

Transmission Specification

Specification for Supplementing the National Grid Relevant Electrical Standards Interface

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| Applies to SHE Transmission | Transmission Specification Specification for Supplementing the National Grid Relevant Electrical Standards Interface | Document ref SP-PS-LT-2060 |
| Classification External | | Revision 0.00 |

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| The author/owner of this document is Gerry Cleary | This document has been approved for issue by Shirley Robertson | Date of issue 10th November 2015 | Review date 10th May 2016 |
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1 Introduction

- 1.1 This document is owned and managed by SHE Transmission Ltd. Any deviation to this document must be approved in accordance with PR-PS-LT-1001 – Deviation from Specification Procedure. For further information or guidance, please contact the Standards, Specifications and Innovation team by emailing transmission.standards@sse.com.
- 1.2 SHE Transmission has adopted National Grid Electricity Transmission's (NGET) Relevant Electrical Standards (RES) for developers wishing to connect to the SHE Transmission Network. This document highlights SHE Transmission specific requirements not captured in the NGET RES for connections to the SHE Transmission Network. The required additions or modifications will be tabled against the relevant NGET RES Reference Number.
- 1.3 This specification shall be read in conjunction with the NGET RES Standards listed in Section 2.1. It supports additions and modifications required by SHE Transmission and will be used in conjunction with the NGET RES in complying with SHE Transmission documentation.

2 Reference Documents

- 2.1 The documents detailed below should be used in conjunction with this specification. All NGET RES references documents listed below are Issue 1, February 2014.

| Reference | Title |
|-------------------------|--|
| NG TS 1 (RES) | Ratings and Requirements for Plant, Equipment and Apparatus for the National Grid System |
| NG TS 2.01 Part 1 (RES) | Substations – Part 1 – Procedural |
| NG TS 2.02 (RES) | Switchgear |
| NG TS 2.12 (RES) | Substation Auxiliary Supplies |
| NG TS 2.19 (RES) | Ancillary Light Current Equipment |
| NG TS 3.01.01 (RES) | Substation Interlocking Schemes |
| NG TS 3.01.02 (RES) | Earthing |
| NG TS 3.02.01 (RES) | Circuit Breakers |
| NG TS 3.02.02 (RES) | Disconnectors and Earthing Switches |
| NG TS 3.02.04 (RES) | Current Transformers for Protection and General Use |
| NG TS 3.02.07 (RES) | Bushings for High Voltage Alternating Current Systems |
| NG TS 3.02.09 (RES) | Solid Core Post Insulators for Substations |
| NG TS 3.02.14 (RES) | Gas Insulated Switchgear |
| NG TS 3.24.15 (RES) | Environmental and Test Requirements for Electric Equipment |
| NG TS 3.24.34 (RES) | Busbar Protection |
| NG TS 3.24.39 (RES) | Circuit Breaker Fail Protection |

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| Reference | Title |
|---------------------|---|
| NG TS 3.24.60 (RES) | Synchronising |
| NG TS 3.24.70 (RES) | Dynamic System Monitoring (DSM) |
| NG TS 3.24.90 (RES) | Protection & Control for HVDC Systems |
| NG TS 3.24.95 (RES) | Ancillary Services Business Monitoring |
| NG PS(T) 044 (RES) | Back-Up Protection Grading Across Network Operator Interfaces |
| NG PS(T) 045 (RES) | Management or Rise of Earth Potential at New and Refurbished Towers |
| NG TGN(E) 186 (RES) | Guidance for Working in Proximity to Live Conductors – Reducing the Risks |
| NG TGN(E) 187 (RES) | Guidance for Conductor Jointing in Substations |

2.2 Substations shall comply with the reference documents listed below unless otherwise stated in this specification. The latest revision of all reference documents shall apply. Where NG, NGT or NGET is referenced in NG TS, it shall be read as SHE Transmission. Where SHE Transmission is referenced in this document it shall be read as SHE Transmission or SSEPD as appropriate to the developer.

