1 SCOPE

This Specification outlines SP Energy Networks (SPEN) technical requirements for the civil design and construction of 275kV and 400kV Substations.

This is a generic technical specification written in a manner that it may be used without alteration for all such works therefore certain parts may not be applicable to all substation construction types. It is not designed to cover every eventuality or site-specific situation; however, prior agreement must be obtained in writing from SPEN Engineering Design and Standards for any proposed variations to the guidelines provided in this Specification.

As far as is reasonably practicable, this Specification shall also apply to works at existing SPEN substation sites, however; this will be determined on a site-specific basis by agreement with SPEN, Engineering Design and Standards considering technical feasibility, cost and site-specific risk.

2 ISSUE RECORD

This is a Reference document. The current version is held on the EN Document Library.

It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
December 2023	Issue 4	Gareth Rees	Section 10.4.1.1 added to consider sustainable design. Updates to flood section inline with new policy. Changes to climate change allowance for drainage. Changes to concrete strength to allow for GGBS. Earthing changes to reflect policy. Changes to timber type for doors.
May 2026	Issue 5	Callum Sharp	Section 12.3 Reference earthworks specification. Section 12.4.3 BS rating of covers adjusted, and additional category added. Section12.5 CEM I restriction added. Section 12.7.3 and 14.5 EV Charger requirements added. Section 12.7.4 Access for Maintenance Added. Section 12.15 SHS and CHS structures removed.

3 ISSUE AUTHORITY

Author	Owner	Issue Authority
Callum Sharp Lead Civil Engineer	Craig Young Engineering Design Manager	Fraser Ainslie Head of Engineering Design and Standards Fraser Ainslie Digitally signed by Fraser Ainslie Date: 2026.05.28 18:22:51 +01'00' Date: .....

4 REVIEW

This is a Reference document which has a 3 year retention period after which a reminder will be issued to review and extend retention or archive.

5 DISTRIBUTION

This document is part of the SPT System Design Virtual Manual maintained by Document Control, but does not have a maintained distribution list. It is also published to the SP Energy Networks website.

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7 GLOSSARY

275kV and 400kV	An assembly of High Voltage Switchgear up to 420kV together with associated Control and Ancillary equipment where the lowest voltage is 400/230V and which may also include one or more Transformers and/or Reactors at voltage levels of 400/275/220/132/33kV all housed within secure enclosures
Adopt	Transfer of title, ownership, operation and maintenance responsibilities as defined in the adoption agreement
AEP	Annual exceedance probability flood event.
AIS	Air insulated Switchgear
Approved	Equipment which is Approved in accordance with SPEN documents for use or installation on the Company network
ARC	Alarm Receiving Centre operated by Corporate Security or 3rd party
CDM Regulations	Construction (Design and Management) Regulations
Civil	Reference to civil or similar shall mean civil, structural and building engineering and shall apply to the design, manufacture, installation and demolition of all related permanent works
CNI	Critical National Infrastructure as defined by the National Protective Security Authority
Company	Refers to SP Distribution plc, SP Transmission plc, SP Manweb plc
Deemed to Satisfy	Considered fit for the Company's purpose and compliant in principle with this Specification by and without further reference to SPEN
Designed flood level	The flood level plus an allowance for climate change.
ED&S	SPEN Engineering Design and Standards
Energisation	The application of Voltage to an item(s) of Equipment from the system
Equipment	Switchgear, transformers, cables, overhead lines, surge arresters, voltage transformers, current transformers, protection & control, telecommunications, unit substations
FSC	Forest Stewardship Council
GIS	Gas insulated Switchgear
GRP	Glass Reinforced Plastic
GPRS	General Packet Radio Service is a packet oriented mobile data standard on the 2G and 3G cellular communication network's global system for mobile communications
High Voltage (HV)	An AC voltage exceeding 1000 volts measured between the phase conductors
ICP	Independent Connection Provider
Indoor Equipment	Equipment designed solely for installation within a building or other housing where the Equipment is protected against wind, rain, snow, abnormal dirt deposits, abnormal condensation and frost
ISS	Integrated Security System
LED	Light Emitting Diode
LPS	Loss Prevention Standards

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Low Voltage (LV)	An alternating current (AC) voltage not exceeding 1000 volts measured between the phase conductors
National Environment Agency	Environment Agency (EA) in England Natural Resources Wales (NRW) in Wales Scottish Environment Protection Agency (SEPA) in Scotland
NGTS	National Grid Technical Specification
Outage	De-energisation of an item(s) of Equipment on the Company's electricity network system
Outdoor Equipment	Equipment designed to be suitable for installation out with a building or other housing where the Equipment is not protected against wind, rain, snow, abnormal dirt/salt deposits, abnormal condensation and frost
PEFC	Programme for the Endorsement of Forest Certification
SCADA	Supervisory Control and Data Acquisition
SP Distribution plc (SPD)	The Distribution Licence Holder for the distribution service area formerly known as ScottishPower
SP Transmission plc (SPT)	The Transmission Licence Holder for the transmission service area formerly known as ScottishPower
SP Manweb plc (SPM)	The Distribution Licence Holder for the distribution service area formerly known as Manweb
SPEN	SP Energy Networks, the brand name for the division of the ScottishPower group of companies that encompasses SP Distribution plc, SP Transmission plc, SP Manweb plc, SP Power Systems Ltd and SP Energy Networks Holdings Ltd
SRA	Security Risk Assessment conducted by ScottishPower Corporate Security
SUDS	Sustainable Urban Drainage Systems
Transformers	Reference to Transformers shall mean Transformers and Reactors

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8 RELATED DOCUMENTS

The design and construction of the works shall be in accordance with the relevant Eurocodes and British Standards specific to that design element. This is detailed further in Section 11 "Standards" of this Specification.

