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CONTENTS

1 INTRODUCTION

2 REFERENCE DOCUMENTATION

3 HEALTH AND SAFETY REGULATIONS

4 SITE REQUIREMENTS

5 RATINGS AND SERVICE CONDITIONS

6 SUBSTATION RISK ASSESSMENTS

7 PLANT

8 DESIGN

9 CIVIL DESIGN

10 SUBSTATION LIGHT CURRENT AND AUXILIARY DESIGN

11 COMMISSIONING

12 HANDING OVER ARRANGEMENTS

13 APPLICABLE STANDARDS

1 Introduction

1.1.1 This specification is intended to be used by any parties installing 33kV substations for adoption, and/or for use, by the distribution businesses of Scottish and Southern Energy Power Distribution (SSEPD).

1.1.2 Substations shall be designed and installed in accordance with current specifications and guidance.

1.1.3 Where a third party is procuring equipment for adoption, or use, by SSEPD, the equipment shall be purchased new. Refurbished or reconditioned equipment is not acceptable. All works shall be in accordance with the Adoption Agreement and all of its' appendices.

1.1.4 This guide is not intended to be implemented retrospectively. Existing sites should not be altered unless substantial works are being undertaken. For example, a new substation building at an existing site should comply with the relevant clauses in this document.

2 Reference Documentation

2.1.1 Substations shall comply with the following reference Documents. The latest revision of all reference documents shall apply.

Table 1: List of Reference Documents

Document	Description
BS EN 60044	Instrument transformers
BS EN 60076	Power Transformers
BS EN 61936-1	Power Installations exceeding 1kV ac
BS EN 61330	High voltage/low voltage prefabricated substations
ENATS 41-24	Guidelines for the design, installation, testing and maintenance of main earthing systems in substations
ENATS 41-36	Distribution switchgear for service up to 36kV (cable and overhead connected)
ENATS 43-8	Overhead line clearances
ENATS 50-18	Design and Application of Ancillary Electrical Equipment
ENATS 50-19	Standard Numbering for Small Wiring
PR-PS-311	Procedure for Evaluating and Recording Risk Assessment on Overhead Lines and Substations - ESQC Regulations
PR-PS-353	Safety, Ownership Signs and Fencing Requirements Applicable to Substations
PR-PS-452	Updating and commissioning of Power Systems Equipment to ENMAC
PR-PS-532	Procedure for SF6 Handling and Topping Up Prefilled Equipment
PR-PS-548	Requirements for the Reporting of SF6 Emissions Plant from Installation Through to Decommissioning
PR-PS-600	Design Criteria for Transformer Bunds in Grid and Primary Substations
SP-PS-008	Value Regulated lead Acid Batteries and Chargers for Use in Substations
SP-PS-016	12kV and 33kV Pole Mounted Switch Disconnectors
SP-PS-017	Specification for 33kV Outdoor Earthed Voltage Transformers
SP-PS-021	36kV Outdoor Open Terminal Circuit Breaker Equipment
SP-PS-022	Specification for 12kV and 36kV Pole Mounted Auto-Recloser
SP-PS-024	6.6 & 11KV Indoor Metal Clad Circuit Breaker Equipment for use in Primary Distribution Substations
SP-PS-026	36KV Indoor Metalclad Circuit Breaker Equipment
SP-PS-027	6.6 & 11KV Indoor Metal Clad Circuit Breaker Equipment for use in Joint User Substations

Document	Description
SP-PS-028	Specification for 11kV Cable Joints & Terminations
SP-PS-031	Specification for the Manufacture and Supply of LV Distribution Wallboards, Cabinets, Pillars and Mini-Pillars
SP-PS-044	Specification for Non Linear Type surge Arresters for A.C. Systems
SP-PS-076	Specification for LV and 11kV Distribution Electricity Cables
SP-PS-091	Specification Overhead Line and Substation Compression Fittings
SP-PS-097	Specification for Tapes
SP-PS-098	Specification for Cable Marker Tapes, Warning Tapes and Cable Tiles
SP-PS-101	Specification for Cable Ducts and Service Tubing
SP-PS-102	Specification for Porcelain and Glass Insulators for use on Overhead Lines and Substations
SP-PS-107	Specification for Bolts, Nuts and Washers
SP-PS-114	Specification for Polypropylene and Metallic Cable Cleats
SP-PS-229	Transmission Palisade Fencing Specification
SP-PS-230	Specification for 33kV Joints and Terminations
SP-PS-232	Specification for the Supply of PAD Mounted Distribution Transformers
SP-PS-239	Specification for 11kV & 33kV Primary Distribution Cables
SP-PS-302	Specification for Separable Connectors and Connex Plugs for Cable Terminations
SP-PS-333	Copper and Aluminium Based Conductors for use on Overhead Lines and Substations
SP-PS-366	Continuous Emergency Rated (CER) & Cycle Rated (Non-CER) Medium Power Primary Transformers
SP-PS-430	Specification for 33kV Pre-fabricated Substation Switchrooms
SP-PS-431	Specification for 36kV Indoor Secondary Switchgear and Equipment for Joint User Substations
SP-PS-436	Static VAr Compensation connecting to the SSEPD Distribution System
TG-PS-074	Technical Guidance for Power Systems Earthing – 33kV Installations
TG-PS-747	Civil Engineering- Transmission Sub Station Design and Construction
TG-PS-148	Technical Guide Distribution Plant Catalogue
TG-PS-647	Technical Guidance for the Installation and Application of Auxiliary Cables
TG-PS-777	Limitation of Fire Risk in Substations
TG-PS-821	Resilience to fluvial and pluvial flooding of grid and primary substation
TG-PS-837	Technical Guide to the Ownership Boundaries for EHV Connections
TG-PS-876	Application of Surge Arresters at Voltages from LV to 400kV
IEC 60071	Insulation co-ordination

