1. SCOPE

The requirements of this document apply to all Plant, Equipment and Apparatus that are part of, or are Directly connected to, the Company network. 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 11kV and above, including 33kV transformer tertiary connections.

Derogation from the requirements of the SPTS 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 Company network.

2. ISSUE RECORD

This is a controlled maintained document.

All copies printed via the Intranet or photocopied will be deemed uncontrolled.

Issue Date	Issue No	Author	Amendment Details
Feb 05	1	A Convery	Initial Issue

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Alan Convery Project Engineer	Alastair Graham Engineering Risk Control Section Head	Andrew Huthwaite Engineering & Transmission Operations Manager ……

4. REVIEW

This document will be subject to review as and when required.

5. CONTENTS

6. DEFINITIONS

For the purposes of the SPTS suite of documents, the terms used are as defined in IEC 60050, and as below:

Apparatus
Physical components of, or associated with, the Company system which are required in support of the plant and Equipment. Examples are substation structures, auxiliary plant and portable test Equipment.

Approved
Refers to plant, Apparatus or material that has been Approved for use in writing by the Company.

Company
Refers to SP Transmission Ltd, SP Distribution Ltd, and SP Manweb plc including all associated design and planning practices.

Directly (connected)
Connected in such a way that performance of the connected Equipment directly affects affects the performance of the Company system. Typically this is limited to Equipment within the coverage of SP PowerSystems busbar protection.

Equipment
Secondary (LV) elements of the Company system such as those for control, measurements, protection and auxiliary supplies.

Plant
Primary (HV) elements of the Company system such as the circuit-breakers, transformers, overhead lines and cables.

PowerSystems
SP Power Systems Ltd, operator of network on behalf of the Company.

SP Distribution Ltd
The distribution Licence Holder for the Distribution service area formerly known as Scottish Power.

SP Transmission Ltd
The distribution Licence Holder for the Transmission service area formerly known as Scottish Power.

SP Manweb Plc
The distribution Licence Holder for the Distribution service area formerly known as MANWEB (Mersey And North Wales Electricity Board).

7. REFERENCES

7.1 UK Regulatory Documents

The GB Grid Code

7.2 UK Health and Safety Legislation

Where appropriate, the relevant legislation in section 8 of SMS-11-005 will be applicable.

7.3 UK Environmental Legislation

Where appropriate, the relevant legislation in section 10 of ENV-04-004 will be applicable.

7.4 ScottishPower Documentation

ScottishPower Safety Rules Handbook, Electrical & Mechanical 4th Edition.
SP PowerSystems Safety Instructions

7.5 International Standards Referred to in Text

IEC 60815	Guide for the selection of insulators in respect of polluted conditions
IEC 60060	High-voltage test techniques
IEC 60050	International Electrotechnical Vocabulary
IEC 60507	Artificial pollution tests on high-voltage insulators to be used on a.c. systems
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60654-1	Industrial - Process Measurement and Control Equipment Operating Conditions; Part 1 Climatic Conditions
IEC 60694	Common specifications for high-voltage switchgear and controlgear standards
ENA-TS-35-1	Distribution Transformers (from 16kVA to 1000kVA)

Engineering Recommendation (ER) G5/4 - Levels of harmonic distortion

7.6 Company Documents Referred to in Text

SMS-11-005	Library – Health & Safety Reference
ENV-04-004	The Register of Legal and Other Requirements
TDM 13/10,004	Numbering and nomenclature standard for Transmission System HV Apparatus
STCP 10-1	Asset Nomenclature

8. INTRODUCTION

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 the Company technical requirements for plant, Equipment and Apparatus for use on, and for direct connection to, the Company network. These documents translate the actual operating characteristics of the Company network into standardised values that assure safe & reliable operation. As far as possible, ratings and requirements are selected from values given in the appropriate IEC standards. Deviations from these standards relate to particular requirements of Company network configurations or operational & safety procedures.

9. SERVICE (ENVIRONMENTAL) CONDITIONS

9.1 General

9.1.1 Plant, Equipment and Apparatus shall be suitable for operation under the following normal and special service conditions.

9.2 Normal Service Conditions

9.2.1 Normal service conditions, as defined in IEC 60694, are applicable. Where a choice exists in IEC 60694, the following selection of values has been made and together with values in IEC 60654-1 are the Company's required values.