8.1 Specific SPEN Documents

ASSET-01-023	Substation Security Policy
CAB-15-004	Handling and Installation Requirements for 132kV Power Cables
EART-03-002	Technical Specification for Earthing 132kV S/S and above
SUB-01-012	Substation Fire Protection Policy
SUB-01-018	Substation Flood Resilience Policy
SUB-03-017	General Specification for the Civil Engineering and Building Design and Construction of Secondary Substations
SUB-03-018	Specification for Prefabricated Glass Reinforced Plastic Enclosures
SUB-03-025	General Specification for the Civil Engineering and Building Design and Construction of Primary and 33kV Switching Substations
SUB-03-026	General Specification for the Civil Engineering and Building Design and Construction of 132kV Substations
SUB-03-039	General Specification for the Re-Use of Concrete Structures
SUB-03-041	General Specification for The Construction of Pre-Fabricated Modular Control Buildings
TRANS-03-006	Specification for the Design and Construction of Substation platforms

8.2 Iberdrola Networks Specifications

INS 50-40-11	Pre-fabricated enclosures for distribution substations

8.3 National Grid (NG) Documents

NGTS 2.10 Series	Generic Electricity Substation Design Manual Civil, Structural and Building Engineering.
NGTS 3.10 Series	Generic Technical Specification (Construction) for Civil, Structural and Building Engineering.
NGTS 3.01.04	Busbar Systems for AIS Substations.

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8.4 British Standards

BS EN 206-1	Concrete. Specification, performance, production and conformity
BS 5266-1	Emergency lighting. Code of practice for the emergency escape lighting of premises
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS 8000	Workmanship on building sites, codes of practice
BS 8500-1	Concrete. Complementary British Standard to BS EN 206-1
BS EN 14889	Fibres for Concrete
BS EN 12464-1	Light and lighting. Lighting of work places. Indoor work places
BS 1722-12	Fences. Steel palisade fences. Manufacturing and installation. Specification
BS 1722-14	Fences. Specification for open mesh steel panel
BS EN 13030	Ventilation for buildings. Terminals. Performance testing of louvres subjected to simulated rain
BS EN 124	Gully tops and manhole tops for vehicular and pedestrian areas
BS 8001	Framework for implementing the principles of the circular economy
BSI Flex 350	Alternative binder systems for lower carbon concrete. Code of practice

8.5 Other Documents

Standards for Highways DMRB Volume 2 – CD 373	Impregnation of reinforced and prestressed concrete highway structures using hydrophobic impregnants
Standards for Highways MCHW – CD 601	Design of Earthworks
Standards for Highways DMRB – CD 225	Design for new pavement foundations
ENA TS 41-24	Guidelines for the design, installation, testing and maintenance of main earthing systems in substations
PAS 2080	Carbon Management in Infrastructure
Ciria C753F	The SuDS Manual

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9 INTRODUCTION

This document outlines SPEN's technical specification requirements for the civil design and construction of 275kV and 400kV Substations.

This technical specification shall be used for 275kV and 400kV Grid Substations:

- Substation Compounds housing Outdoor Equipment up to 420kV installed within and enclosed by a secure perimeter;
- Substation Buildings housing Indoor Equipment up to 420kV installed within discrete purpose designed and traditionally built secure enclosures, with or without Outdoor Equipment (e.g. transformers or air insulated switchgear);
- Substation Buildings housing indoor Gas Insulated Switchgear up to 420kV and associated plant installed within and enclosed by a secure perimeter.

Certain sections within this specification may not be applicable to all 275kV and 400kV Substation construction types and additionally the specification is not designed to cover every eventuality or site-specific situation.

Project-specific deviations from the design-build principles and construction details within this Specification will be considered by SPEN Engineering Design and Standards (ED&S) where it can be demonstrated that they offer an equivalent or better technical and/or lower risk solution. It is the responsibility of the project delivery team to ensure that all such deviations are fully discussed with and approved by Engineering Design and Standards within timescales that do not adversely affect project objectives.

The technical specification for the civil engineering and building design and construction of Secondary and Primary Substations equipment enclosures and 132kV Grid Substations which can form an integral part of 275kV and 400kV Substation schemes shall be as follows:

- Construction of Secondary Substations SUB-03-017
- Construction of Primary and 33kV Switching Substations SUB-03-025
- Construction of 132kV Substations SUB-03-026
- Construction of Pre-Fabricated Modular Control Buildings SUB-03-041
- Specification for the Design and Construction of Substation Platforms TRANS-03-006

9.1 Feasibility

Once the requirement for a 275kV or 400kV Grid Substation has been established and the general arrangement of the substation has been agreed, it is important that during the detailed design stage the requirements highlighted during the feasibility phase and detailed in other referenced documents are given due consideration and are factored into the detailed design.