2.1.2 Where conflicts exist, documentation takes the following order of preference.

- This Specification
- SSEPD specifications
- ENA TS (or ENATS or ESI)
- BS/BS EN
- IEC

3 Health and Safety Regulations

3.1.1 The design and construction of substations, substation enclosures and equipment accesses are covered by, but not restricted to, the Construction (Design and Management) Regulations, Management of Health and Safety at Work Regulations and the Health and Safety at Work Act.

3.1.2 Designers and Contractors must ensure that the substations meet with the safety requirements of SSEPD staff or agents requiring to install, maintain or decommission plant either during construction or in the future.

3.1.3 The design of all substations shall consider access requirements for construction, operation and maintenance and subsequent removal and replacement of plant.

4 Site Requirements

4.1.1 Site selection shall consider :

- operational access; 24 hours unrestricted access must be available.
- flood risk; should be outwith 1 in 1000 year flood plain
- future expansion; space should be provided for at least one extra bay on each end section of busbar, over and above all foreseen requirements
- environmental issues; guidance for SSEPD staff is available in PR-PS-453 (Substation Site Selection Guidelines)

4.1.2 The size of the substation shall be calculated according to the design requirements below. Whenever practical, the platform (see clause 9.1) shall extend 1m beyond the security fence to allow ease of access and inspection and the landownership boundary shall extend 2m beyond the security fence. 2m is required to prevent the post and wire boundary fence being used a climbing aid to cross the security fence.

4.1.3 Where access is required via a private road or other private access, the developer will ensure that SSEPD has the legal right to use the access to get to the substation from the nearest adopted highway at any time.

4.1.4 Colour coding on legal documents shall be as follows:

- Access only over land – brown
- Access with cables beneath – brown hatched black
- Cable way easement/servitude – green
- Substation site - pink

4.1.5 The access route shall be at least 4m wide and have headroom greater than 5m. The route shall be suitable for a loaded vehicle with a weight of 60 tonnes.

4.1.6 SSEPD requires 24 hour access to all substations. Where the substations are within a secured site, or, within a building, rights will be required and provision made to permit access through the site, or common parts of the building.

4.1.7 Cable easements/servitudes, where required, shall be at least 2m wide. No development or deep rooted planting is permitted on easement/servitudes.

4.1.8 The SSEPD Wayleave Officer will purchase the substation site(s) and any associated access rights and easements/servitudes. A leasehold site will only be considered in exceptional circumstances where it is not possible to purchase the site. The lease must be for a minimum period of 99 years. Where SSEPD are adopting a site from a third party developer, the purchase or rent will be settled with a single payment of £1.

4.1.9 A substation cannot be energised until all legal work is completed. Where applicable, this includes the completion of the Adoption Agreement and associated appendices.

5 Ratings and Service Conditions

5.1.1 Substation common ratings and service conditions shall be in accordance with table 2 “General Parameters”, table 3 “Voltage Specific Parameters” and table 4 “Environmental Parameters”, unless varied by the project specific specifications.

Table 2: General Parameters

Description	Value
Power supply for electrical operation of switchgear: (a)Closing (b)Tripping	 108 V DC 108 V DC
Power supply for Scada / communications	48V or 24V
Supply voltage for auxiliary equipment	400 / 230 /110 V AC
Supply voltage for auxiliary equipment	108 / 48 / 24V DC
Minimum creepage distance over complete insulator Indoor and Outdoor Outdoor Special	 25 mm/kV IEC 60815 pollution class III 31 mm/kV IEC 60815 pollution class IV *
Insulator Shed profile	ALS

Note * Pollution Class IV will be specified for sites judged to be subject to severe costal or industrial pollution.

Table 3: Voltage Specific Parameters

Voltage between phases (kV) (nominal)	33	11 and below
Rated Voltage of Plant (kV)	36	12
Impulse voltage withstand (kV Peak) Phase-Earth	170	75
Minimum power frequency withstand voltage - 1 minute (wet) (kV rms)	70	28
Rated continuous current; line /cable/transformer (A)	2500 2000 1250	2000/2500 1250 630
Rated continuous current; busbars & bus section / bus coupler equipment (A)	2500 2000	2000/2500 1250 630
Rated short time current (kA 3Φ)	25	25
Rated short time current DC Time constant (mS) [1]	45	45
Rated short time current duration (s)	3	3
Minimum clearance between live metal of one phase and earth (m)[2]	0.50	0.50
Minimum clearance between live metal of different phases (m)[2]	0.43	0.25
Minimum total air gap between terminals of the same pole of isolators (m)[2]	0.43	0.25
Gap between live and earthed arcing horns or rings (m)	-	-
Safety Distance (SSE Safety Rules)	0.8	0.8
Working and Access Clearance vertical (m)	2.9	2.9
Working and Access Clearance Horizontal (m)	2.3	2.3
Minimum insulation height (pedestrian access) (m)	2.40	2.40

