV)	Rated short-duration power frequency withstand voltage (kV)		Rated switching impulse withstand voltage (kV.pk)			Rated lightning impulse switching withstand voltage (kV.pk)	
		Common value*/ Phase to earth & between phases	Across open switching device and/or isolating distance	Phase to earth	Between phases	Across open switching device and/ or isolating distance	Common value*/ Phase to earth & between phases	Across open switching device and/ or isolating distance
400	420	520	610	1050	1575	900 (+345)	1425	1425 (+240)
275	300	380	425	850	1275	700 (+245)	1050	1050 (+170)
132	145	275*	315	N/A	N/A	N/A	650*	750
66	72.5	140*	160	N/A	N/A	N/A	325*	375
13	17.5	38*	45	N/A	N/A	N/A	95*	110

Table 3 - Insulation Level Requirements

Nominal voltage (kV)	Mid-line overhead line arcing gap setting (m)	Substation approach (1.6km) overhead line arcing gap setting (m)	Transformer & reactor screened co-ordinating gaps (m)	Cable sealing end co-ordinating gaps (m)	Unscreened gaps applied to existing transformers/ reactors (m)
400	2.8	2.5	1.5	2.54	1.68
275	2.13	1.9	1.2	1.9	1.22
132	1.1	1	0.66	1	0.66
66	N/A	N/A	N/A	0.54	0.54
13	N/A	N/A	0.1	0.1	N/A

Table 4 - Arcing & Co-ordinating Gap Settings

2.4 Earthing of System Neutral

Plant and Equipment shall satisfy their specified functional and performance requirements under the neutral earthing condition given in Table 5.

Nominal Voltage (kV)	Maximum Earth Fault Factor	Earthing Type
400, 275, and 132	1.4	Multiple direct
66	Site specific	Site specific impedance earthing
13 (tertiary)	Site specific	Site specific

Table 5 - Neutral earthing

2.5 Fault clearance time

Plant and Equipment shall be suitable for operation under the conditions detailed in Table 6.

Nominal Voltage(kV)	Target fault interruption time of main in-feeding circuit (ms)	Target total fault clearance time (all infeeds) (ms)	Target back-up clearance time (ms)
400	80	140	500 (1000*)
275	100	160	500 (1000*)
132	120	N/A	<1500
66	120	N/A	<1500
13	75 (of which 35ms max' protection time)	N/A	N/A

Table 6 - Target fault clearance requirements

**Informative: Fault clearance times for zone 3 distance protection and residual earth fault protection on feeder circuits of 1 second are acceptable.*

In the event of a circuit-breaker failure, circuit-breaker fail protection shall trip all necessary contiguous circuit-breakers which are capable of supplying a fault infeed within a target fault clearance time not exceeding 300 ms.

2.6 Primary Currents

Substation Plant and Equipment shall be suitable for operation under the condition detailed in Table 7. Further details regarding overload requirements are detailed in PS(T)042 and TS 2.1.

System Voltage	Normal Current	Short-circuit Current	Duration of short-circuit	DC Time Constant
kV	A	(3- and 1-phase) kA	s	ms
400	4000	63	1	45
275	3150	40	1	45
132*	2000	40	3	45
		31.5	3	135
66	2000	31.5	3	135
13	4000	50	1	96

Table 7 - Short-circuit and load current requirements

*132kV equipment is required to meet **both** short-circuit current ratings detailed in Table 7.

3 DESIGN REQUIREMENTS

3.1 Use of SF₆ Gas

National Grid's policy regarding the installation of SF₆ filled equipment is detailed in PS(T)005. Further information regarding ongoing management of SF₆ filled equipment is provided in TGN (E) 178.

New SF₆ gas shall conform to IEC 60376.

Recycled SF₆ gas shall conform to IEC 60480 and Appendix A of this document.

At the time of commissioning of switchgear containing SF₆ gas, the gas shall have a moisture content of no greater than 25 mg/kg (approximately -35⁰C dew point at atmospheric pressure).

National Grid reserve the right to require reprocessing where the differential between the moisture content of the filling gas and final moisture content is greater than 10 mg/kg (approximately a 5⁰C dew point change).

Equipment containing SF₆ shall, as far as reasonably practicable, be leak free for its anticipated operating lifetime. Where leak free operation is not achievable the leak rate shall be minimised and, in the extreme, shall not exceed 0.5% per annum.

4 OPERATIONAL, MAINTENANCE AND MONITORING REQUIREMENTS

4.1 Multi-pole Opening/Tripping and Auto-reclosing

Plant and equipment shall be suitable for operation under the following circuit-breaker operating conditions:

- a) Simultaneous three-phase opening/tripping.
- b) Simultaneous three-phase auto-reclosing on overhead line feeder circuits.

Informative: The switching of shunt capacitor banks and shunt reactors may require the use of circuit-breakers with intentional non-simultaneity of poles. In such cases these requirements will be modified on a project specific basis and/or by lower level TSs.

Informative: Single-phase high-speed auto-reclose may be required on a circuit specific basis. Where this is the case the requirements will be given on a project specific basis.

