1. SCOPE

This Relevant Electrical Standard (RES) defines the relevant technical specifications, policies and procedures that shall be complied with by all users connected to or seeking connection to the SP Transmission System as set out under clause CC.6.2.1.2 of the Grid Connection Conditions and pursuant to the terms of the Bilateral Connection Agreement.

This Relevant Electrical Standards document applies only in accordance with the existing provisions of CC.6.2.1.2 of the Grid Code Connection Conditions. Equipment that was commissioned prior to the implementation date of this RES will continue to be subject to the standards applicable at the time of commissioning that equipment.

This RES seeks to ensure that equipment directly connected to the SP Transmission System has an acceptable standard of construction, manufacturing and installation quality to maintain an appropriate level of reliability and security for the System operated by SP Transmission. The document describes the technical requirements for User's equipment located within the SP Transmission busbar protection zone operating at nominal voltages of 400 kV, 275kV, 220 kV, 132 kV and 33 kV unless otherwise agreed with the user as defined in the Bilateral agreement.

2. ISSUE RECORD

Issue Date	Issue No	Author	Amendment Details
November 2016	1	Kevin Butter	First Issue

3. ISSUE AUTHORITY

Lead Author	Owner	Issue Authority
Kevin Butter Lead Engineer Engineering Design & Standards	Alastair Ferguson Substation Manager Engineering Design & Standards	Martin Hill Head of Engineering Design & Standards

4. REVIEW

This is a Controlled document and shall be reviewed as dictated by business /legislative change but at a period of no greater than 5 years from the last issue date.

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6. REFERENCE AND RELATED DOCUMENTS

This document makes reference to, or implies reference to, the following documents. This document is intended to amplify and/or clarify the requirements of those documents where alternative arrangements are permitted by those documents and/or where further information is required.

It is important that users of all standards, specifications and other listed documents ensure that they are applying the most recent editions together with any amendments. For dated references, only the edition cited applies. For undated references, the edition of the referenced document (including any amendments) valid at the date of issue of this specification applies.

UK Safety Legislation

Health and Safety at Work etc. Act 1974

Electricity at Work Regulations 1989

Construction (Design and Management) Regulations 2015

SP Energy Networks Policies and Specifications

Scottish Power Safety Rules (Electrical and Mechanical) 4th Edition

Energy Networks Association Documents

ER G5/4	Engineering Recommendation G5/4-1: Planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom

ENA TS 41-36	Distribution switchgear for service up to 36kV (cable and overhead conductor connected)
ENA TS 50-18	Application of ancillary electrical equipment
ENA TS 50-19	Application of Ancillary Electrical Equipment Standard Numbering for Small Wiring
ENA TS 48-3	Instantaneous high-impedance differential protection
ENA TS 48-4	DC relays associated with a tripping function in protections systems
ENA TS 48-6-1	ENA Protection Assessment Functional Test Requirements – Distance Protection
ENA TS 48-6-2	ENA Protection Assessment Functional Test Requirements – Feeder Unit Protection
ENA TS 48-6-3	ENA Protection Assessment Functional Test Requirements – Transformer Protection
ENA TS 48-6-4	ENA Protection Assessment Functional Test Requirements – Busbar Protection
ENA TS 48-6-5	ENA Protection Assessment Functional test Requirements – Voltage and Frequency Protection
ENA TS 48-6-6	Functional Test Requirements – Overcurrent and Earth Fault Protection
ENA TS 48-6-7	Communications services for tele-protection systems
ENA TS 48-6-8	Functional Test Requirements – Loss of Mains Relays
ENA ER G91	Substation Black Start Resilience
ENA ER-C55/4	Insulated Sheath Power Cable Systems

National Documents

	The Grid Code

International Electrotechnical Commission (IEC) Standards

IEC 60099-4	Surge arresters Part 4: Metal oxide surge arresters without gaps for AC systems
IEC 60376	Specification of technical grade sulphur hexafluoride (SF_6) for use in electrical equipment
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60815-1	Selection and dimensions of high voltage insulators intended for use in polluted conditions – Definitions, information and general principles
IEC 61869-1	Instrument transformers - Part 1: General requirements
IEC 61869-2	Instrument transformers - Part 2: Additional requirements for current transformers
IEC 61869-3	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers
IEC 61869-4	Instrument transformers – Part 4 Additional requirements for combined transformers
IEC 61869-5	Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers
IEC 61936-1	Power installations exceeding 1 kV a.c. - Part 1: Common rules
IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 62271-100	High-voltage switchgear and controlgear - Part 100: Alternating current circuit-breakers