9.2.2 Indoor Plant

Temperature class minus 5 indoor.

9.2.3 Outdoor Plant

(a) Temperature class minus 25 outdoor. Ice coating class 10 mm.
(b) Ice Coating class 10 mm

9.2.4 Protection and Control Equipment Operating Environments

The operating environment for Equipment, such as control and protection, is categorized in Table 1. Equipment shall be suitable for operation in its intended environment including the ability to maintain critical functions in the event of failure of environmental control facilities such as air conditioning.

Class	Siting Conditions	Class according to IEC 60654-1	Ambient Temperature Range (a) (b)	Relative Humidity Limits
1	Rooms having a closely controlled environment	A1	+18 to +27°C	20 to 75%
2	Control rooms and Equipment rooms not fully air conditioned	B3	-5 to +55°C	5 to 95%
3	Plant areas, rooms and block houses away from high temperature plant and subject to greater extremes than Class 2	*N/A*	-5 to +40°C	5 to 95%
4	Outdoors	C2	-25 to +40°C	10 to 100%

Table 1: Temperature and Humidity Classes for Equipment

Notes to Table 1:

(a) The ambient temperature maxima assume negligible solar gain and negligible localised temperature excursions i.e. adequate ventilation. The validity of these assumptions must be considered, and confirmed, at the application stage.

(b) For ventilated Equipment the ambient temperature is defined as being the free air temperature existing at a point level with the top of the Equipment.

9.3 Special Service Conditions

9.3.1 Plant & Equipment shall be suitable for operation in a pollution environment as defined in Table 2.

9.3.2 External insulation shall be in accordance with the relevant requirements and recommendations of IEC 60815.

9.3.3 For ceramic insulation, test conditions to prove this performance level shall be as defined in Tables 2 & 3. Service experience offered in lieu of artificial pollution testing shall be identical to that detailed for composite insulation.

9.3.4 Insulation, including composite insulation, will comply with the requirements for minimum specific creepage as specified in IEC 60815.

9.3.5 Ceramic insulation for vertical application meeting the following criteria is deemed to meet the requirements of Tables 2 & 3 without further testing.

Alternate Long Short (ALS) profile.
(p1 - p2) ≥ 15 mm , s ≥ 70mm

Insulation	IEC 60815 Pollution Class	IEC 60507 Salt Fog Withstand Test Specification[1] kg/m^3
Indoor	I	No test withstand required
Outdoor	III	80
Outdoor (special)	IV	>160
Outdoor Horizontal	III& IV	80

Table 2: Pollution, Salt Fog and Heavy Wetting Test Requirements

Rated Voltage of Insulation (kV)	145	300	420
Test Voltage (phase-to-earth) kV	84	173	242
Test Voltage (phase-to-phase) kV	145	300	420
Test Voltage for other Insulation (as per IEC 60060)	The maximum power frequency voltage to which the insulation may be stressed in service. For insulation enclosing a switchgear interrupting gap, or if insulation is specified for enclosures for isolating gaps, or for insulation connected in parallel with such an interrupting or isolating gap, this test voltage shall be the out-of-phase voltage.		

Table 3: Test Voltage Levels for Pollution, Salt Fog and Heavy Wetting Test

[1] Where Deemed necessary by the Company, an additional heavy wetting test may be required.

9.3.6 Phase-to-phase AIS solid external insulation is not acceptable.

9.3.7 The application of an anti-pollution palliative coating to the external surface of ceramic insulation in order to satisfy the requirements of this specification is not acceptable.

9.3.8 Products consisting of internally graded insulation contained within an external AIS insulating enclosure or weather-shield, such as bushings, instrument transformers or grading capacitors, shall be considered a single item for the purposes of pollution and heavy wetting tests where required.

9.3.9 Phase to earth insulation connected in parallel and having a shed-to-shed separation distance of less than 0.5 times the phase-to-earth clearance, shall be considered as a single item for the purposes of pollution and heavy wetting tests.

9.3.10 Horizontally oriented insulation and insulation intended for mounting > 15° from the vertical shall meet the pollution and heavy wetting requirements in its intended orientation.

9.3.11 The insulation shall be mounted at the orientation intended for service during pollution and heavy wetting tests.

9.3.12 Composite external insulation shall be supported by satisfactory evidence detailing the suitability of the insulation for the intended site.