| Reference | Title |
|-----------------------|--|
| PR-PS-LT-1001 | Deviation from Specification Procedure |
| PR-PS-LT-910 (Draft) | General Requirements for Protection IEDs used on the Scottish Hydro Electric Transmission Network |
| SP-PS-399 | Substation Design Specification |
| SP-PS-401 | Specification for Disconnectors, Earth Switches and the Provision for Portable Earthing within Substations at 66kV and Above |
| SP-PS-404 | Specification for 110V and 48V Direct Current Auxiliary Supplies |
| SP-PS-405 | Specification for Earthing of Structures and the Equipment Earth Mat |
| SP-PS-406 | Specification for Labelling on the SHE Transmission System |
| SP-PS-407 | Specification for Transmission Sites LVAC Auxiliary Supplies |
| SP-PS-408 | Specification for Protection & Control Equipment – 400kV, 275kV & 132kV Transmission Networks |
| PR-PS-453 | Substation Site Selection Guidelines for Voltages at or Above 33kV |
| BS EN 50341 Parts 2-9 | Overhead Electrical Lines Exceeding AC 1kV. General Requirements. Common Specifications |
| BS EN 50522 | Earthing of Power Installations Exceeding 1kV AC |
| ENA TS 41-24 | Guidelines for the Design, Installation, Testing and Maintenance of Main Earthing Systems in Substations |
| ENA TS 50-18 | Application of Ancillary Electrical Equipment |

3 Abbreviations

| | | |
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|--------|--|
| A | Amps |
| AC | Alternating Current |
| BS | British Standard |
| DC | Direct Current |
| ENA | Energy Networks Association |
| ENA ER | Energy Networks Association Engineering Recommendation |
| ENA TS | Energy Networks Association Technical Specification |
| etc. | Etcetera |
| HVDC | High Voltage Direct Current |
| IED | Intelligent Electronic Device |
| kV | kilo-Volts |
| m | metres |
| mAOD | Metres Above Ordnance Datum |
| N/A | Not Applicable |
| NGET | National Grid Electricity Transmission |
| NOC | Note of Conformity |
| PAC | Physical Access Control |
| RES | Relevant Electrical Specification |
| SF6 | Sulphur Hexafluoride |
| SHE | Scottish Hydro Electric |
| SLD | Single Line Diagram |
| SSE | Scottish and Southern Energy |
| SSEPD | Scottish and Southern Energy Power Distribution |

4 Hierarchy

Where conflict exists between this specification, referenced standards and any other referenced documentation, the following ranking applies for relevance:

1. This specification (for discussion with the NGET Review Panel Meeting, November 2015)
2. Referenced National Grid Standard

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5 NGET RES TS1

5.1 Rating and General Requirements for Plant, Equipment and Apparatus for the National Grid System

| NG RES Clause | Description | Addition/Modification |
|---------------|----------------------------|---|
| 1 | Environmental | All environmental parameters, including ice and wind loadings will be based on SP-PS-399 and substation altitude to be assessed on a per project basis. |
| 1 | | For reference, Table 4 of SP-PS-399 is included in Appendix A of this document. |
| | | When referencing BS EN 50341 Part 2-9-2015 (in SP-PS-399), the substation's altitude level to be taken as the minimum planned switchgear height in mAOD. |
| 2.2 | Rated Insulation Level | <p>SHE Transmission will adopt the parameters and values detailed in Table 3 and associated notes of SP-PS-399, which is included in Appendix B for reference, i.e. 400kV, 275kV, 132kV, 33kV, 33kV tertiary & 11kV (and below).</p> <p>SHE Transmission to specify that assessments that are made at busbars that have large generators connected in close proximity could result in higher X/R ratios, and to be assessed on a per project basis.</p> |
| 2.4 | Earthing of System Neutral | <p>13kV tertiary connections are not adopted by SHE Transmission, Clause 2.5, Table 2. Instead SHE Transmission to adopt 33kV tertiary connections.</p> <p>For clarity, the maximum earth fault factor and earthing type to be as per the NG RES specification.</p> |
| 2.6 | Primary Currents | SHE Transmission specific primary fault levels to be adopted, with reference to Table 3 and associated notes of SP-PS-399, as per Appendix B of this specification. |