IEC 62271-102	High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches
IEC 62271-200	High-voltage switchgear and controlgear –Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-203	High-voltage switchgear and controlgear - Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV
IEC 62271-209	High-voltage switchgear and controlgear- Part 209: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV
IEC 60044-1	Current Transformers
IEC 60076-X	Power Transformers (All Parts)
IEC 60137	Insulated bushings for alternating voltages above 1000V
IEC 60270	Partial Discharge Measurements
IEC 60214-1	On-Load Tap Changers
IEC 60529	Degree of protection for Enclosures
IEC 60296	Fluids for electrotechnical applications. Unused mineral insulating oils for transformers and switchgear
IEC 60947	Low Voltage Switchgear and Control Gear
IEC 60050	International Electrotechnical Vocabulary
IEC 60616	Terminals and tapping markings for power transformers
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
IEC 60050	International Electrotechnical Vocabulary
IEC 60287	Calculations of the Continuous Current Rating of Cables
IEC 60815	Guide for the Selection of Insulators in respect of Polluted Conditions

British Standards

BS381C	Specification for colours for identification, coding and special purposes
BS EN 50160	Voltage Characteristics of Electricity Supplied by Public Distribution Systems

International Organization for Standardization

ISO 9001	Quality Management Systems
ISO 14001	Environmental Management Systems

7. DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

The SP Transmission plc.	The Transmission Licence Holder for the transmission service area formerly known as Scottish Power.
Plant	Primary elements of The Company system such as the circuit-breakers, transformers, overhead lines and cables.

Equipment	Secondary elements of The Company system such as those for control, measurements, protection and auxiliary supplies.
Apparatus	Physical components of, or associated with, The Company's system which are required in support of the Plant and Equipment. Examples are substation structures, auxiliary plant and portable test Equipment.

8. INTRODUCTION

The ratings and requirements for Plant, Equipment and Apparatus shall be selected from the standard values given in the appropriate IEC standards. Deviations from these standards may be required to meet particular requirements of The Company's system configurations.

9. HEALTH, SAFETY AND ENVIRONMENT

All Plant, Equipment and Apparatus shall be designed for operation where safety is the primary consideration. Products and installations shall be designed to minimise, as far as reasonably practicable, health & safety risks to personnel, contractors and members of the public.

The design of all Plant, Equipment and Apparatus shall meet the requirements of the Health and Safety at Work Act 1974 and the Electricity at Work Regulations 1989 for the maximum safety of all personnel. The Regulations made under the Health and Safety at Work Act imposes specific duties on the installers and operators of Plant, Equipment and Apparatus in the UK. These duties apply irrespective of the origin of the equipment.

All installations shall be designed, constructed and installed so as to reduce the potential for accidents; injury and ill health in accordance with the principles of Construction (Design and Management) Regulations 2015 (CDM) to ensure that persons are not exposed to unreasonable risks when carrying out any work on the installation including, operations, inspection and maintenance of the equipment.

To ensure safety of operational staff and contractors, equipment supplied shall comply with the requirements of Scottish Power Safety Rules (Electrical and Mechanical).

10. CLIMATIC AND ENVIRONMENTAL CONDITIONS

10.1 General

The following requirements define the climatic and environmental conditions for Plant, Equipment and Apparatus which is directly connected to The Company's system.

Plant, Equipment and Apparatus shall be suitable for climatic and environmental conditions specified in clause 4.4 of IEC 61936-1 as a minimum; additional requirements applicable to specific types of equipment are detailed in the relevant sections in this document.

10.2 Normal conditions

The normal service conditions for Plant, Equipment and Apparatus are defined in clause 4.4.2 of IEC 61936-1 with the following additions/modifications.