4.2 Lifetime management

The Supplier shall indicate the maintenance requirements (both time based and duty based), and any mid-life refurbishment activity required to achieve the anticipated asset life.

4.3 Condition assessment and condition monitoring

Provision shall be made for condition monitoring, diagnostics and site testing. The application and nature of this monitoring and test equipment and apparatus is detailed in the appropriate level 3 TS documents. Where these facilities are integral to equipment they shall not reduce the integrity of the prime function of the equipment.

National Grid policies for the application of condition monitoring systems are defined in PS(T)008.

5 SAFETY, HEALTH, ENVIRONMENT AND SECURITY REQUIREMENTS

Products supplied for installation on the National Grid System or property, and owned and operated by or on behalf of National Grid, shall comply with all relevant UK Health and Safety and Environmental legislation.

Products shall comply with the requirements of the National Grid Safety rules.

Products and installations shall be designed to minimise, as far as reasonably practicable, health & safety risks to operational personnel and members of the public.

A suitable & sufficient environmental assessment covering all stages of the product life-cycle shall be submitted for all products.

Details of any materials or components requiring special precautions or handling shall be submitted for all products.

The National Grid system, in its entirety, complies with the Electromagnetic Compatibility (EMC) Directive (Statutory Instrument No. 2372 'The Electromagnetic Compatibility Regulations 1992') i.e. it is designed and constructed such that it does not introduce intolerable electromagnetic disturbances to its environment and is immune to electromagnetic disturbances in its environment. Equipment introduced into the system shall not detrimentally effect this compliance.

5.1 Date Proofing

All products shall be immune to failure or malfunction due to the presence of date sensitive elements.

5.2 Degree of Protection (Safety of Persons)

All plant, equipment and apparatus shall have a degree of protection of at least IP2X under normal operating conditions.

Informative: For these purposes "normal operating conditions" includes activities such as local operation which may require cabinet doors to be opened.

5.3 Temperature of Touchable Surfaces

Where contact with a surface is not possible or foreseeable, the maximum temperature of the surface shall be as allowed by the applicable standards for the equipment concerned. Where contact with a surface is possible or foreseeable, the following requirements shall additionally apply.

The maximum allowable temperature of touchable surfaces shall be determined by considering the likely duration of contact and the nature of the surface.

Where unintended contact is possible, a contact duration of 4 s shall generally be used. The contact duration may, however, be reduced to 1 s where it can be demonstrated by risk assessment that it is safe to do so. In this latter case, it shall be demonstrated that there is no restriction on movement of the individual nor risk of consequential injury due to reflex action.

For parts held for short periods, such as knobs and switches, a contact duration of 4 s shall be used. For parts held continuously in normal use, a contact duration of 10 s shall be used.

The maximum allowable surface temperature appropriate to the contact duration shall be determined from BS EN 563. Values for metallic components are as summarised in Table 8.

Duration of contact (s)	Maximum permissible surface temperature (°C)		
	Bare metal	Enamelled metal	Painted
1	65	74	83
4	58	60	64
10	55	56	55

Table 8 - Maximum allowable temperatures of touchable surfaces

5.4 Product Identification

All products shall be provided with a suitable & sufficient means of identification, such as a nameplate. Nameplates, or supplementary data plates, shall indicate the date of supply of the equipment and the duration of the warranty.

Provision shall be made for all products to be clearly marked with their operational identity in accordance with TP109.

6 MANUALS, SUPPORT DOCUMENTATION AND DRAWINGS

All products shall be supported by suitable and sufficient documentation including, but not limited to, Type Test Certificates or Reports of Performance, installation and operation manuals, commissioning schedules, testing recommendations and drawings.

All manuals and drawings shall clearly indicate the product manufacturer, type and model that they refer to, and also indicate the issue date of the document/drawing.

Manuals shall, as a minimum, address the following: a technical description and specification of the product, requirements for transportation, storage, installation, operation, commissioning, maintenance, de-commissioning and disposal. Particular attention shall be paid to aspects such as access for maintenance, inspection and/or testing (internal and external to the product), lifting and handling facilities for heavy or awkward parts and/or

covers, and prevention of access to parts that might represent a hazard due to, for example, voltage levels, temperature or mechanical movement etc.

Details shall be provided of spares requirements to achieve the anticipated asset life and of any additional equipment or software required in support of the product during its expected service life.

Informative: It is preferable for installation manuals to be physically separate from operation and maintenance manuals

7 FORMS AND RECORDS

None.

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

8 DEFINITIONS

8.1 Directly (Connected)

Connected in such a way that performance of the connected equipment directly affects the performance of the National Grid System. Typically this is limited to equipment within the coverage of National Grid busbar protection.

8.2 Plant

Primary (high voltage) elements of the National Grid System such as the circuit-breakers, transformers, overhead lines and cables.

8.3 Equipment

Secondary (low voltage) elements of the National Grid System such as those for control, measurements, protection and auxiliary supplies.