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| NG RES Clause | Description | Addition/Modification |
|---------------|---------------|---|
| | | <p>SHE Transmission will specify 3-phase and 1-phase fault levels separately on a per project basis, where applicable. It should be noted that NGET do not separately define 3-phase and 1-phase fault levels.</p> <p>Refer to Appendix E of this specification for SHE Transmission request for clarity from NGET.</p> |
| 4.1 | Multi-Pole | The requirement for a point-on-wave circuit breaker to be assessed by SHE Transmission on a per project basis. |
| 5.1 | Date Proofing | SHE Transmission date proofing to be carried out in accordance with Clauses 5.5 - 5.10 of SP-PS-406, which is included in Appendix C of this specification for reference. |

6 NGET RES TS 2.01

6.1 Substations – Part 1 - Procedural

| NG RES Clause | Description | Addition/Modification |
|---------------|-----------------------------|---|
| 4.2.3 | Current in Normal Operation | <p>Table 1 of the NGET RES specification is for voltage only, not current. The full version of TS 2.01 includes Table 1 which states overload factors for normal rated current.</p> <p>SHE Transmission does not consider that this is appropriate for developers.</p> <p>Refer to Appendix E of this specification for SHE Transmission request for clarity from NGET.</p> |
| 4.4.103 | Environmental Protection | All enclosures and kiosks should be stainless steel or aluminium and have a design life of 40 years. |
| 4.5.2 | Noise Level | Noise levels will be agreed with the Local Planning Authority. Noise mitigation measures will be installed to ensure compliance with local planning conditions. |
| 5.3 | Minimum Clearances | SHE Transmission will adopt the parameters and values detailed in Table 3 and associated notes of SP-PS-399, |

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| | | which is included in Appendix B of this specification for reference, i.e. 400kV, 275kV, 132kV, 33kV, 33kV tertiary & 11kV (and below). |
| 5.101 | Electrical Safety Clearances | SHE Transmission will provide specific guidance in regard to substation layouts where assets are shared with another operator. SHE Transmission will adopt the parameters and values detailed in Table 3 and associated notes of SP-PS-399, which is included in Appendix B of this specification for reference, i.e. 400kV, 275kV, 132kV, 33kV, 33kV tertiary & 11kV (and below). |
| 5.102 | Oversailing Conductors | |
| 7.1 | Installations – General Requirements | SHE Transmission will adopt the methodology detailed in PR-PS-453, 'Substation Site Selection Guidelines for Voltages at or Above 33kV', in regard to the design, consenting, construction and operation of substations, which meets the requirements of Schedule 9 of the Electricity Act 1989. |
| 9 | Protection, Control and Auxiliary Systems | SHE Transmission does not currently specify metallic cables of low smoke, low fume design for all works. SHE Transmission does not have any objections in regard to developers specifying metallic cables of low smoke, low fume design. |
| Annex C | Standard Substation Bay SLD | SHE Transmission will confirm arrangements required at boundary points on a per project basis. |

7 NGET RES TS 2.02

7.1 Switchgear

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|--------------------------------|
| N/A | N/A | No additions or modifications. |