10. SYSTEM REQUIREMENTS

10.1 System Voltage

10.1.1 Plant and Equipment shall satisfy their specified functional and performance requirements over the range of primary voltages given in Table 4.

10.1.2 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.

10.1.3 Plant and Equipment shall satisfy their specified functional and performance requirements with phase voltage unbalance up to a maximum of 1 %[2].

10.1.4 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 (phase to phase) (kV)	**400**	**275**	**132**	**33**	**11**
Maximum continuous System voltage (kV)	420	303	145	34.98	11.66
Minimum continuous System voltage (kV)	360	247	119	31.02	10.34
Rated voltage of plant (kV)	420	300	145	36	12

Table 4: System Voltage Levels

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

10.2 System Frequency

10.2.1 Plant and Equipment shall satisfy their specified functional and performance requirements over the range of frequencies given in Table 5.

10.2.2 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	49.5 Hz

Table 5: System Frequency

10.3 Earthing of System Neutral

10.3.1 Plant and Equipment shall satisfy their specified functional and performance requirements under the neutral earthing condition given in Table 6.

Nominal Voltage (kV)	**Maximum Earth Fault Factor**	**Earthing Type**
400, 275, and 132	1.4	Multiple Direct
33 (Tertiary)	1.9	Resistance
33	1.9	Multiple Resistance
11	1.6	Multiple Direct

Table 6: Earthing of System Neutral

10.4 Fault Clearance

10.4.1 Plant and Equipment shall be suitable for operation under the conditions detailed in Table 7

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	180	<1500
33	200	300	<1500 (5000**)
25	200	300	<1500
11	<500	<600	<1500
11***	200	200	<1500

Table 7: Target Fault Clearance Requirements

* Fault clearance times for zone 3 distance protection and residual earth fault protection on feeder circuits of 1 second are acceptable.
** Fault clearance time for SBEF Stage 1.
*** Interconnected circuits only.

10.4.2 At 132kV, 275kV and 400kV, in the event of a circuit-breaker failure, circuit-breaker fail protection shall trip all necessary contiguous circuit-breakers, capable of supplying a fault infeed, within a target fault clearance time not exceeding 300 ms.

10.5 Multi-pole Opening/Tripping and Auto-reclosing

10.5.1 Plant and Equipment shall be suitable for operation under the following circuit-breaker operating conditions, unless otherwise requested by PowerSystems[3]:

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

11. RATING REQUIREMENTS

11.1 Primary Currents

11.1.1 Substation Plant and Equipment shall be suitable for operation under the condition detailed in Table 8.

System Voltage (kV)	Maximum Normal Current (A)	Single Phase Short-Circuit Current (kA)	3 Phase-Earth Fault Current	Fault Duration (s)	DC Time Constant (ms)
400	4000	55	55	1	60
275	3150	40	31.5	1	60
132	2000	25	20	3	90
33	2500	17.5	4.2	3	135
11	2000	13.1	13.1	3	60

Table 8: Rated Normal and Rated Short-circuit Currents

11.2 Rated Insulation Level and Protective Gap Settings

11.2.1 Plant shall meet the requirements of Tables 9 and 10 with regard to its rated insulation level and protective gap settings (if any).

[3] 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 by lower level specifications. Single-phase high-speed auto-reclose may be required on a circuit specific basis.

Normal System Voltage	KV	400	275
Rated Voltage for Plant	kV	420	300
(a) Rated lightning impulse withstand voltage to earth (1.2/50 μs wave)		1425	1050
(b) Rated lightning impulse withstand voltage between poles (1.2/50 μs wave)		1425	1050
(c) For switching devices (including disconnectors) rated lightning impulse voltage withstand between terminals on one pole when open (impulse waveshape 1.2/50 μs)		1425 kV impulse plus 240 kV peak power frequency voltage	1050 kV impulse plus 170 kV peak power frequency voltage
(d) Rated switching impulse withstand voltage to earth (250/2500 μs wave) kV Peak	kV Peak	1050	850
(e) Rated switching impulse withstand voltage between poles (250/2500 μs wave)	kV Peak	1575	1275
(f) For switching devices (including disconnectors) rated switching impulse withstand voltage between terminals of one pole when open (impulse waveshape 250/2500 μs)		900 kV Impulse plus 345 kV peak power frequency voltage	700kV Impulse plus 245 kV peak power frequency voltage
(g) Rated Power Frequency dry withstand voltage across switching devices (including disconnectors)	kV	610	435
(h) Overhead Line Arcing Gaps (Mid-line)	m	2.8	2.13
(i) Transformer and Reactor Coordinating Gaps (screened gap) (see (k))	m	1.5	1.2
(j) Cable Sealing Ends Arcing Gaps	m	2.54	1.9
(k) Existing transformers and reactors may have un-screened loop-loop gaps	m	1.68	1.22