To avoid possible abortive effort and subsequent delay; the project team shall confirm at the earliest opportunity how these requirements are to be met. This should be undertaken by discussing the principles at a Scheme Team meeting in order that any site-specific issues can be factored into the substation design proposal. This should ensure that the design principles being adopted are acceptable. These works shall include (but shall not be limited to):

- Minimising Outages, Outage periods and impact on Company assets;
- Plant access/egress, including access routes and the method by which plant will be installed/removed;
- Operational, Inspection and Maintenance access and limitations on onerous activities;
- 24-Hour independent access/egress for SPEN personnel (NB access via third parties is not acceptable);
- Emergency access/egress;

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- Fire segregation;
- Cable entries / routes;
- Natural ventilation to Outdoor Equipment (in particular transformers);
- Avoidance of Noise nuisance;
- Avoidance of flood risk and impacts of climate change;
- Consideration of site security.

Basement substations shall not be permitted without the express agreement of ED&S.

Enclosures to Outdoor Equipment that do not provide adequate natural ventilation shall not be acceptable.

9.1.1 Existing Substation Sites

Where works are proposed at existing substations and it is identified that existing civil assets have the potential to be utilised, a whole life cost analysis should be undertaken. Where a substation compound contains concrete support structures then guidance shall be sought from SUB-03-039 - 'General Specification for the Re-Use of Concrete Structures'. This analysis should conclude if the assets can be retained in their existing condition, repaired such that they can be reused or demolished and a new asset constructed. To identify the most appropriate solution the whole life cost assessment should incorporate the following:

- A Design and Condition Assessment of the relevant existing civil asset based on the requirement for it to support the functional requirements of the proposed electrical plant over the anticipated design life;
- Identification of any replacement/strengthening/repair/refurbishment works, and associated costs, required to extend the service life of the civil asset, in line with the life expectancy of the electrical plant;
- Identification of any departures from this Specification that are required to be agreed and any risks associated with utilising existing civil assets;
- An outline programme of the likely Inspection and Maintenance requirements associated with any extension to the service life of the asset.

10 GENERAL REQUIREMENTS

10.1 Consents

Consents matters are outside the scope of this document, but the design and construction teams are responsible for ensuring that all necessary legislation is followed, that all statutory consents and permissions are in place and that any associated applicable conditions are discharged prior to commencement of construction.

Over and above the minimum legislation and statutory consent requirements the following should be considered:

- Land Acquisition or Lease arrangements;
- Approvals for discharge to surface water, groundwater and foul drainage systems from the relevant Regulatory Authority;
- Construction Site Licenses;
- Party Wall Etc Act, or where this is not applicable, prior formal notification of proposals to adjacent third-parties who potentially may be affected by the works.
- Building Warrants or Building Standards/Regulations Approval
- Planning consent

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10.2 Pre-Engineering Studies

Adequate and appropriate desktop and site-based Pre-Engineering Studies to provide the information necessary to ensure:

- The safe transfer of design loadings to ground;
- Compliance with respect to contamination and ground water risk;
- Identification of utilities above and below ground;
- Drainage discharge options are identified;
- Environmental risks are identified and independently verified including, but not limited to, ecology, noise nuisance and flood related risks.

Other studies should be undertaken where considered necessary or appropriate on a site-specific basis.

Unless rock-head is confirmed as shallow by other means (e.g. trial pits) then boreholes shall be drilled as close as possible to the proposed locations of buildings, transformers and other items of plant within the proposed site.

Additional Pre-Engineering Studies should be undertaken as necessary where substations are located in complex situations. In particular where desktop studies indicate that particular risks may be present from:

- Brownfield or infilled sites;
- In the vicinity of principle aquifers, coastal zone areas or areas with a high-water table;
- Potentially contaminated sites;
- Where piling or ground improvement may be required;
- Where there has been previous deep or shallow mine working activity (coal, salt, metals, etc.).

Where ecology survey results indicate that they are present, all traces of invasive plant species such as Japanese Knotweed, Giant Hogweed and Himalayan Balsam shall be entirely removed as necessary for the purpose of the works and provision made to prevent them from re-establishing in those areas. Where identified, consideration of the impact on adjacent land and properties is required. Waste material from these plants is classed as 'controlled waste' and must be disposed of at a suitably licensed or permitted waste site.

Pre-Engineering Study records and reports shall be available for audit inspection by SPEN, including confirmation that:

- Worst case design load combinations would be safely transferred to suitable ground of adequate bearing capacity and that the extent of any potential future settlement would not adversely affect the operation of the substation, its infrastructure or its equipment (including cables/cable entries and other services);
- The substation operation would not be adversely affected by a 1:1000 year flood event. Flooding of the substation during a 1:1000 year flood event will not lead to loss of supply or damage to key equipment within the substation. Vehicular access to the key plant and buildings within the substation is also required to be maintained;
- The substation operation would not be the source of a 3rd-party noise nuisance complaint in relation to transformers or other noise generating equipment (including ‘future’ nuisance complaint).