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8 NGET RES TS 2.12

8.1 Substation Auxiliary Supplies

| NG RES Clause | Description | Addition/Modification |
|---------------|--|---|
| 1.3 | AC Supplies | Works to be carried out with reference to SP-PS-407 'Specification for Transmission Sites LVAC Auxiliary Supplies'. |
| 1.4.4 | DC Supplies | <p>Works to be carried out with reference to SP-PS-404, 'Specification for 110V and 48V Direct Current Auxiliary Supplies'.</p> <p>SHE Transmission requires battery systems to supply full rated substation load for 12 hours. This is included in the requirements for maximum tripping loads which should be achievable at the end of the 12 hour cycle.</p> <p>It should be noted that essential services are not fed from the DC system.</p> |
| 2.2 | Performance Requirements – DC Supplies | <p>SHE Transmission will adopt the battery requirements specified in SP-PS-404, 'Specification for 110V and 48V Direct Current Auxiliary Supplies'.</p> <p>For reference, Clause 2.2.3 of NGET RES 2.12 specifies a minimum of 102V for the case of a centralised 110V system. However, Clause 5.1 of SP-PS-404 specifies a minimum voltage of 99V at 110V system voltage.</p> <p>At 48V system voltage, SP-PS-404 specifies a minimum voltage of 43V, whereas a 46V minimum voltage is specified in NGET RES 2.12.</p> |
| 2.2.3 | | Where 6 hour period is referenced, delete and replace with 12 hour. |
| 2.2.4 | | Where 6 hour period is referenced, delete and replace with 12 hour. |

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9 NGET RES TS 2.19

9.1 Ancillary Light Current Equipment

| NG RES Clause | Description | Addition/Modification |
|---------------|---------------------------|--|
| 1.3 | Indoor Equipment Cubicles | All Indoor cubicles must have 2m unimpeded space to the front and 1m unimpeded space to the rear for the whole width of the cubicle. |
| 1.4 | Outdoor Kiosks | For clarity, SHE Transmission specifies handles that can be locked as per SP-PS-399, Clause 5.3.1 i.e. All handles and locking points must be provided with the facility for fitting a padlock device which will be supplied separately by SHE Transmission. Handles with integral locks or those operated by a separate removable panel keys are not acceptable. |
| 1.6 | Marshalling | SHE Transmission does not permit top entry cables. |
| All | Colouring | Clarification should be added to ensure that a developer's cable colouring is co-ordinated with SHE Transmission. |
| All | Colouring | SHE Transmission will also comply with ENA TS 50-18. |

10 NGET RES TS 3.01.01

10.1 Substation Interlocking Schemes

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|--|
| All | All | SHE Transmission only specifies electrical interlocking. Therefore other interlocking methods will not be adopted. |

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11 NGET RES TS 3.01.02

11.1 Earthing

| NG RES Clause | Description | Addition/Modification |
|-------------------|------------------------------------|--|
| 1.2 | Earth Potential Rise (EPR) | <p>SHE Transmission will adopt the step and touch potential limits previously detailed in NG TS 3.01.02, Issue 4 (March 2005) and ENA TS 41-24, Issue 1 (1992).</p> <p>Further technical discussion is outlined in Appendix D of this specification.</p> <p>Refer to Appendix E of this specification for SHE Transmission request for clarity from NGET.</p> |
| 1.5, 1.6 & 1.8.4 | Measurement Test Points/Facilities | <p>SHE Transmission does not currently specify earthing measurement test points/facilities.</p> <p>SHE Transmission does not have any objections in regard to developers installing earthing measurement test facilities/points.</p> |
| 1.3.3 & 1.3.5 | Backfill Material | <p>SHE Transmission does not currently specify any detailed requirements in regard to backfill.</p> <p>SHE Transmission does not have any objections in regard to developers carrying out detailed assessment/installations in regard to backfill materials.</p> |
| 1.11.9 - Figure 8 | Fences | <p>Electric powered gates are not required. Manually operated gates, with a locking padlock system are sufficient. The locking mechanism is to be approved by SHE Transmission.</p> <p>Where PAC (or otherwise) security access is installed on the main gate, or other accesses in the fence line, an isolating transformer and associated wiring shall be installed in accordance with Figure 8.</p> |