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

Table 4: External Environmental Parameters

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 (sites < 200m altitude)	48m/s
Max Wind speed (Vz BS EN 50341) for Short circuit and wind calculations (sites < 200m altitude)	48m/s
Maximum wind speed (Vz BS EN 50341) for Ice and wind load calculations (sites < 200m altitude)	33m/s
Radial Ice thickness (r_r BS EN 50341) for equipment operation	10mm (density 912 kg/m³.) (20mm shall be used if the site is outdoors in Scotland at an altitude of > 200m)

6 Substation Risk Assessments

6.1 ESQC Regulations

6.1.1 Risk assessments shall be conducted in line with PR-PS-311. This procedure requires an initial risk assessment at the start of the design; once a site has been selected. The assessment shall then be revised prior to commissioning.

6.1.2 The risk assessment shall categorise the substation as High, Medium or Low risk.

6.2 Oil Risk

6.2.1 Oil risk assessments shall be conducted in line with PR-PS-311.

6.3 Security

6.3.1 The Site Security Risk Index (SSRI) shall be calculated in line with PR-PS-353. This assessment will define the required security provision at the substation.

6.4 Fencing and Signing Requirements

6.4.1 The above risk assessments are used to define the required signs and fencing for the substation in accordance with PR-PS-353.

7 Plant

7.1 Ratings

7.1.1 Switchgear ratings shall be chosen to ensure the circuit capacity is not restricted by the switchgear under any circumstances. Ratings shall be selected from options listed in table 3.

7.1.2 For transformer circuits where the transformer has a Continuous Emergency Rating (CER), any associated cables and switchgear shall be rated to match or exceed the transformer CER rating.

7.1.3 For transformer circuits where the transformer is specified to BS EN 60076 (non-CER), any associated cables and switchgear shall be rated for at least 130% of the transformer nameplate rating.

7.1.4 For cable circuits, the switchgear rating shall be rated for at least the cable circuit winter loading with no de-rating for any parallel circuits.

7.1.5 For overhead line circuits, the switchgear shall be rated for at least the maximum post-fault winter rating.

7.2 Primary Transformers

7.2.1 Primary transformers shall comply with SP-PS-366.

7.2.2 SSEPD staff shall contact procurement for details of the current framework providers.

7.3 Provision of equipment other than on current SSEPD contract

7.3.1 Whenever appropriate, plant items shall be selected from the Distribution Plant Catalogue (TG-PS-148). This ensures that SSEPD staff are operationally familiar with it, spares are held, it is fit for purpose and important ancillary equipment is available for use (such as earthing trucks etc.). If other manufacturers, or other types of, equipment are specified, SSEPD require that

- It is fit for purpose. Generally this means complying with Energy Networks Association (ENA) Technical Specifications and usually passed ENA assessment (Notice of Conformity)..
- Adequate training is provided for SSEPD operational staff likely to use the equipment.
- Installation, Operation and Maintenance Manuals are provided for SSEPD use and short-form manuals are provided giving basic operational requirements.
- Minimum quantities of spares are provided or are available on site for all likely failure modes of the equipment. For certain types of plant this may involve a replacement item rather than parts.

7.3.2 It is important that equipment is not ordered until written confirmation of its acceptability to SSEPD has been received. Within SSEPD, acceptability of plant is decided by Engineering Policy who will produce a Technical Authority Report once the information in 7.3.1 is provided.

7.3.3 Each proposal is considered on its individual merits for suitability of connection to the SSEPD Network. This may result in rejection of the proposal should any of the above not be complied with.

7.3.4 Parties seeking to use equipment not previously approved by SSEPD shall submit full details, in English, including:

- Details of any applicable Notices of Conformity or Type Registrations
- A list of exceptions, stating where the equipment does not comply with any appropriate ENATS and SSEPD specification.
- Arrangement drawings and wiring diagrams
- Operation and maintenance manuals
- Reference lists
- Material specifications
- Type Test reports

SSEPD will then assess the plant. The Quality and Approval process may take some time and attract a charge for the work. In addition there may be a requirement for suppliers to undertake modifications (at their own expense) to the operational and safety aspects of the equipment to comply with SSE Power Distribution working practices and to provide operational spares where replacements cannot be made for SSEPD standard strategic stock.

8 Design

8.1 Substation Design

8.1.1 Substation design shall generally comply with BS EN 61936-1.

8.1.2 The neutral earthing on both the 11kV and 33kV systems shall generally be single point earthing via resistors at source. Direct earthing is used when the source transformer is rated below 5MVA. The resistors and earthing transformers are sized to limit earth fault current infeed from each transformer to 750A on the 33kV network and 625A on the 11kV network. A small number of sites in Scotland use different earthing arrangements. Specific details will be provided by SSEPD System Planning where required.

8.1.3 At 33kV and below, it is preferred that new substations are designed to eliminate the HV zone by utilising indoor metal-enclosed switchgear and cable connections. This will be prohibitively expensive for small sites and it is recognised that HV zones will continue to be provided in many cases.

8.1.4 Sufficient disconnecters shall be provided to allow all plant items on site to be isolated for maintenance without the need to visit another site. This requirement does not apply to the line disconnecters, line earth switches or line surge arrestors.