10.2.1 Existing Substation Sites

Where electrical plant is being replaced and supporting structures are proposed to be utilised then theoretical assessments, visual inspections, non-destructive testing and intrusive testing/analysis as

specified within SUB-03-039 shall be carried out to confirm that the existing foundation plinths, superstructure supports or other assets can be utilised as part of the new works.

10.2.2 Substation Earthing

Compound Earthing Systems are designed and installed in accordance with SPEN specification – EART-03-002. The Constructor shall carry out adequate and appropriate Earthing Studies, from which the earthing design shall be developed. The resulting Earthing Report shall be available for audit inspection by SPEN.

10.3 Scheme Development

Subject to preliminary layout (feasibility) drawings being acceptable in principle to SPEN, it shall then be the responsibility of the project team to develop the scheme in detail in accordance with this Specification. Proposed General Arrangement and Construction drawings shall be submitted to include plans, elevations and sections of the buildings, structures and external works and shall clearly indicate the main dimensions, material and forms of construction proposed as follows:

- Site location plan showing the whole of the site and access route, together with surrounding landscape and land use;
- Site layout plan(s) showing the configuration of equipment and equipment enclosures within the site, together with setting out data, electrical clearances, site finishes, environmental mitigation, access roads, drainage, external lighting and security fencing;
- General arrangement drawing(s) for buildings that include details of floor layout(s) and indicate dimensional access, operation and maintenance clearances between and around equipment:
    - Sections, a minimum of two (one in each plane) for each enclosure, to include all cable entries and outgoing services, clear headroom to plant and relevant finished ground and floor levels;
    - Elevations for the overall substation in total, including all buildings and equipment enclosures showing doors and any natural ventilation;
    - Building services etc., e.g. small power, lighting, heating, ventilation, security alarm, direct mains water supply, etc;
    - Earthing;
    - Signage.
- Other relevant information as applicable.

10.3.1 Equipment Enclosures (Buildings, Containers/Housings & Compounds for Indoor & Outdoor Equipment)

SPEN will only install equipment into or formally adopt Approved Equipment installed by others within enclosures that satisfy the requirements of this Specification and the specification for prefabricated enclosures.'SUB-03-041 - General Specification for The Construction of Pre-Fabricated Modular Control Buildings'.

Selection of a particular type of enclosure may be subject to varying operational and supply requirements that take precedence over considerations of appearance, cost, local environment, etc.

Generic functional requirements include:

- Suitable access for and cover to high and low voltage cables, including sealed cable entries to prevent below ground ingress of moisture, gas and vermin to buildings containing Indoor Equipment and escape of oil from enclosures containing oil filled Outdoor Equipment (e.g. transformers);
- Security, in preventing hazardous intrusions as well as unauthorised entry. These maybe subject to a site-specific Security Risk Assessment (SRA);

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- Design to ensure no loss of supply or damage to key equipment within the substation during a 1:1000-year flood event. This should consider the impacts of overland surface water flows generated by high intensity rainfall.

10.3.1.1 Indoor Equipment

SPEN utilise proprietary prefabricated and traditional conventionally built housings for Indoor Equipment. Where these house 275/400kV switchgear the preferred enclosure type is a robust structural steelwork portal framed construction with a proprietary insulated steel sheet cladding system that is deemed to relieve and/or contain an internal pressure rise due to a disruptive failure of the plant.

Generic functional requirements include:

- Weather-tight enclosure construction to prevent moisture ingress;
- Preclusion of surface water run-off entry;
- Suitable internal enclosure environment, in particular with respect to natural ventilation and the elimination of condensation;
- Minimum 1-hour fire segregation between substation compartments.

SPEN accept that in particular site-specific environmental situations it may be necessary to consider alternative building or enclosure types. In such situations, subject to approval from SPEN, the functionality requirements stated within this specification shall be factored into the building or enclosure design, together with any other relevant factors that are specific to the designed solution.

10.3.2 Security Requirements

To ensure the requirements outlined in SPEN's security policy 'ASSET-01-023 Substation Security Policy' are achieved ScottishPower Corporate Security should be engaged at the earliest opportunity to ensure that any required Integrated Security Systems (ISS) works or upgrades are incorporated into the substation project to mitigate the risks identified in the site Security Risk Assessment (SRA).

Any ISS works or upgrades that are required shall be agreed by the project team, ED&S and ScottishPower Corporate Security such that they prevent hazardous intrusions and unauthorised entry.

ISS solutions will be installed by the ScottishPower Corporate Security preferred framework contractor and any civil works (ducting, earth works, foundations) will be installed by a separate civil contractor however responsibility for the various elements of the works should be agreed on a project-specific basis.

10.4 Design

10.4.1 Design Methodology

Civil and building infrastructure in its entirety shall be designed to meet the functional requirements of the works for a minimum of 40 years. Where SPEN subsequently adopt the civil and building fabric, the design and construction detail shall be such that future inspection and maintenance is minimised with a first life maintenance of not less than 20 years.