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12 NGET RES TS 3.02.01

12.1 Circuit Breakers

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|--------------------------------|
| N/A | N/A | No additions or modifications. |

13 NGET RES TS 3.02.02

13.1 Disconnectors and Earthing Switches

| NG RES Clause | Description | Addition/Modification |
|---------------|--|---|
| 2.5 | Mechanical Interface | <p>As outlined in Section 10 of this specification, SHE Transmission only specifies electrical interlocking. Therefore other interlocking methods will not be adopted.</p> <p>Care should be taken to ensure that there is sufficient space to allow SHE Transmission padlock(s) and a developer's padlock(s) to be applied in close proximity to the same item of equipment.</p> <p>As the SHE Transmission padlock and a developer's padlock might be of different sizes then appropriate checks must be carried out to ensure appropriate clearance.</p> |
| 2.10 | Condition Monitoring for Disconnectors | <p>This clause is not currently applicable to SHE Transmission as condition monitoring is not applied to disconnectors.</p> <p>Clause 2.10, would be applicable to any developer's connecting at a SHE Transmission site.</p> |
| General | General | Care should be taken to consider any future requirement where SHE Transmission might need to lock a developer's plant. |

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14 NGET RES TS 3.02.04

14.1 Current Transformers for Protection and General Use

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|--------------------------------|
| N/A | N/A | No additions or modifications. |

15 NGET RES TS 3.02.07

15.1 Bushings for High Voltage Alternating Current Systems

| NG RES Clause | Description | Addition/Modification |
|---------------|-----------------|---|
| N/A | Purpose & Scope | <p>SHE Transmission will adopt any specification clauses that are relevant to Scotland on a per project basis.</p> <p>The NGET RES specification makes reference to England & Wales only.</p> |

16 NGET RES TS 3.02.09

16.1 Solid Core Post Insulators for Substations

| NG RES Clause | Description | Addition/Modification |
|---------------|-----------------|---|
| N/A | Purpose & Scope | <p>SHE Transmission will adopt any specification clauses that are relevant to Scotland on a per project basis.</p> <p>The NGET RES specification makes reference to England & Wales only.</p> |

17 NGET RES TS 3.02.14

17.1 Gas Insulated Switchgear

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|-----------------------|
|---------------|-------------|-----------------------|

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| NG RES Clause | Description | Addition/Modification |
|---------------|----------------------|--|
| 1.2 | SF6 Gas Alarm Scheme | <p>SF6 Over Pressure alarms will be set at the appropriate level by SHE Transmission.</p> <p>SHE Transmission will discuss the gas alarm scheme with the developer to determine whether a low pressure in a developer's bay should trip the SHE Transmission busbar with no warning and vice-versa.</p> <p>For reference, SHE Transmission manages the isolation of circuits with low gas pressure manually.</p> <p>Any specific requirements for an automated alarm system would need to be discussed further between NGET, SHE Transmission's Network Management Control Centre and a developer, as appropriate.</p> |

18 NGET RES TS 3.24.15

18.1 Environmental and Test Requirements for Electric Equipment

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|---|
| General | General | <p>All equipment to have relevant ENA testing as per SP-PS-408 requirements (and SP-PS-LT-910 - Draft).</p> <p>In addition, NOC documents to be attached, as appropriate.</p> |

19 NGET RES TS 3.24.34

19.1 Busbar Protection

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|---|
| General | General | All equipment to have relevant ENA testing as per SP-PS-408 requirements. |

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| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|---|
| | | | In addition, NOC documents to be attached, as appropriate. |
| | | | SHE Transmission may require High-Impedance Busbar Protection. This will be assessed/agreed on a per project basis. |