8.1.5 Prior to completing a substation layout, a main connections and protection single line diagram shall be produced and accepted by the SSEPD project manager. The main connections and protection single line diagram shall show all primary plant, nomenclature, instrument transformers and their associated protection schemes. Plant ratings, vector groupings and ratios shall be shown as appropriate.

8.2 Overvoltage Protection

8.2.1 The Basic Insulation Level (BIL) shall be chosen according to table 3.

8.2.2 Surge arresters shall be provided at all overhead line entries to a substation where the overhead line design does not encompass an earthwire. The surge arrestors shall generally be installed on the overhead line terminal pole.

8.2.3 Surge arresters shall be provided on all exposed air insulated cable terminations. The surge arrestors shall be installed as close as practicable to the cable terminations.

8.2.4 Surge arresters shall be provided on all air insulated 33kV transformer bushings.

8.2.5 Surge arresters shall also be provided at any points where switching overvoltages may be expected; such as at the terminals of reactive compensation devices which are switched without specific control measures such as point-on-wave switching.

8.2.6 Guidance for SSEPD staff on the application of surge arresters can be found in TG-PS-876.

8.3 Clearances

8.3.1 Circuits shall be arranged to ensure that one can be maintained whilst all others remain live. Consideration shall be given to the arrangement of future bays.

8.3.2 Minimum clearances stated in Table 3 shall be complied with.

8.3.3 The design shall ensure adequate clearance is allowed such that MEWP's and other access equipment can access any point of work. Design shall be based on a MEWP with the following characteristics as shown in Figure 1:-

- Maximum height of MEWP with boom lowered for transport: 2290mm
- Maximum height of MEWP platform when lowered for transport 1100mm

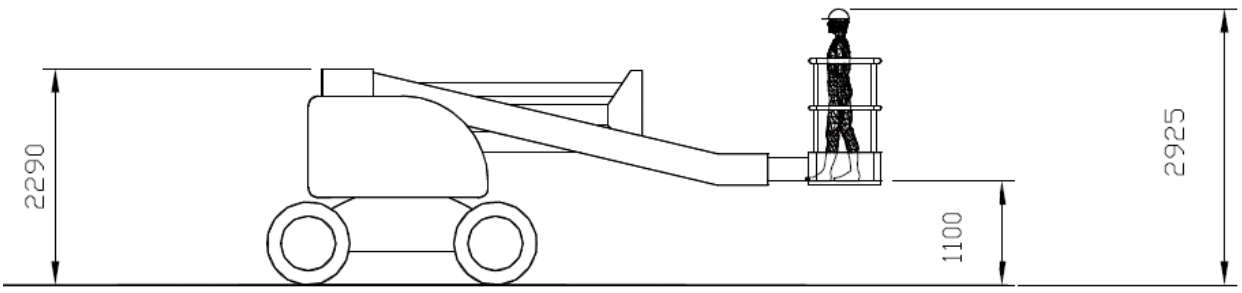

Figure 1: Dimensions of MEWP used for maintenance

8.4 AIS Substation Layout

8.4.1 Working and access clearance shall be provided between live equipment and any point of the security fence.

8.5 Indoor Substation Layout

8.5.1 The substation building and doors shall be of a suitable size to allow any individual panel of switchgear to be removed and replaced without moving any other switchgear panel and without any temporary works to the building or other plant.

8.5.2 Manufacturers minimum clearances will be provided on all sides of, and above, the metal-enclosed switchgear. In addition, there shall be sufficient space within the substation to allow safe access to and operation of all equipment with a minimum of 600mm clearance to the sides and rear of the switchgear, 500mm from an open switchgear or panel door and 1000mm to the front. The minimum unobstructed width of the escape route shall be not less than 900mm. Where the switchgear design and housing construction allows (i.e. access for jointing, VT replacement etc. and internal arc venting) the switchgear may be mounted adjacent to the rear wall. These minimum clearances may only be reduced with specific agreement from SSEPD Engineering Policy.

8.5.3 If the metal-enclosed switchgear is not at ground level then a landing platform shall be provided to allow switchgear panels to be offloaded onto the platform and then skidded into the switchgear room.

8.5.4 Consideration shall be given to cable access and the provision of sufficient space to undertake cable jointing. Suitable options include cable trenches, basements, installing the switchgear above ground level with an undercroft or using inverted cable boxes.

8.5.5 Inverted cable boxes or installing the switchgear above ground level avoid any issues with confined space or water ingress below ground level. These solutions should be considered the preferred options.

8.5.6 Cable trenches are generally lower cost and are preferred over cable basements. Cable trenches become impractical if the position of the termination on the switchgear is too low down for practical working. Cable trenches are also highly restrictive if the cable circuits need to cross each other within the confines of the substation. In such circumstances, cable basements should be provided.

8.5.7 All basements shall have a minimum of two access routes; at least one of which much be a staircase complete with handrails. Where a cable basement is greater than 8m in length, a staircase access shall be provided at both ends. Cable basements shall be sealed against water ingress and provided with a pump and water level alarm. The minimum height for a cable basement is 2.0m measured from the floor to the lowest point of the ceiling construction.