Substation design shall take cognisance of Pre-Engineering Studies and shall be such that no sprinkler systems, gas, water, drainage or other third party service pipes, cables or heating and ventilation ducts are built within, through or beneath substations, in particular through or beneath equipment housings or supports within substations.

A design methodology that identifies all significant factors in the design and ensures proper attention is given to each factor at every stage in the design process shall be adopted. Where required Design Basis Statements shall be created for each element of the work and these will describe the high-level design philosophy and assumptions to be adopted and shall include but shall not be limited to:

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- Geotechnical Assumptions;
- Foundation Design Concept;
- Load Cases giving the magnitude of all dead, imposed, plant, wind and short circuit forces (etc.) considered to be appropriate for each structural element;
- Load Case Combinations;
- Support Structure and Building parameters.

Design Basis Statement shall identify applicable BS/BS EN documents.

Dead, imposed and dynamic loadings/actions for approved equipment are available from the manufacturers. Foundations and support structures to AIS Outdoor Equipment shall be designed such that these adequately resist short circuit forces, including vertically in the case of sealing end installations.

The detailed design submission must be in the English language and shall be prepared in terms of SI units in accordance with the recommendations of applicable BS/BS EN documents. All dimensions shall be in millimetres.

10.4.1.1 Sustainability / Net Zero

SP Energy Networks are committed to achieving net zero by 2035 and have set ambitious Science Based Targets – focussed on decarbonising all operations. including indirect emissions associated with the development of our infrastructure.

Substation design and construction should follow the principles of PAS 2080 Carbon Management in Infrastructure. Where possible, whole life carbon emissions associated with the substation shall be quantified and opportunities to reduce carbon impact through more intelligent design, construction and energy efficiency should be considered at each stage in the project and taken forward where practical.

In line with BS 8001, the principles of circularity should be considered during the development of the scheme design and across the life of the substation. Design considerations such as optimising cut/fill volumes in earthworks, minimising material being exported off site, the use of recycled and low carbon materials and end of life and recyclability of materials should be undertaken in line with ScottishPower's circularity plan.

10.4.2 Flood Mitigation

Substations shall be designed such that there is no loss of supply or damage to strategic equipment during a 0.1% (1 in 1000) annual exceedance probability (AEP) flood event (with a design allowance for climate change effects). Access routes to the substation shall also be considered to ensure access will be available during flood conditions and consideration of staff access to the key plant and buildings during the 0.1% (1 in 1000) annual flood event.

In those instances where there is a compelling reason to locate a substation inside this zone and this is accepted by SPEN Network Planning & Regulation the substation design shall eliminate or mitigate against the risk of such a flood impacting the operation of the substation (access requirements, loss of supply, or damage to equipment).

275/400kV substation platforms shall be constructed at a minimum level of 600mm above the 0.1% or (1 in 1000) designed flood level, the 600mm freeboard allows for uncertainties in data and modelling. The designed flood level shall include an allowance for climate change for a 50-year design life, in accordance with the requirements of the relevant national environment agency. Where climate change guidance is not available then a minimum of 200mm shall be applied in addition to the 600mm freeboard. The flood design should consider Pluvial, Fluvial, Coastal and Reservoir flooding, as well as combinations of these.

In addition, such schemes shall incorporate any requirement for compensatory storage as required by the Flood Risk Assessment (FRA) and be approved by the national environment agency or applicable local authority.

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Written acceptance for any proposed design measures to mitigate flood risk is required from ED&S prior to the construction of the works.

10.4.3 Structural Design

The structural design of the civil and building fabric is entirely the responsibility of the designer and shall be prepared, checked and approved to professionally recognised design Quality Assurance procedures by appropriately qualified and experienced Chartered Civil or Structural Engineers. Calculations shall be available for audit inspection by SPEN and, where applicable, calculation information shall be included within the CDM Health & Safety File handover to SPEN.

Structures and foundations associated with Busbars and GIB should be designed in accordance with Specification document 'NGTS 3.01.04 - Busbar Systems for AIS Substations'.

Dead, imposed and dynamic loadings/actions for approved plant and equipment are available from the manufacturers, in particular with respect to applied loading to floors from Indoor Equipment and to plinths/support structures for Outdoor Equipment.

10.4.4 Disruptive Failure

Although substation equipment is extremely reliable and the probability of a disruptive failure due to internal arcing is very low this does have implications for both the design and location of substations, and designers should be aware that considerable internal overpressure and fireball may be produced when this condition occurs.

Buildings enclosing 275kV and 400kV or lower voltage switchgear shall be designed such that they maintain their integrity and relieve or withstand the overpressure that can be developed during a disruptive failure under the most onerous simultaneous operation condition. Designers shall give due consideration to such potential for disruptive failure in their designs, including if necessary provision of pressure-relief panels to walls and roofs enclosing GIS equipment and in locating egress routes. Freestanding robust construction steel portal framed buildings with insulated steel sheet cladding that relieve and/or contain an internal pressure rise due to a disruptive failure, are the preferred and most appropriate form of enclosure.

In line with the CDM design obligation to limit the risk associated with disruptive failure the preferred and optimum location for a substation is freestanding and detached from other development.