20 NGET RES TS 3.24.39

20.1 Circuit Breaker Fail Protection

| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|---|
| General | | General | <p>All equipment to have relevant ENA testing as per SP-PS-408 requirements.</p> <p>In addition, NOC documents to be attached, as appropriate.</p> <p>SHE Transmission does not require Circuit Breaker Fail as standard for 132kV and below. SHE Transmission will notify the developer on a per project specific basis. This will usually be included when the existing connection assets have low impedance Busbar Protection.</p> |

21 NGET RES TS 3.24.60

21.1 Synchronising

| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|--|
| General | | General | <p>All equipment to have relevant ENA testing as per SP-PS-408 requirements.</p> <p>In addition, NOC documents to be attached, as appropriate.</p> |

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| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|--|
| | | | Synchronising requirements shall be confirmed by SHE Transmission and will require further discussion between NGET and the SHE Transmission Control Room Centre. |

22 NGET RES TS 3.24.70

22.1 Dynamic System Monitoring (DSM)

| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|---|
| General | | General | <p>All equipment to have relevant ENA testing as per SP-PS-408 requirements.</p> <p>In addition, NOC documents to be attached, as appropriate.</p> <p>SHE Transmission requires Qualitrol IDMPPlus Fault Recorders or similar for use on the SHE Transmission System. Selected DSM equipment shall be subject to SHE Transmission approval.</p> |

23 NGET RES TS 3.24.90

23.1 Protection & Control for HVDC

| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|--|
| All | | All | <p>The design of proposed HVDC schemes will be assessed against NG TS 3.24.90 and any proposed additions to or modifications to NG TS 3.24.90 will be discussed with NGET, as appropriate.</p> <p>All equipment to have relevant ENA testing as per SP-PS-408 requirements, as appropriate.</p> <p>In addition, NOC documents to be attached, as appropriate.</p> <p>Protection & Control requirements will require further discussion between NGET and the SHE Transmission HVDC team</p> |

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| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|--|
| | | | <p>and will be assessed/agreed on a per project basis.</p> <p>SHE Transmission will consider HVDC requirements with reference to appropriate documentation as HVDC schemes are developed further.</p> <p>In some cases, other documents might supersede NGET documentation based on the specific requirements of a particular project, e.g. multi-terminal HVDC schemes might not be adequately covered by NGET documentation.</p> |

24 NGET RES TS 3.24.95

24.1 Ancillary Services Business Monitoring (ASBMON)

| NG Clause | RES | Description | Addition/Modification |
|--------------|-----|-------------|--|
| All | All | | <p>All equipment to have relevant ENA testing as per SP-PS-408 requirements.</p> <p>In addition, NOC documents to be attached, as appropriate.</p> <p>ASBMON requirements will require further discussion between NGET and the Asset Management team and will be assessed/agreed on a per project basis.</p> |

25 NGET RES PS (T) 044

25.1 Back-up Protection Grading Across Network Operator Interfaces

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|--------------------------------|
| N/A | N/A | No additions or modifications. |

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26 NGET RES PS (T) 045

26.1 Management of Rise of Potential at New and Refurbished Towers

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|---|
| General | General | To be considered with reference to Section 11 and Appendix D of this specification. |

27 NGET TGN (E) 186

27.1 Guidance for Working in Proximity to Live Conductors – Reducing the Risks

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|---|
| N/A | N/A | SHE Transmission will refer to this guidance document on a per project basis, as appropriate. |

28 NGET TGN (E) 187

28.1 Guidance for Conductor Jointing in Substation

| NG RES Clause | Description | Addition/Modification |
|---------------|-------------|---|
| N/A | N/A | SHE Transmission will refer to this guidance document on a per project basis, as appropriate. |

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Appendix A: Environmental Parameters