8.6 Earthing

8.6.1 Earthing shall comply with TG-PS-074 and ENATS 41-24.

8.6.2 TG-PS-074 states a target substation earth resistance of less than 1.0 Ohm. Where post-construction testing of the earth resistance is not considered practical, usually because of an urban location, then a specialist consultant shall be employed to survey the site and design the earth mat.

8.6.3 All substations shall have a separately earthed boundary fence. Advice must be sought from Engineering Policy if it is not possible to achieve a separately earthed fence.

8.6.4 The Rise of Earth Potential (ROEP) for the site shall be calculated according to ENATS 41-24. Where the ROEP exceeds 430V, the site is classed as a hot site. A final record drawing shall be provided which identifies the contour of the 430V ROEP around the site.

8.7 Line Landing Gantries/Wood Pole Terminations

8.7.1 The substation designer is to design gantries, or wood pole terminations, to comply with the overhead line design, both to achieve the designed wire clearance and to ensure gantries are capable of withstanding the forces on the downleads. Wire clearance and down lead force data will be provided by the overhead line designer.

8.7.2 Where wood poles are used within a substation, clearances shall be sufficient to allow access by MEWP.

8.8 Interlocking

8.8.1 Key interlocking shall not be provided at 33kV substations, with the exception of the 33kV incomer from the 132kV network where the 132kV network utilises manually operated disconnecters and earth switches. In this specific case, the opening of the 33kV incoming circuit breaker shall release a key which shall then prevent operation until the key is returned. The key shall be utilised on the 132kV network to allow the operation of the transformer disconnecter.

8.8.2 Metal-enclosed switchgear shall include mechanical or electrical interlocking of disconnecters and earth switches to prevent inappropriate operation.

8.9 Fire Prevention

8.9.1 Fire Prevention shall be in accordance with TG-PS-777.

8.10 Outdoor Lighting

8.10.1 A complete floodlighting scheme shall be provided to achieve a maintained average of 6 lux illumination throughout the HV compound and transformer enclosures. The maintained minimum point illumination shall be 2.5 lux measured at ground level. All floodlights must be accessible for maintenance without circuit outages. Floodlights to be controlled from inside the substation building.

8.10.2 Lights with passive infrared (PIR) detectors are to be provided to illuminate the access gates and doors to assist personnel entering the site during the hours of darkness. PIR detectors shall not be provided external to the site if they are likely to cause nuisance.

8.11 Equipment Life

8.11.1 The substation is to be designed with the following design life:-

- HV Equipment, above ground structures and buildings to have a life of 40 years.
- Protection & Control Equipment to have a life of 40 years.
- Below ground foundations to have a life of 50 years.

8.12 Cable Systems

8.12.1 Cable shall be compliant to the relevant cable specifications, detailed in the reference section. Earthing arrangements are specified in TG-PS-074.

8.12.2 Cable ratings shall match or exceed the rating of the circuit or transformer that they are associated with. It is not necessary to match the rating of the associated switchgear.

8.13 Busbar Systems

8.13.1 Busbar ratings, busbar sizes, life cycle and service conditions shall be in accordance with tables 2, 3 and 4.

8.13.2 For AIS substations, a layout drawing shall be provided which shall show the complete busbar systems including each type of clamp and section of busbar together with a component schedule.

Wind Loads

8.13.3 Substations located up to 200m above sea level shall be based on an effective wind speeds shown in table 4. Substations more than 200m above sea level will have wind loads calculated on a per project basis

Ice Loads

8.13.4 The weight of ice deposited shall be calculated, assuming a uniform coating of ice thickness through out the length of busbar systems. The basic thickness of ice shall as shown in table 4.

Busbar End Caps

8.13.5 All sizes of hollow tubular busbars shall be fitted with end caps to avoid water / moisture ingress creating additional unnecessary loading to the busbar systems. Busbars shall not be drilled to create drainage holes.

8.14 Gantries & Support Structures

8.14.1 It is preferred if all new structures are fabricated in aluminium to avoid corrosion, to avoid the need for mounting earth tapes on the structure and to aid handling. Concrete structures may be utilised on existing sites where it is more economical.

8.14.2 Steel may be used where structural requirements would result in aluminium structures being particularly large and difficult to accommodate or where switchgear manufacturers only offer steel, e.g. circuit breaker supports, pantograph supports or line entry gantries. Steel structures shall be provided with a protective metallic zinc coating which shall be hot-dip galvanising conforming to ISO 1459, 1460 and 1461 to the minimum average coating mass (on 10 samples) of 500g/m².

8.14.3 Where steel structures are supplied to support equipment then the equipment shall be bonded to the earth mat with a fully rated copper earth connection. The earth tapes shall be secured along the structures so as to deter any interference.

8.14.4 The supplier shall demonstrate that the strength and capability of structure, line landing gantries, primary equipment support structures and foundations exceed the requirements for the loading combinations in this specification.

8.14.5 Any hollow structures shall be designed to avoid the collection of water.

8.15 Labelling

8.15.1 All plant, equipment, kiosks, panels, marshalling cubicles, storage locations, access points, transfer drain and filling points and other installed items shall be uniquely labelled to allow an authorised person to clearly understand their function and contents, and to distinguish between items of similar function. All items installed under the civil, mechanical or electrical works allowing access, requiring maintenance, or having contents of any form, shall be labelled.

8.15.2 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 black lettering on a white background unless otherwise approved.