10.2.1 Indoor Plant, Equipment and Apparatus

Indoor Plant Equipment and Apparatus shall be suitable for normal service conditions as defined in clause 4.4.2.1 of IEC 61936-1 and for a minimum ambient air temperatures of -5 °C (Class "-5 indoor").

Plant and Equipment housed indoors shall have a minimum degree of protection of IP2X as defined in IEC 60529. Higher degrees of protection may be required for some categories of Plant and Equipment types depending on its application.

10.2.2 Outdoor Plant, and Equipment and Apparatus

Outdoor Plant, Equipment and Apparatus shall be suitable for normal service conditions as defined in clause 4.4.2.2 of IEC 61936-1 and as defined below:

i) Minimum ambient air temperature of -25°C (Class "-25 outdoor")
ii) Ice coating up to 10 mm (Class 10)
iii) Wind speeds up to 34 m/s. (Higher wind speeds may be specified on a site per site basis).

Plant and Equipment housed outdoors shall have a minimum degree of protection of IP54 as defined in IEC 60529. The site pollution severity (SPS) according to IEC 60815-1 applicable to non-coastal sites shall be Class "d" (heavy) according to IEC 60815-1. The minimum unified specific creepage distance (USCD) of outdoor insulators and bushings used at these sites shall be 43.3 mm/kV.

10.3 Special conditions

It can be expected that saline pollution may be deposited onto external insulator surfaces at coastal locations. Outdoor insulation used at coastal locations shall be designed for Type B pollution and a SPS Class "e" (very heavy) according to IEC 60815-1. Insulators and bushings used at these sites shall have a minimum USCD of 53.7 mm/KV. SPS Class "e" may also be specified for some non-coastal sites due to pollution conditions prevalent at that site.

11. ELECTRICAL REQUIREMENTS

11.1 System Voltage

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

Nominal system phase-phase voltage (kV)	400	275	220	132	33
Maximum continuous System voltage (kV)	420 [1)]	303	242	145	35.0
Minimum continuous System voltage (kV)	360	247	198	119	31.0
Rated voltage of Plant & Equipment (kV)	420	300	245	145	36

Table 1: System voltage levels

[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 periods up to 15 minutes.

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 ENA Engineering Recommendation ER G5/4. Plant and Equipment shall satisfy their specified functional and performance requirements with phase voltage unbalance up to a maximum of 2%.

11.2 Rated insulation level

The rated insulation levels of Plant shall be in accordance with Table 2. These values shall apply unless explicitly modified in standards, specifications and documents pertaining to particular Plant types.

11.3 System frequency

The frequency of the National Electricity Transmission System shall be nominally 50Hz and shall be controlled within the limits of 49.5 - 50.5Hz unless exceptional circumstances prevail. The System Frequency could rise to 52Hz or fall to 47Hz in exceptional circumstances as outlined in clause CC.6.1.3 of the Grid Code.

User's Plant and Apparatus shall satisfy their specified functional and performance requirements over the range of frequency ranges described clause CC 6.1.3 of the Grid Code.

Nominal voltage (kV)	Rated voltage (kV)	Rated short duration power frequency withstand voltage (kV) [4]			Rated switching impulse withstand voltage [2] (kV peak)			Rated lightning impulse withstand voltage (kV peak) [3]		
		Common value/ Phase to earth & between phases	Across open switching device	Across the 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	Across the isolating distance
400	420	520	610	610	1050	1575	900 (+345) [1]	1425	1425 (+240) [1]	1425 (+240) [1]
275	300	395	435	435	850	1275	700 (+245) [1]	1050	1050 (+170) [1]	1050 (+170)[1]
220	245	460	460	530	N/A	N/A	N/A	1050	1050	1200
132	145	275	275	315	N/A	N/A	N/A	650	650	750
33	36	70	70	80	N/A	N/A	N/A	170	170	195

Table 2: Insulation level Requirements

[1] Values in brackets are the peak values of the power-frequency voltage applied to the opposite terminal with impulse voltage applied to other terminal of open switching device. See IEC 62271-1.

[2] Impulse wave shape – 250 /2500 µs

[3] Impulse wave shape -1.2/ 50 µs

[4] Dry withstand voltage for minimum duration of 1 minute. Power frequency wet withstand voltages may be specified for outdoor Plant. Longer durations for power frequency tests for some Plant (e.g. cables) may be specified in standards and specifications.