From SP-PS-399, 'Substation Design Specification', Table 4:

| Description | Value |
|--|--|
| Maximum Design Temperature | 40°C (30 °C average in 24 hours) |
| Minimum Design temperature | -25°C |
| Max Wind speed site reference wind speed (Vr BS EN 50341) for structures | 48m/s |
| Max Wind speed (Vz BS EN 50341) for Short circuit and wind calculations | 48m/s |
| Maximum wind speed (Vz BS EN 50341) for Ice and wind load calculations | 33m/s |
| Ice thickness (rr BS EN 50341) for equipment operation | 10mm (density 912 kg/m ³ .) |
| Ice thickness (rr BS EN 50341) for static and dynamic equipment and structures withstand | 20mm (density 912 kg/m ³ .) |

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Appendix B: Ratings – Voltage Specific Parameters

From SP-PS-399, 'Substation Design Specification', Table 3:

| Voltages between Phases (kV) | 400 | 275 | 132 | 33 | 33 Tertiary Connected to SGT's | 11 and Below |
|--|--------------------------------|-------------------|--------------------------------|--|---|-------------------------|
| Rated Voltage of Plant (kV) | 420 | 300 | 145 | 36 | 43 | 12 |
| Impulse voltage withstand (kV Peak) Phase-Earth | 1425 | 1050 | 650 | 170 | 170 | 75 |
| Impulse voltage withstand (kV Peak) Across open switching device / Isolating distance | 1425 (+240) | 1050 (+170) | 750 | NA | NA | NA |
| Switching Impulse voltage withstand (kV) Phase – Phase | 1575 | 1275 | NA | NA | NA | NA |
| Switching Impulse voltage withstand (kV) Phase – Earth | 1050 | 850 | NA | NA | NA | NA |
| Switching Impulse voltage withstand (kV) Across open switching device / Isolating distance | 900 (+345) | 700 (+245) | NA | NA | NA | NA |
| Minimum power frequency withstand voltage - 1 minute (wet) (kV rms) | 520 | 380 | 275 | 70 | 70 | 28 |
| Rated continuous current; line /cable/transformer/tertiary reactor equipment (A) | 4000 | 3150 | 2000 | 2000 ^[2] 1250 ^[2] (2200 ^[1]) | 1250 | 1250 |
| Rated continuous current; busbars & bus section / bus coupler equipment (A) | 4000 (5000 ^[1]) | 3150 | 2000 (3150 ^[1]) | 2000 ^[2] 1600 ^[2] (2200 ^[1]) | NA | 1600 |
| Rated short time current (kA 3Φ) | 40 (63 ^[1]) | 40 | 25/31.5 ^[3] | 25 | 31.5 | 25 |
| Rated short time current DC Time constant (mS) | 45 ^[2] | 45 ^[2] | 45 ^[2] | 45 ^[2] | 120 | 45 ^[2] |
| Rated short time current duration (s) | 1 | 1 | 3 | 3 | 3 | 3 |

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| Voltages between Phases (kV) | 400 | 275 | 132 | 33 | 33 Tertiary Connected to SGT's | 11 and Below |
|---|---------------------|---------------------|---------------------|---------------------|---------------------------------------|---------------------|
| Minimum clearance between live metal of one phase and earth (m) ^[4] | 2.80 | 2.10 | 1.20 | 0.50 | 0.50 | 0.50 |
| Minimum clearance between live metal of different phases (m) ^[4] | 3.60 | 2.40 | 1.40 | 0.43 | 0.43 | 0.25 |
| Minimum total air gap between terminals of the same pole of isolators (m) ^[5] | 3.60 | 2.40 | 1.40 | 0.43 | 0.43 | 0.25 |
| Gap between live and earthed arcing horns or rings (m) | 2.54 | 1.90/2.34 | 0.99 | - | - | - |
| Safety Distance (SSE Safety Rules) ^[4] | 3.1 | 2.4 | 1.4 | 0.8 | 0.8 | 0.8 |
| Minimum safety clearance between live metal and positions to which access is permissible with other equipment live (m) ³ | 5.50 ^[4] | 4.80 ^[4] | 3.50 ^[4] | 2.90 ^[4] | 2.90 ^[4] | 2.90 ^[4] |
| Working and Access Clearance vertical (m) | 5.2 | 4.5 | 3.50 | 2.90 | 2.90 | 2.90 |
| Working and Access Clearance Horizontal (m) | 4.6 | 3.9 | 2.9 | 2.3 | 2.3 | |
| Minimum insulation height (pedestrian access) (m) | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 | 2.40 |

Notes

^[1] Indicates value by exception only. SHE Transmission Development will confirm when to use this value.