8.4 Apparatus

Physical components of, or associated with, the National Grid System which are required in support of the plant and equipment. Examples are substation structures, auxiliary plant and portable test equipment.

9 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
1	April 1992	New document		Mike Humphries Technology and Science General Manager
2	June 1998	Complete restructuring into NGTS1 and CSS1 documents Incorporation of the requirements placed on the users of the NGC system when making direct connections to the system. NGC Type Approval changed to NGC Type Registration	Jim Reid Substations and Cables	John Scott Engineering and Technology General Manager
3	March 1999	Revision. Removal of abnormal conditions clauses. Editorial changes. Inclusion of Environmental Impact, de-commissioning and dispersal requirements.	Jim Reid Substations and Cables	John Scott Engineering and Technology General Manager
4	January 2001	Improvement of maintenance and environmental requirements. Improvements of ratings section. Removal of special ratings. Removal of auxiliary supplies section, as this is adequately covered in NGTS level 2 and 3. General corrections in layout.	Jim Reid Substations and Cables	Andy Heath Engineering and Technology General Manager
5	December 2003	Modification to remove aspects of Policy and Procedure which are to be relocated in Policy Statements and Guidance documents. Minor technical simplifications. Introduction of pollution performance requirements from NGTS 2.2.	Mark Waldron Asset Policy	Mike Dean Asset Strategy Manager
6	November 2005	Table 9, item (a), column 1 – stated value for rated lightning impulse withstand voltage to earth (1.2/50 μ s wave) corrected from 425 kV peak to 1425 kV peak.	Mark Waldron Asset Policy	Peter Roberts Asset Strategy Manager
7	June 2007	Adoption of new format Scope extended to 66kV Ratings aligned with PS(T)042 Temperature of touchable surfaces introduced Removal of pollution performance requirements (to TS 2.1) Editorial improvements	Mark Waldron Asset Policy, ENI	Edgar Goddard Electricity Network Investment Manager

PART 3 - GUIDANCE NOTES AND APPENDICES

10 REFERENCES

BS EN 60071	Insulation co-ordination
BS EN 60529	Degrees of protection provided by enclosures (IP Code)
BS EN 60654-1	Industrial – Process Measurement and Control Equipment Operating Conditions; Part 1 Climatic Conditions
IEC 61936-1	Power installations exceeding 1kV : Common rules
Engineering Recommendation (ER) G5/4	Levels of harmonic distortion
National Grid Safety Rules	
CI 01	Technical and Operational Characteristics of the National Grid Transmission System

APPENDIX A - THE USE OF RE-CYCLED SF₆ GAS

A1 BACKGROUND

National Grid supports the principle of using recycled SF₆ gas in new switchgear in line with the recommendations made by CIGRE Study Committee 23, Working Group 23.10, Task Force 01.

A2 GENERAL REQUIREMENT FOR THE USE OF RECYCLED SF₆ GAS

The re-use of SF₆ gas for switchgear to be supplied on National Grid Projects shall satisfy the following specific checks and conditions.

A3 MOISTURE CONTENT

The moisture content of the gas shall be as low as possible and at most no greater than or equal to - 35°C referred to atmospheric pressure. This is approximately equivalent to 25 mg/kg. This limit is as recommended by CIGRE and it is recognised that it is lower than the value given in IEC 60694 which is the required value to prevent condensation.

A4 OTHER GASEOUS CONTAMINATION

Contamination by air, CF₄ or N₂ shall be less than 2% by volume. This shall be measured by a suitable SF₆ percentage measuring instrument rather than by an oxygen content as a precaution against N₂ contamination.

A5 ACIDIC SF₆ DECOMPOSITION PRODUCTS

Contamination by acidic SF₆ decomposition products shall be # 50 ppmv of HF equivalent. Measurement shall be by means of (SO₂ + SOF₂) detector tubes supplemented by the method for measurement of total acidity detailed in Section 8 of BS5209:1975.

CIGRE advise that a concentration of 12 ppmv (SO₂ +SOF₂) is equivalent to 50 ppmv total acidity. Due to current lack of detailed information on correlation between (SO₂+SOF₂) levels and total acidity, any gas with (SO₂+SOF₂) levels in excess of 5 ppmv shall be tested for total acidity with an acceptance level of 50 ppmv. The requirement for the total acidity test will be reconsidered following review of field experience.

A6 SOLID CONTAMINATION

The Supplier shall aim to have no solid contaminants present in the gas. An acceptable level is achieved by passing the gas through a dust filter of 1Φm pore size.

A7 INSTRUMENT CALIBRATION

All instruments used for the above tests shall have an up-to-date certificate of calibration from an organisation acceptable to National Grid

A8 ACCEPTABLE LIMITS

The acceptance limits specified above apply to each gas container/cylinder individually. It is not acceptable to aggregate the results from good and poor containers/cylinders when filling a switchgear product.

A9 IDENTIFICATION OF CONTAINERS/CYLINDERS

Each gas container/cylinder containing recycled gas shall be clearly marked:

“RECLAIMED SF₆ SUITED FOR REUSE IN ELECTRIC POWER EQUIPMENT”