11.4 Earthing of system neutral

Plant and Equipment shall satisfy their specified functional performance requirements under the neutral earthing conditions given in Table 3.

Nominal voltage (kV)	Maximum Earth Factor	Type of neutral earthing
400	1.4	Multiple Direct
275	1.4	Multiple Direct
220	1.4	Multiple Direct
132	1.4	Multiple Direct
33 (Tertiary)	1.9	Resistance
33	1.9	Multiple Resistance

Table 3: Earthing of system neutral

11.5 Fault clearance times

Plant and Equipment shall be suitable for operation under the conditions detailed in Table 4. In the event of a circuit-breaker failure on the 132kV, 220kV, 275kV and 400kV systems, circuit breaker fail protection shall trip all necessary contiguous circuit-breakers capable of supplying a fault infeed within a target fault clearance time of 300ms.

Nominal voltage (kV)	Target fault interruption time of main in-feeding circuit (ms)	Target total fault clearance time for all infeeds (ms)	Target back-up clearance time (ms)
400	80	140	500 (1000) [1)]
275	100	160	500 (1000) [1)]
220	100	160	500 (1000) [1)]
132	120	180	1500
33	200	300	1500 (5000) [2)]

Table 4: Target fault clearance times

[1)] Fault Clearance times of 1 second for Zone 3 distance protection and REF protection on feeder circuits are acceptable
[2)] Fault Clearance time for SBEF Stage 1

11.6 Short-circuit currents

Plant and Equipment shall be capable of carrying the short-circuit current for the duration given in Table 5. The rated short-time withstand current of Plant and Equipment shall be selected from the standard values given in IEC standards to meet the ratings given in Table 5.

The system short-circuit currents at some sites exceed the standard values in Table 5. At such sites, equipment with higher rated short-time withstand current will be specified.

Nominal voltage (kV)	Single phase short-circuit current (kA rms)	Three phase short-circuit current (kA rms)	Duration of short-circuit (s)	D.C. time constant (ms) [2)]
400	55	50	1	60
275	40	40	1	60
220	40	31.5	1	60
132	25	20	3	90
33	4.2 [1)]	17.5	3	135 [3)]

Table 5: Short-circuit current requirements

1) Single phase short-circuit current on 33kV system is based on a maximum of two 120 MVA 275/33 kV transformers operating in parallel at a Grid Supply Point.
2) The rated peak withstand current of Plant and Equipment shall be defined according to the system D.C. time constant (See IEC 62271-1). At some sites (especially those associated with generator connections), significantly higher system DC time constants may be experienced.
3) At sites remote from Grid Supply Points, lower values of 33kV system D.C time constant may be specified.

11.7 Normal current

The maximum values of normal currents applicable to each voltage level are given in Table 6. Lower rated normal currents may be selected to suit the installation requirements. The rated normal currents are selected from the standard values given in IEC standards to meet the required circuit ratings.

Nominal voltage (kV)	Maximum normal current (A)
400	4000
275	3150
220	2000
132	2500
33	2500
11	2000

Table 6: Normal current requirements

11.8 Multi-pole opening/ tripping and auto-reclosing

Plant and Equipment shall be suitable for operation under the following circuit breaker operating conditions, unless otherwise stated by The Company.

i) Simultaneous three-phase opening/tripping
ii) Simultaneous three-phase auto-reclosing on overhead line feeder circuits

The switching of shunt capacitor banks and shunt reactors may require the use of circuit-breakers with intentional non-simultaneity of poles. Single-phase high-speed auto-reclose may be required on a circuit specific basis.

12. GENERAL REQUIREMENTS FOR SWITCHGEAR TO BE CONNECTED TO THE SP TRANSMISSION SYSTEM

12.1 Normal and special service conditions General requirements for switchgear

12.1.1 Normal service conditions

Indoor switchgear shall satisfactorily perform the required functions when the environmental conditions are within the limits indicated for “minus 5 indoor” equipment as specified in clause 2.1.1 of IEC 62271-1.