10.4.5 Fire Risk

The project team shall be responsible for ensuring that any necessary approvals are obtained from applicable fire authorities. Where applicable, any necessary fire certification shall be included within the CDM Health & Safety File handover to SPEN.

In addition, a site-specific risk assessment shall be carried out that shall consider:

- The likelihood of members of the public being in the vicinity/close proximity.
- The substation type and location with respect to property types and public areas.
- The transformer, plant, and insulant type.
- The access/egress arrangements for members of staff/contractors.

The fire risk should be assessed by the project team and shall provide no less than the minimum mitigation measures to enclosures housing Indoor Equipment and to oil containing Outdoor Equipment (e.g. transformers and reactors) in accordance with this Specification and SPEN Substation Fire Protection Policy SUB-01-012.

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10.4.6 Discharges to Surface Water, Foul Water and Groundwater Drainage Systems

The project team shall be responsible for obtaining any necessary approval of proposals for discharge from surface and foul water drainage systems from the relevant national environment agency or applicable local authority before proceeding with the relevant construction work.

Any formal consent approvals shall be included within the CDM Health & Safety File when it is handed over, together with any applicable permits, consents, exemptions, licences and legal rights to discharge.

10.5 Substation Site Layout

The preferred and optimum location for a 275/400kV Grid Substation is freestanding on a level compound with access at ground level from the public highway. The maximum fall across the compound should be 1:200 unless agreed with ED&S. Substation enclosures (e.g. buildings or Containers), should not form part of the compound boundary.

Freestanding 275/400kV Grid Substation compounds shall have a minimum of 2m clear level access around the perimeter externally and, for security purposes, clear visibility for 5m beyond the substation compound fence. Any proposed landscaping or fixed feature should take cognisance of this requirement. SPEN shall have bespoke rights of access, operation and maintenance in this area beyond the security fence.

Reliance on recourse to third parties for compliance with the requirements of this Specification to provide suitable unrestricted 24-hour access/egress for SPEN Authorised personnel would not be acceptable, and standard Company suited lock(s) must control this.

Oil separators, septic tanks, SUDS features and associated equipment shall be sited adjacent or close to roads to facilitate access for maintenance vehicles.

Pedestrian safety barriers may be required where the site layout is such that emergency egress from the substation is towards a vehicular traffic route. These barriers should be demountable if this were also a plant access route for the substation. These barriers shall be placed as to avoid providing a climbing aid to enter the substation. Road restraint systems may be required external to the substation where the site layout is such that SPEN perceive there to be a risk of impact to the substation from vehicular traffic (e.g. substations adjacent to vehicle turning areas or where access roads are at a higher level).

10.6 Setting Out

It is essential that substations be set out in accordance with Land Acquisition and detailed design drawings where the Company have or will subsequently take freehold or leasehold possession of the land on completion.

10.7 Services

At existing sites all utility apparatus, including cables, pipes, trenches, buried earthing conductors and services of any kind (including spare ducts) which may be encountered during the course of the works are to be maintained in position, protected and kept in working order. Where these are identified as not being in accordance with the existing records an accurate location and depth survey of these services should be undertaken during the construction works and this information shall be incorporated into the CDM Health & Safety File.

Existing and new sites may be crossed by underground services, the location and depth of which may not be known. During the construction works all practicable measures should be undertaken to identify and prove the location of ALL underground services by detection and/or hand excavated trial pits prior to the start of the works. During the construction works a system to permanently mark the routes of such underground services for the duration of the site works shall be implemented.

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10.8 Construction

The project team shall ensure that civil engineering and building contractors engaged to carry out works under this specification comply with all relevant legislation and industry best practice and are competent, qualified and experienced with respect to the nature of electricity substation construction. The contractors should hold appropriate membership of the National Federation of Builders, Federation of Master Builders, Civil Engineering Contractors Association or similar professional trade body. Operatives should hold appropriate Construction Skills Certification Scheme (CSCS) Cards or National Vocational Qualifications (NVQs); in particular welders shall be tested to meet and satisfy the requirements of the National Structural Steelwork Specification for Building Construction.

The project team shall be responsible for ensuring that the design and construction of all temporary works deemed necessary to facilitate the construction works are undertaken by appropriately qualified engineers. All temporary works should be removed from site prior to project handover.

The standard of workmanship shall be in keeping with industry best practices and shall not be less than that specified by BS 8000.

The civil engineering and building contractors engaged to carry out works under this Specification shall take all reasonable precautions to ensure the safety of all parties concerned with or affected by operations associated with substation construction works.

The safety or operation of any existing Company utility plant must not be prejudiced; records of buried services must be obtained from all utilities and safe-digging practices must be adopted, including the use of a cable-locating tool.

Substation construction shall be such that no sprinkler systems, gas, water, drainage or other third party service pipes, cables or heating and ventilation ducts are built within, through or beneath substations, in particular through or beneath equipment housings or supports within substations.

SPEN will not install equipment into substation enclosures until and unless all civil engineering and building works (except post-commissioning finishing works) are complete and are in accordance with this Specification. Unless the relevant variations have been agreed in writing with ED&S a delay in plant installation and/or energisation could result if works are not in accordance with this Specification.