8.15.3 Each circuit breaker, disconnecter and earth switch mechanism box, VT fuse box and marshalling kiosk shall carry a label giving the circuit name and plant nomenclature with a lettering height of at least 25mm.

9 Civil Design

9.1 Platform and Earthworks

9.1.1 The substation equipment will be built on a level site. It is acceptable for a substation to utilise several platform heights provided maintenance access is available on level ground around all plant.

9.1.2 The platform is constructed in the layers noted below:

- Finished Platform level 75mm thick 20mm angular gravel for earthing purposes.
- Sub Platform level capping layer of 200mm thick Type 1 sub base material

9.1.3 The sub-platform shall have a minimum bearing capacity >= 100kN/m^2.

9.2 Drainage and Flood Resistance

9.2.1 Each substation site will have its own drainage scheme. All substations will be designed to drain efficiently and result in no ponding or flooding within the site boundary. The drainage design shall be minimised by use of porous surfaces wherever possible.

9.2.2 A flood analysis shall be carried out against a 1 in 100 year (fluvial) and 1 in 200 year (pluvial and coastal) flood risk. Suitable mitigation shall be incorporated into the design to protect the site against risk identified in the analysis. Primary substations shall generally be designed to provide level 2 resilience as defined in TG-PS-821. TG-PS-821 also provides guidance on options for flood mitigation.

9.2.3 All existing drainage around any proposed site must be diverted out with the site where possible and reconnected to its original path. Attenuation ponds may be constructed to deal with volume capacity of existing water courses. Every effort shall be made to pass surface water run off from roofs and

surfaced areas free from the potential of pollution to a water course either via a Sustainable Urban Drainage System (SUDS) or directly in accordance with SEPA or EA guidelines.

9.3 Equipment Foundations

9.3.1 All foundations for electrical equipment will be designed based on the electrical design loadings. It is preferred that any structures are fixed to structural bases by resin anchor.

9.3.2 All in-situ cast structural concrete foundations will have full formwork/ falsework, there will be no mass pour unsupported foundation construction. All concrete edges will have a 50mm chamfer finish. All finished concrete will have a steel float finish. Precast concrete units may be used.

9.3.3 The exposed surface area of the plinth above the substation finished level shall be kept to a minimum whilst ensuring the integrity of all fixing bolts. To assist with MEWP clearances, equipment plinth designs will not exceed 150mm from the holding down bolts to the inside edge of the chamfer. The structures feet, plinth and bolt selection will have to be co-ordinated to ensure this is not exceeded.

9.3.4 All foundations are to sit 75mm above finished platform level.

9.4 Substation Roads

9.4.1 Substation roads shall be at least 3m wide with an internal radius of at least 3m.

9.4.2 Transformer delivery roads shall be at least 4m wide. Transformer delivery roads will have an internal radius of at least 8m. Project specific issues may alter the design of transformer access roads and site access requirements; the objective being to ensure the transformer transporter can deliver the transformer and then be manoeuvred or turned to minimise road closures.

9.4.3 Busbars over roads that are designated transformer deliver roads shall have a minimum height of 5.8m (Safety Distance plus 5 metres) to allow for the highest transport loads.

9.4.4 The main access road to the substation building will have kerbs installed on each side of the roadway. The minimum cross fall across the road will be 1in 40. Drop kerbs will be installed at designated MEWP access points. A minimum of two parking spaces shall be provided within the site off the main access road; without infringing access for large vehicles.

9.5 Multicore Cable Trenches & Ducts

9.5.1 All control cabling within the substation footprint will be run within a secure duct and/or trench system from its point of connection to the control building. No cabling will be laid directly within the platform construction. All ducting will have a minimum cover of 500mm of hardcore and shall have a warning tape laid 300mm above all ducts.

9.5.2 Multicore Cable Trenches and Ducts shall be sized to allow for the ultimate redevelopment of the substation including spare capacity. The initial design will allow for the routing of cabling for all future bays envisaged in the substation layout without the removal of the initially installed cables. To ensure this is possible, no more than one third of the available trench and duct capacity shall be used in the initial installation.

9.5.3 All UPVC ducting will be black in colour for control cables and dimensioned based on the electrical design requirements. The interior of all ducts will be smooth walled and fully roped between draw pits and trenches. Bend radius of ducting will be a slow radius and be an ancillary product to the specified system with a maximum radius of 90 degrees.

9.6 Substation Building

9.6.1 The substation building may be of a brick, block or steel portal frame construction or, if specifically approved by SSEPD, prefabricated GRP construction. The provisions of SP-PS-430 shall be applied.

9.6.2 The substation building shall include the following separate rooms as a minimum:

- 33kV switchgear room (if required)
- 11kV switchgear room (if required)
- Control / store room

Certain sites may also require:

- Separate store
- Toilet

9.6.3 Switchgear rooms shall take the metal-clad switchgear layout into consideration as detailed in section 8.5. Two means of egress shall be provided. Where a site has both 11kV and 33kV switchgear and, at either voltage, the switchgear is arranged as a single busbar section, then it is permissible for the 11kV and 33kV switchgear to share the same room.

9.6.4 The control room shall contain the LVAC switchboard, DC batteries and chargers, communications, control and relay panels as required, RTU, control HMI on a suitable desk and filing cabinet for final records. The room shall be suitably sized to allow 1m access around all suites of panels including all future provision. Two means of egress shall be provided.