Outdoor switchgear shall satisfactorily perform the required functions when the environmental conditions are within the limits indicated for “minus 25 outdoor” equipment as specified in clause 2.1.2 of IEC 62271-1

12.1.2 Special service conditions

Any variation for the normal service conditions will be specified by the SP Transmission on a site per site basis.

12.2 Ratings

The ratings of Switchgear shall be as detailed in Part 12 of this RES.

12.3 Design and construction

12.3.1 Accessibility and ergonomics

Appropriate measures shall be taken to avoid working at height. Where working at height cannot be avoided, switchgear shall be designed to facilitate the work to be carried out in a safe manner in accordance with the Work at Height Regulations 2005 (as amended).

There shall be a safe and convenient means of access to all parts of the switchgear where the need for access can be foreseen during the service life of the switchgear.

12.3.2 Requirements for gases in switchgear

Where SF_6 gas is used for arc-extinction or operation, clause 5.2 of IEC 62271-1 shall apply.

12.3.3 Auxiliary and control equipment

All auxiliary and control equipment associated with high voltage switchgear shall comply with requirements of ENA TS 50-18.

12.3.4 Closing and opening releases and operating devices

The closing and opening devices and the auxiliary and control circuits associated with the switchgear shall have a rated supply voltage of 125V and a rated supply frequency of d.c. This equipment shall operate correctly over the voltage range (measured at the terminals of auxiliary equipment or shunt release) as detailed in Table 7 and in accordance with clause 4.8.3 and 5.8 of IEC 62271-1.

Users may employ different DC Voltage Supply Limits providing the DC system is not connected to the SP Transmission DC supply systems.

Rated supply voltage operating range	DC Voltage (V)			
	Auxiliary and control circuits	Operating devices	Shunt closing releases	Shunt opening releases (V)
Rated supply voltage (u_a)	125	125	125	125
Maximum operating voltage	137.5	137.5	137.5	137.5
Minimum operating voltage	106 (85% of U_a)	106 (85% of U_a)	93.5 [1)] (75% of U_a)	77 [2)] (62% of U_a)
Notes: The minimum operating voltage for shunt closing releases is based on 85% of the nominal voltage of the substation battery (110 V) This minimum operating voltage for shunt opening releases is based on 70% of the nominal voltage of the substation battery (110 V) The above minimum voltages are to ensure that circuit-breakers can be successfully opened or closed in the event of an emergency condition where the substation battery charger is unavailable.				

Table 7: DC Voltage limits

12.3.5 Gas insulated metal-enclosed switchgear

Gas Insulated switchgear (GIS) shall meet the requirements of IEC 62271-203.

12.3.6 Circuit breakers

Circuit-breakers shall meet the requirements of IEC 62271-100.

Circuit-breakers for use on systems with nominal voltage of 33kV and below shall meet the requirements of ENA TS 41-36.

12.3.7 Disconnectors and earthing switches

Disconnectors and earthing switches shall meet the requirements of IEC 62271-102.

Disconnectors for use on systems with nominal voltage of 33kV and below shall meet the requirements of ENA TS 41-36.

12.3.8 Inductive voltage transformers

Inductive voltage transformers shall meet the requirements of IEC 61869-1 and IEC 61869-3.

Inductive voltage transformers for use on systems with nominal voltage of 33kV and below shall meet the requirements of ENA TS 41-36.

12.3.9 Capacitive voltage transformers

Capacitive voltage transformers shall meet the requirements of IEC 61869-1 and IEC 61869-5.

12.3.10 Current transformers

Current transformers shall meet the requirements of IEC 61869-1 and IEC 61869-2.

12.3.11 Metal oxide surge arresters

Metal oxide surge arresters shall meet the requirements of IEC 60099-4.

12.4 Switchgear test requirements

12.4.1 Type testing

The supplier shall be responsible for carrying out all type testing in accordance with section 6 of IEC 62271-203. The supplier shall also carry out all type testing specified in the relevant IEC standards for the particular type of switchgear and controlgear.

Switchgear for use on systems with nominal voltage of 33kV and below shall be type tested in accordance with meet the requirements of ENATS 41-36.