SPEN will not consider formal adoption of Approved Equipment or civil infrastructure installed and commissioned by others until and unless all associated building and civil engineering works are complete and in accordance with this Specification, including receipt of As-Built information where applicable (i.e. in relation to adoption of civil fabric such as enclosures/buildings/compounds).

10.9 As-Built Information

As-Built drawings, Operating Manuals and CDM Health & Safety Files shall be submitted to SPEN in an agreed electronic format. To allow SPEN to manage their assets a Civil Asset Management Plan should be provided for each project. This document should be in an agreed format that will allow the development of an inspection and maintenance regime for the project.

10.10 Quality Assurance

All materials shall be of good quality, suitable for purpose, designed and manufactured such that they provide safe and continuous service and are capable of withstanding the various stresses and onerous conditions to which they may be subjected to on the site of installation without suffering any undue deterioration.

The Contractor shall adhere to the agreed project Environmental & Quality Management plan to ensure that the scope of the project is carried out in accordance with all specified standards, specifications, current legislation, drawings and documents and to ensure that a high standard of workmanship and quality is maintained throughout the project.

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11 STANDARDS

Civil and building infrastructure in its entirety shall be designed and constructed to comply with the following documents, in the following hierarchy, unless expressly varied by this Specification.

- SPEN Policy documents;
- SPEN Specification documents;
- NGTS 2.10 and 3.10 document suites;
- European Standards;
- British Standards;
- Codes of Practice;
- Relevant Industry Guidance.

Some basic civil engineering and building technical compliance information that is contained within such documents is repeated within this Specification, over and above functional design and construction requirements, in order to assist in the initial development and costing of the civil aspects of substation projects.

Where associated Standards do not explicitly relate to civil, structural or building engineering but nonetheless contain requirements that may impact upon these aspects it shall be the responsibility of the designer to ensure a holistic and compliant overall design solution (e.g. in relation to earthing).

Building Regulations requirements shall apply unless stated or expressly implied otherwise within this Specification. Where literal compliance is not possible the work shall be to a standard agreed with SPEN that takes the Building Regulations as its basis.

12 TECHNICAL REQUIREMENTS

12.1 Security

Substation security is of prime importance and buildings shall be designed and detailed to minimise the potential for vandalism and unauthorised entry. Corporate Security shall be consulted on a project-specific basis and may undertake a site-specific SRA to identify any additional security measures. These additional measures shall only be incorporated with the express agreement of ED&S.

The specification of CNI (Critical National Infrasturcture) sites is considered outwith the scope of this document. Where a site falls under the classification of CNI, ScottishPower Corporate Security are responsible for the specification of the required security measures.

12.2 Site Clearance

Prior to the start of the construction works, the site should be cleared of all rubbish and debris, with nothing being burnt or buried on site. The removal of all natural or man-made features where they conflict with the proposed works including roads, fences, walls, and vegetation should be undertaken in accordance with any project environmental constraints.

Where materials cannot be reused or recycled within the works they should be taken off site and disposed of in strict accordance with current legislation and best practise.

12.3 Earthworks

Earthworks shall be constructed in accordance with TRANS-03-006 Specification for the Design and Construction of Substation platforms. All foundations shall be set on undisturbed inorganic strata that provide a minimum design safe ground bearing capacity of 100kN/m². Within existing sites testing of the ground bearing capacity should be undertaken at the proposed foundation formation level and the foundations designed to provide the most efficient solution.

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A list of acceptable and unacceptable earthworks materials, including recycled materials, are detailed within Standards for Highways MCHW – CD 601. Where stabilised fills are proposed these shall be developed inline with CD 225 and the relevant British Standard. To align with SPEN's sustainability goals the preference is for proposed earthworks materials to be from site won or recycled sources. A minimum 30% of all imported fills shall be procured from recycled sources. Recycled fills are to be a clean fill that meets the technical requirements of their intended use.

The bottom of excavated areas shall be trimmed, levelled or graded and well rammed or otherwise compacted. The construction sequence shall be such that undue exposure of the formation level to excavations is avoided. Excavations shall be kept free from all sources of water, with any removal of water complying with environmental legislation and best practise.

Where reclaimed infill material is proposed this shall be accordance with Standards for Highways MCHW – CD 601 and shall include submission of a true representative sample for inspection and a suite of tests. These tests should demonstrate that the fill material can be suitably compacted, can resist the required allowable bearing pressures and axle loads reasonably anticipated and that the settlement characteristics with regard to tolerances can be reasonably achieved within the timescale of the proposed works without undue further settlement or ground heave which could potentially affect the operational aspects of the plant to be installed.

The works should ensure that further settlement or ground heave effects after the construction of foundations, access roads, buildings, underground services, cable trenches, security fences and walls are restricted to a maximum long term settlement of 25mm. Differential settlement across the site shall also be controlled to not affect the function of plant or apparatus.

Where the use of reclaimed infill is accepted it shall satisfy the requirements of this Specification and shall not contain any deleterious, degradable or non-degradable material of any size or proportion.

Any excess excavated material from the site which is unsuitable for use in the works and cannot be used elsewhere within the project, including in any designed landscaping, should be removed from site to a suitable landfill site.