9.6.5 The store shall have minimum dimensions of 3m x 2m and shall be equipped with shelving along one wall. All sites with more than one busbar section at any voltage shall be provided with a separate store. The store may be provided externally to the building. Smaller sites may have storage facilities provided in the control room.

9.6.6 All substations should be provided with a toilet unless it is demonstrated that such provision is unreasonable. The cost of providing a toilet is considered unreasonable if an alternative 24 hour facility is available to SSEPD staff within 10 minutes travel under normal circumstances. Where possible a potable water supply will be run to the site. Where this is not practical a gravity-fed rain harvesting system will be installed for flushing toilets only.

9.6.7 The building services shall include internal and external lighting, emergency lighting, small power, heating, ventilation, fire/smoke alarm system, intruder alarm system, telephone system and sanitary installations.

9.6.8 Internal finishes shall be simple but durable, e.g. painted blockwork or cladding; all finishes shall be appropriate for the location at which they are to be used.

9.7 Fencing

9.7.1 Security fencing and additional security measures shall be provided in accordance with PR-PS-353 and SP-PS-229.

9.7.2 The purchased land limit of any substation will be delineated with a post and wire fence as a minimum.

9.8 Transformer Oil Containment Bunds

9.8.1 Oil containment bunds shall be provided in accordance with PR-PS-600.

10 Substation Light Current and Auxiliary Design

10.1 Protection Design Requirements

10.1.1 Provision is to be made, in accordance with the specified Protection Scheme, for all the panels required to accommodate relays and other protection equipment such as V/T's and C/T's which are not an integral part of other equipment. Provision is also to be made to accommodate the DC battery cabinet required for protection monitoring and tripping and the back up supply for the communications as well as the communications cabinet.

10.1.2 Provision for additional space shall be made to accommodate extra Protection equipment required if expansion of the substation is allowed by the design plan.

10.2 Outdoor Kiosks, Control Boxes and Mechanism Housings

10.2.1 Outdoor Kiosks, Control Boxes, Mechanism Housings and other outdoor enclosures are to be weatherproof to IP55 and constructed in either stainless steel or aluminium, and designed to withstand severe salt corrosion. They are to be supplied complete with all the necessary terminal

blocks, multicore cable glands, labels and anti-condensation heaters. Fuse boxes to be fitted with appropriate rating and number of fuses. An earth terminal suitable for 70mm^2 conductor is to be incorporated.

10.2.2 All handles and locking points must be provided with the facility for fitting a padlock device which will be supplied by SSEPD. Handles with integral locks or those operated by a separate removable panel keys are not acceptable.

10.3 Relay Panels

10.3.1 Relay panels to be in accordance with SP-PS-455.

10.4 Auxiliary Supplies and LVAC Switchboard

10.4.1 Two LVAC supplies shall be provided for primary substations. LVAC supplies shall generally be taken from the auxiliary transformer on the primary transformer(s).

10.4.2 The electrical installation shall be carried out in accordance with BS7671:2008+A1:2011 Requirements for electrical installations. IET Wiring Regulations. Seventeenth edition.

10.4.3 A wall-mounted LVAC switchboard shall be provided; generally in accordance with BS EN 61439. Top and bottom cable entry shall be provided.

10.4.4 Where two LVAC supplies are provided, there shall be provision for an automatic changeover system either using MCCB's or contactors

- The first changeover from the first or second supply (normally selected to first supply shall be initiated when the incoming volts drop by 25% or more on any, or all, phases.
- On reinstatement of either first or second supply the system shall revert to the normal supply. Changeover to the normal supply should only be instigated when the supply has remained live for 30 seconds.

10.4.5 A three phase and neutral distribution board complete with suitably rated and sized MCB's and integral appropriate sized switch disconnector conforming to BS EN 60439-3 and BS 5486-12 to be fitted adjacent to the incoming fused isolator / 60A fused cutout.

10.4.6 The following equipment is to be provided / connected:

- A suitably rated fused spur / MCB supplying the trip/close battery charger
- A 13A fused spur / MCB supplying the scada battery charger.
- A 13A fused spur / MCB supplying a 230/110V transformer.
- A 5 way 110V ac distribution board fitted with appropriate MCBs.
- A 5A lighting circuit.
- A 16A, 3 pin industrial, 230V socket will be provided to connect an external generator with an access facility to the building or within a secure external fitting connected via a changeover switch to the LVAC panel.
- Loss of supply relays will be provided to indicate loss of low voltage supplies to substation auxiliary supply. An alarm shall be sent to the Network Management Centre for loss of either LVAC supply.

10.4.7 No provision for metering is required.

10.4.8 Grading of all fuses, MCCB's, MCBs and protection devices shall be provided to ensure discriminative clearance of all possible faults on the LVAC auxiliary supply system.

10.5 DC Auxiliary Supplies

10.5.1 DC supplies shall comply with SP-PS-008. Tripping supplies shall be on a separate DC system to telecontrol supplies.

10.5.2 Due to the size and the weight of the batteries, the battery cabinet must be sited with sufficient surrounding space to enable the easy maintenance and replacement of the batteries using appropriate mechanical handling equipment as well as storage space for the mechanical handling equipment. The flooring must be capable of carrying the concentrated load of the battery banks.