12.4.2 Routine Tests

Routine tests shall be carried out by the supplier at the point of manufacture and shall satisfy the requirements of section 7 of IEC 62271-1. The supplier shall also carry out routine testing specified in the relevant IEC standards for the particular type of switchgear and controlgear.

12.4.3 Tests after installation on site

Adequate Quality Assurance procedures for site assembly and testing shall be carried out to ensure that the switchgear is assembled and installed correctly.

13. GENERAL REQUIREMENTS FOR TRANSFORMERS TO BE CONNECTED TO THE SP TRANSMISSION SYSTEM

This Section defines the performance requirements for Transformers and Reactors to be connected to the Company System. All testing and certification should be conducted in accordance with the relevant IEC standards, unless explicitly specified otherwise. Deviations from the requirements listed here will only be acceptable if approved by the Company, and it can be shown that no extra risk is posed to the Company network.

Definitions given in IEC 60050-421 and IEC 60076-1 shall apply, however terms and definitions detailed in this document take precedence.

13.1 General Requirements

13.1.1 Overall Requirements

All transformers and reactors shall comply with IEC 60076 (all relevant parts).

The projected lifespan of all transformers and reactors shall not be less than 40 years.

The connector shall make the Company aware of the maintenance requirements and procedures that are required with any transformer or reactor that is to be connected to the Company System.

Suitable provision shall be made to allow condition monitoring, diagnostic testing and on site tests to be facilitated.

13.1.2 Fluids

Mineral insulating oil shall be tested in accordance with all of the relevant parts of IEC 60296. Unused synthetic organic esters shall be tested in accordance with all relevant parts of IEC 61099.

13.1.3 Tap Changers

Where tap changers are fitted they shall be tested in accordance with all relevant parts of IEC 60214

13.1.4 Bushings

High Voltage (HV) bushings shall be tested in accordance with IEC 60137.

13.1.5 Operating Mechanisms, Ancillary Equipment and their Enclosures

The local control and monitoring apparatus shall be accommodated at the transformer or reactor that it controls (this is termed the LCC, or Local Control Cubicle). Such accommodation shall be clearly labelled to indicate the apparatus it contains and the transformer controlled.

The LCC shall be located at ground (floor/fixed access) level.

Indication of the operational position of the apparatus being controlled (such as tap changers) shall be unambiguous and clearly visible from ground (floor/fixed access) level.

13.1.6 Current Transformer Test Loops

A CT Primary test loop of an Approved type shall be made available on the Transformer or reactor intended for connection, to allow the Company to verify protection configurations in order to ensure that the Company can verify any integrated protection schemes operate as intended.

13.2 Test Requirements for Transformers and Reactors

Tests shall be carried out in accordance with all relevant sections of IEC 60076.

Table 8 below lists the minimum test voltages that shall be used.

Rated voltage between phases			kV	400	275	132	33	11	<1.1
Test Voltages:	(a) Minimum lightning impulse voltage withstand		kVp	1425	1050	550	170	75	-
	(b) Minimum induced overvoltage withstand		kV rms	630	460	230	66	22	-
	(c) Minimum applied voltage withstand		kV rms	45	45	45	70	28	3
	(d) Minimum switching impulse voltage withstand		kVP	1050	850	460	-	-	-
	(e) Core to Frame and Core to Earth	in oil	kV rms	5	5	5	2	2	-
		in oil	kV dc	5	5	5	2	2	-
		in air	kV dc	3	3	3	2	2	-

Table 8: Test Voltages

14. GENERAL REQUIREMENTS FOR CABLES TO BE CONNECTED TO THE SP TRANSMISSION SYSTEM

Connectors shall be responsible for ensuring the satisfactory performance of all aspects of the cable system design.

14.1 Cable and Cable Accessories

For land cables with system voltages below 132kV the requirements of the Electricity Association Type Approval shall apply.

14.2 Cable System

14.2.1 Sheath Losses

To reduce sheath losses special bonding arrangements may be adopted. The requirements for insulated sheath cable systems are specified in ENA-ER-C55/4

Sheath Voltage Limiters (SVLs) may be used.

14.2.2 Fibre-Optic Temperature Sensors

All 275kV and 400kV cables shall be constructed or installed with optical fibres for use as part of a distributed cable temperature and rating monitoring system.