Table 9: Rated Insulation Levels for 420kV and 300 kV Plant

Nominal System Voltage	kV	132	33	11
Rated Voltage for Plant	kV	145	36	12
(a)Rated lightning impulse withstand voltage to earth (1.2/50 μs wave)	kV Peak	650[4]	170	75
(b)Rated lightning impulse withstand voltage between poles (1.2/50 μs wave)	kV Peak	650	170	75
(c)For switching devices other than disconnectors and switch-disconnectors rated lightning impulse withstand voltage between terminals on one pole when open (1.2/50 μs wave)	kV Peak	650	170	75
(d)For disconnectors and switch-disconnectors rated lightning impulse withstand voltage between terminals on one pole when open(1.2/50 μs wave)	kV Peak	750	195	85
(e)Rated power frequency dry withstand voltage (1 minute)	kV	275	70	28
(f)For open type Equipment rated power frequency wet withstand voltage (1 minute) (preferred method is as per IEC 60060)	kV	275	80	45
(g) Across the isolating distance of disconnectors and switch-disconnectors rated power frequency dry, and where applicable wet, withstand voltage (1 minute)	kV	315	80	32
(h) Overhead Line Arcing Gaps (Mid-line)	m	1.10	N/A	N/A
(i) Overhead Line Arcing Gaps (first 1.6 km from the substation)	m	1.00	N/A	N/A
(j) Transformers and Reactor Co-ordinating Gaps (see (l))	m	0.66 screened gap	N/A	Refer to ENA-TS-35-1
(k) Cable Sealing Ends Arcing Gap[5]	m	1.00	N/A	N/A
(l) Existing 132 kV transformers and reactors may have un-screened loop-loop gaps	m	0.66	N/A	N/A

Table 10: Rated Insulation Levels for 145,36,12 kV Plant

[4] In the case of 132kV Transformers, the lightning impulse withstand value will be reduced to 550kV
[5] At Voltages below 132kV, Surge Arrestors will be used in the place of Arcing Gaps

12. GENERAL REQUIREMENTS

12.1 Equipment orientation

12.1.1 Where practicable, Plant shall be type tested in the orientation in which it is intended to be applied.

12.2 Health, Safety and Environment

12.2.1 Products supplied for installation on the Company network, and operated by PowerSystems, shall comply with all relevant UK Health and Safety and Environmental legislation.

12.2.2 Products shall comply with the requirements of the ScottishPower Electrical & Mechanical Safety Rules, in addition to the SP PowerSystems Safety Instructions.

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

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

12.2.5 Equipment containing SF_6 shall, as far as reasonably practicable, be leak free. Where leak free operation is not achievable the leak rate shall be minimized and, in the extreme, shall not exceed 0.5% per annum.

12.3 Degree of Protection

12.3.1 Controlgear and other Equipment housed outdoors in association with high voltage plant shall have a degree of protection of at least IP54 as defined in IEC 60529.

12.3.2 All plant, Equipment and Apparatus shall have a degree of protection of at least IP2X under normal operating conditions[6].

12.4 Date Proofing of Systems Used in Plant, Equipment and Apparatus

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

12.5 Product Identification

12.5.1 All products shall be provided with a suitable & sufficient means of identification, such as a nameplate.

12.5.2 Provision shall be made for all products to be clearly marked with their operational identity in accordance with TDM 13,10,004 (to be superceded by STCP 10-1).

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

13. MANUALS, SUPPORT DOCUMENTATION AND DRAWINGS

13.1.1 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.

13.1.2 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.

13.1.3 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[7].

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

[7] It is preferable for installation manuals to be physically separate from operation and maintenance manuals.