^[2] A DC time constant of 45ms equates to an X/R of 14 and requires checked for suitability.

^[3] Selection by project team.

^[4] BS values used as design value in preference to Working and Access Clearance. See section 4.3 for further details on safety clearances. The Minimum safety clearance is the Safety Distance plus (2.1 m for 132 kV & below) or (2.4 m for 275 & 400 kV).

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^[5] These clearances are applicable only to equipment not subject to impulse voltage tests. They apply for conditions of maximum swing and sag. For clearances to be maintained to oil piping, see relevant transformer specification.

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Appendix C: Data Proofing

From SP-PS-406, 'Specification for Labelling on the SHE Transmission System':

- Clause 5.5 All equipment shall generally be labelled using UV resistant engraved laminated plastic labels with mechanical fixing which are clearly visible. Engraving on labels shall be of at least 6mm height unless otherwise approved. No labels should be put onto removable duct covers.
- Clause 5.6 Each circuit breaker, disconnecter and earth mechanism box, VT fuse box and marshalling kiosk shall carry a label giving the circuit name and type of device, and operating reference e.g. "Kintore/SGT1 (XT3) Line earth switch L31" with lettering height of 25mm. A second Label showing the operational reference only shall be provided with lettering height of 100mm e.g. L31. Where the size of the label results in insufficient space for their installation in a clearly visible location, the commissioning panel shall agree the label format during the design period.
- Clause 5.7 Earth Switches shall also be identifiable by colouring as indicated in SP-PS-401, Specification for Disconnectors, Earth Switches and the Provision of Portable Earthing within Substations.
- Clause 5.8 Where covers could be interchanged an additional matching label (or mechanism) shall be provided to ensure the correct cover is installed.
- Clause 5.9 General equipment labels to be white background with black lettering and Warning / hazard labels to be white background with red lettering.
- Clause 5.10 The requirements of this specification shall be additional to statutory labelling requirements.

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Appendix D: Step and Touch Potential Limits

The step and touch potential prescribed safety limits in NGET RES specification 3.01.02 are higher than those previously taken from NGTS 3.01.02 Issue 4 (March 2005)/ENA TS 41-24 Issue 1 (1992).

For reference, the values stated in NGTS 3.1.2 Issue 4/ENA TS 41-24 are:

| | Maximum Voltage for Touch | Maximum Voltage for Step |
|-------------------|---------------------------|--------------------------|
| Chippings Surface | 1400V | 4600V |
| Soil Surface | 1000V | 3100V |

For reference, the prescribed safety limits stated in the NGET RES document is stated below. It should be noted that these are almost identical to Table NA.1 of BS EN 50522, for a protection clearance time of 200msec, with the minor discrepancy being attributed to numerical rounding differences.

| | Maximum Voltage for Touch | Maximum Voltage for Step |
|---------------------------|---------------------------|---|
| Chippings Surface (150mm) | 2.06kV | Limit could not foreseeably be exceeded |
| Chippings Surface (75mm) | 1.78kV | Limit could not foreseeably be exceeded |
| Soil Surface | 1.57kV | Limit could not foreseeably be exceeded |

The higher touch potential limits may allow a reduced earthing system, i.e. most likely a reduced size of internal earthing mesh.

The NG RES 3.01.02 specification does not clearly state step potential limits. SHE Transmission will specify step potential values on a per site basis.

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