10.5.3 Third party users may not connect to SSEPD owned DC systems.

10.6 Multicore Cabling

10.6.1 Multicore cabling shall be in accordance TG-PS-647 “Technical Guidance for the Installation and Application of Auxiliary Cables”.

10.6.2 All cables shall be steel wire armoured.

10.6.3 All multicore cabling above ground level without exception shall be fixed/supported by heavy duty galvanised or stainless steel cable tray. The location of tray work must take account of switchgear operations and operating handle arcs, and remove any trip hazards.

10.6.4 Final records are to include cable schedules and core sheets.

10.6.5 All cables must be permanently identified at both ends with due regard to the environment in which it is installed. Where more than one cable enters a panel cable identification shall be applied internally and externally immediately adjacent to the glands, or in a readable position, to TG-PS-647.

10.7 Real Time Systems (RTS)

10.7.1 The RTS delivery department shall order and supply the necessary equipment to connect all substation equipment to Enmac.

10.7.2 The process for RTS engagement and delivery is described in PR-PS-452. RTS shall coordinate the delivery of a communications circuit for the RTU.

10.8 Communications

10.8.1 Communications circuits shall be provided via SSE Telecomms. The circuit shall be ordered by the SSEPD RTS project manager via the IT Service Centre.

10.8.2 All primary substations shall be provided with an SSEPD internal phone line.

10.8.3 Protection systems may require additional communications circuits. Any such requirement must be notified to the SSEPD RTS project manager.

10.9 Metering

10.9.1 Metering must be purchased and installed according to the appropriate Code of Practice of the Balancing Settlement Code for England and Wales or the Settlements Agreement for Scotland.

10.9.2 If CTs are required they must be specified to BS EN 60044 with an accuracy of Class 0.5. VTs must be specified to BS EN 60044 with an accuracy of Class 1.

10.9.3 CT and VT calibration certificates must be supplied to SSEPD on or before handover of the substation.

10.9.4 A separate cable is required from the meter panel to pick up a volt free contact for fuse-failure and phase-imbalance alarms. The panels require a dedicated 110V DC metering auxiliary supply that may be looped between panels.

10.9.5 Further guidance on metering is available in TG-PS-837.

11 Commissioning

11.1.1 The commissioning of the equipment is the last opportunity to find faults and errors in the installation before the distribution system is exposed to unnecessary risk and the consequential risk to security of supply and company reputation. As such commissioning should be undertaken in a logical, diligent and professional manner and the approach taken by the commissioning team should be to assume all is incorrect until proven otherwise. The SSEPD Project Manager shall be advised prior to the commencement of any commissioning tests to allow for witnessing to be arranged as appropriate.

11.1.2 The following commissioning tests shall be undertaken and test evidence shall be provided to SSEPD.

- Internal wiring inspection
- Insulation resistance
- CT ratio and mag curves

- Secondary Injection
- Primary Injection
- Functional Checks, including interlocking
- Scada tests
- Load/stability checks
- Phasing checks
- HV pressure tests
- Ductor tests
- Substation earth resistance measurement
- Other equipment specific commissioning such as switchgear timing tests, transformers and dc systems

12 Handing Over Arrangements

12.1.1 A certificate of commissioning and handing over shall be provided and accepted by a representative of SSEPD. SSEPD document FO-PS-110 shall be used for this purpose.

12.1.2 Where appropriate the Adoption Agreement and all appendices shall be completed and retruned to SSEPD.

12.1.3 Final records shall be provided in electronic and paper format. The paper copies shall be left on site in a suitable cabinet. The electronic copies shall be provided to the SSEPD project manager for entry into appropriate record systems. Records are required as follows:

- Land title drawings
- Wayleaves and easements/servitudes
- Substation layout and sections
- Cable schedule
- Earthing layout
- Earthing survey and 430V contour plot
- Civil layout
- Building design drawings
- Foundation details
- Cable route drawings
- General arrangements, schematics and wiring diagrams of all plant items
- Transformer and switchgear test certificates
- Current transformer magnetisation curves
- Protection schematics and wiring diagrams
- Protection settings applied
- Operation and maintenance manuals
- Other records deemed necessary for the specific substation

12.1.4 The SSEPD project manager shall ensure that all SSE databases are updated and final records lodged in the appropriate locations.

12.1.5 The substation building will be checked by SSEPD Civil Engineering Section to ensure suitability of plinths, cable trenches and ventilation. Any remedial work required shall be carried out prior to its' final acceptance and energisation

13 APPLICABLE STANDARDS

13.1.1 Third Parties must obtain copies of non SSEPD Standards, such as BS or ENA documents, from the issuing organisations at their own expense. These documents may be subject to copyright.

13.1.2 Documents for use by third parties are classified as Public and are available on the SSEPD website, http://www.ssepd.co.uk/Library/ConnectionsUsefulDocuments/

13.1.3 Documents not displayed on the internet are not publically available as they are deemed not to be needed by third parties. Where third parties require copies of these SSEPD documents they can be

requested from the SSEPD Power Systems Document Administrator, Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ.

13.1.4 There will be a cost of £150 for each copy of each document (irrespective of size). This cost is due to the administration required to ensure that updates to the documents (which are controlled) are sent out to third parties.