14.2.3 Transient Sheath Voltages

To reduce the Rise of Earth Potential (ROEP) on cable systems, the cable sheath system and any additional earth continuity conductor shall be connected to earth via suitable low impedance connections at joint bays and terminations except where this is not practicable. Earth connections are specified for cables and for adjacent substation and overhead line earth systems with the intention of ensuring that an adequate continuous metallic earth conductor is provided for the Company network. The transient sheath voltages arise from lightning and switching impulses and additionally from any faults producing 50 Hz short-circuit currents.

14.2.4 Steady State Sheath Voltages

Where metalwork may be subject to a standing voltage in excess of 10V A.C precautions shall be taken to prevent accidental contact.

14.3 Performance Requirements

14.3.1 Cable System Life

Cable systems shall be designed for an operating life of 40 years.

14.3.2 Transient Sheath Voltages

Special bonding arrangements will normally require the use of sheath sectionalising insulation. Where it is necessary to control transient voltages across the sectionalising insulation sheath voltage limiters (SVLs) may be used.

14.3.3 Steady State Sheath Voltages

Where SVLs are fitted the sheath voltage shall not exceed their maximum A.C. continuous voltage rating under normal loading, emergency loading and the external single-phase-to-earth short-circuit conditions.

14.3.4 Short Circuit Rating

The cable system design shall ensure that the full declared three-phase and single-phase short-circuit currents can be carried for the durations in Table 9 without the cable system sustaining any permanent damage. The short-circuit capability shall be calculated for operation at the maximum conductor temperature.

Table 1: Maximum Short-Circuit Durations

System Voltage (kV)	Duration of Short-Circuit (s)
132	3
275	1
400	1

Table 9: Maximum Short-Circuit Durations

15. GENERAL REQUIREMENTS FOR PROTECTION AND CONTROL EQUIPMENT TO BE USED ON SITES CONNECTED TO THE SP TRANSMISSION SYSTEM

This section outlines the documents which should be referenced to detail the protection and control requirements of 400kV, 275kV, 220kV, 132kV, 33kV and 11kV networks.

15.1 General Requirements

Adequate Protection systems should be developed to fulfil the requirements of the ESQC Regulations for all applications.

Devices used for protection and network control functions should comply with all applicable Environment Test Requirements listed in ENA TS 48-5.

15.2 Protection Application Requirements

Instantaneous high-impedance differential protection shall be in accordance with ENA TS 48-3.

DC relays associated with a tripping function in protections systems shall be in accordance with ENA TS 48-4.

Ancillary Electrical Equipment used for Protection or Control Purposes shall be in accordance with ENA TS 50-18

The category of service requirements for Tele-protection Communications shall be in accordance with Tele-protection application as per the definitions outlined in ENA TS 48-6-7

15.3 Verification of Protection Functions

Devices used to provide protection functions shall be tested in accordance with ENA standards as defined in Table 10

Protection Type	ENA Test Standard
Unit Feeder Main Protection	ENA TS 48-6-2
Protection for Double Wound Transformers and Auto Transformers	ENA TS 48-6-3
Busbar Protection	ENA TS 48-6-4
Distance Protection	ENA TS 48-6-1
Overcurrent and Earth Fault protection	ENA TS 48-6-6
Voltage and Frequency Protection	ENA TS 48-6-5
Loss of Main Protection	ENA TS 48-6-8

Table 10: Protection Function Testing Requirements

16. GENERAL REQUIREMENTS FOR AUX SUPPLIES TO BE USED ON SITES CONNECTED TO THE SP TRANSMISSION SYSTEM

16.1 General Requirements

The operational security of SP Energy Networks 400kV, 275kV, 220kV, 132kV and 33kV Transmission and 132kV GSP substations, and the availability of the high voltage plant and secondary equipment within these substations are dependent upon reliable and secure auxiliary supplies.

The following sections of this document will describe the functional and performance requirements for both AC and DC auxiliary power supplies and equipment installed at SP Energy Networks 400kV, 275kV, 220kV and 132kV Transmission and 132kV GSP substations.

16.1.1 Equipment

Manufacturing facilities shall be certified by a recognised accreditation organisation to ISO 9001.

The Supplier shall preferably have in place or be working towards installation of Management systems compatible with the International Environmental Management System Standard ISO 14001.

All equipment shall meet statutory requirements for safety as specified in Section 9.

No-break supplies for protection, control, measurements, telecommunications and other electronic equipment shall be fed from 48V DC and/or 110V DC supplies.

AC supplies may be used where a short duration supply interruption is tolerable (typically 0-2 mins arising from the time taken for a permanent supply to change over or for a standby diesel generator to run up to speed and provide a standby supply). Where a break is not acceptable and the equipment requires a no-break AC supply such as for a computer and monitor then it shall be fed from a DC supplied inverter or a stand-alone uninterruptible power supply (UPS).

PC's and monitors should be powered directly from a DC supply where reasonably practicable.

For safety reasons, the use of 230V AC supplies for control systems shall be avoided where reasonably practicable. If AC supplies must be used for general control purposes, a suitable transformer providing 110V with centre tapped earth is recommended to derive an acceptable control voltage.

16.1.2 AC Supplies

All SP Energy Networks 400kV, 275kV, 220kV and 132kV Transmission and 132kV GSP substations shall be equipped with an LVAC supply. The LVAC power supply shall be designed to provide a voltage maintained within the limits of 400/230V + 10%, - 6% and 50 Hz ±1%.

All components of the LVAC supply should be capable of operating correctly at the levels of harmonics specified in BS EN 50160.

16.1.3 DC Supplies

The 110V DC supply systems at 400kV, 275kV (excluding 275/33kV substations), 220kV substations and all substations which are denoted as being Strategically Important Sites[1], shall be provided by two independent DC supply systems.

[1] The list of Strategically Important Sites is Confidential and not included in this Policy document. SP Energy Networks Asset Management team should be consulted to confirm which substations have been denoted Strategically Important Sites.

The 110V DC supply systems at 275/33kV, 132/33kV GSP's and all 132kV substations (excluding substations denoted as being Strategically Important Sites) shall be provided by a single 110V DC supply system (single battery dual charger arrangement).

At 400kV, 275kV (excluding 275/33kV substations), 220kV substations and all substations which are denoted as being Strategically Important Sites, the arrangement of the DC systems at these sites shall be such that it is possible to re-establish full DC supplies in the event of a loss of one supply, by a manual changeover mechanism.

The standby period required for each independent 110V DC and 48V DC supply system shall be designated on the basis having a minimum of 72 hours resilience in line with the guidance given in ENA ER G91. The process outlined in Appendix 1 on ENA ER G91 should be followed to ensure that resilience is provided of associated sites. Any deviation from the guidance contained in ER G91 shall be agreed in writing with the relevant Scottish Power Asset Manager. At strategically important sites[1] the minimum standby period required for each independent 110V DC and 48V DC supply system shall be 168 hours.

In sites where there is standby generation provided, the minimum battery resilience period specified shall be 6 hours.

16.2 Performance Requirements

16.2.1 AC Supplies

The LVAC system shall be fully rated and designed such as to be capable of supplying the connected loads in accordance with the site specific substation LVAC system specification.

The LVAC system shall accommodate a +10% load growth prediction to that of the current design requirements without modification to the equipment housing or building.

For all non HV operational loads, a diversity factor of 0.8 shall be applied.

In specifying the equipment the designer should consider:
a) The site load demands from its connected LVAC loads.
b) Any legacy partitioning (essential/standby configurations) of the LVAC board that remain following replanting.
c) Any forecasted re-planting schemes that may affect the overall HV rating of the site.
d) The ability of the system to meet the application of large block or large induction motor connected loads whilst meeting the regulation performance requirements.

Where a permanent LVAC facility exists to connect a mobile diesel generator, this shall be rated so as to maintain full HV operating capability of the substation.

16.2.2 DC Supplies

DC systems shall provide no-break supplies at all times up to the end of the specified standby period.;

The battery/charger system shall maintain the voltage on the distribution boards at all times and at the extremes of the AC supply voltage to the charger.

16.3 Test Requirements

All type test and routine tests shall be in accordance with the requirements of the appropriate Technical Specifications and Equipment Approvals Procedure.