Excavations to reinforced concrete foundations shall receive a minimum 50mm thick layer of blinding concrete cover on completion. Where precast foundations are proposed, a compacted 50mm blinding sand or gravel layer is also acceptable.

12.4 Compound Construction

12.4.1 Stoned Compound Areas

Compound surfacing shall not be less than 300mm overall depth of construction comprising:

- A minimum 75mm layer of approved recycled angular 14-20mm graded aggregate;
- A minimum 225mm layer of approved recycled Type 1/Type 3 granular layer compacted in a minimum of two layers;
- Where it is deemed that existing ground conditions are poor and to avoid surface rutting, and deformation of the sub-grade/sub-base layer an approved geotextile separation membrane can be provided between the sub-grade layer and the Type 1/Type 3 granular layer, unless the subgrade layer is a newly constructed platform with a minimum depth of 0.5m.

Structural geotextiles or *Geogrid* reinforcement type systems shall additionally be designed and incorporated into the substation platform design where ground conditions dictate and where reinforcement and or separation of the underlying strata is required to provide increased ground bearing capacity and limit ground settlement.

Stoned areas shall be finished at or below the bottom of chamfers to structure plinths and the detail shall be such that trip hazards are avoided.

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12.4.2 External Perimeter to Substation Compounds

275kV and 400kV Substations containing Outdoor Equipment shall incorporate a minimum 2m wide perimeter maintenance access footpath external to the substation footprint/security fence. It should be noted that for security purposes, clear visibility for 5m beyond the substation compound fence is required.

External perimeter footpaths shall not be less than 150mm overall depth of construction subject to removal of all organic soil matter; comprising an approved build-up of:

- A 50mm thick layer of approved recycled 6-10mm angular stone chipping topping;
- On a minimum 100mm thick compacted layer of approved recycled Type 1 sub-base;
- An approved weed suppressing geotextile membrane below the Type 1 sub-base.

12.4.3 Access Covers (General)

Access covers to manholes, catch pits, gullies, service trenches, draw pits and the like shall be rated in accordance with BS EN 124. Access covers are to be coloured to identify access type as per Table 1.

Colour / Designation	Substation Location	BS EN 124 Class
Green - Light Duty	Pedestrian only areas (Areas inaccessible to vehicles)	A15
Grey - Medium Duty	MEWP only access routes and crossing points	B125
Yellow - Heavy Duty	Designated roadways and vehicle crossing points	C250
Red – Very Heavy Duty	Designated Transformer Access Routes	D400

Table 1 – Access Cover Designation

12.4.4 Multi-Core Trench Systems

Multi-core cable trench system layouts shall consider the practical and logistical issues relating to the installation of the associated cables such as pulling lengths, changes in direction and future extensions.

Multi-core cable trench systems shall be designed and built such that they prevent the build-up of rain or ground water within, including incorporation of positive drainage systems where site-specific conditions dictate.

Multi-core cable trench system inverts shall be screeded up to entries to buildings to ensure that water is drained away from the building. In addition, trench entries to buildings shall be sealed with a proprietary sealant system on completion such that no water or vermin can enter the building.

Multi-core cable trench systems shall incorporate rounded splays to all trench walls on the inside radius of cable routes where the change in direction is greater than 45˚. Such splays shall bisect the change of direction and create two angles each less than or equal to 45˚, compatible with the worst case cable bending radius.

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Multi-core cable trench systems shall incorporate duct entries through side walls where applicable.

The overall size of trough sections shall be designed to accommodate proposed and identified 'Future' services together with any additional capacity that can be reasonably foreseen. Wherever practicable, trough section internal depth shall not exceed 600mm.

Multi-core cable trench systems shall comprise:

- Pre-cast concrete trough sections with integral upstands that are rebated to receive trench covers. Separate edge kerb gravel boards shall not be acceptable;
- Easily manageable and adequately removable pre-cast concrete or proprietary GRP covers capable of withstanding all anticipated pedestrian loadings (A15 load class covers) and vehicle axle loadings (B125, C250 and D400 load class covers) at designated vehicle cross-over points;
- Cable trench covers that are suitable for 'single-man' lift except where proprietary mechanical cover-lift equipment is permanently provided on site as part of the works. Mechanical cover-lift equipment shall have all-terrain wheels;
- Cable trench cover systems that readily indicate load-bearing capacity, in particular that identify designed vehicle crossing points (e.g. colour coded GRP systems).

12.4.5 Compound Earthing Systems

Compound Earthing Systems shall be in accordance with SPEN specification – EART-03-002.

12.4.5.1 Installation

Earthing System installation shall be designed and sequenced with the bulk earthwork and compound construction activities to minimise duplication of excavation.

The earthing tape shall be placed in 150mm surround (300mm x 300mm) of fill as defined by the requirements of EART-03-002 enclosed by a geotextile separator. The fill shall be compacted in such a way to maintain the integrity of the earthing tape. The detailed proposals shall be submitted and reviewed as part of the project's Quality Management system prior to installation.

Installation of buried bare metal earth tape and earth rod systems to compounds shall be by SPEN approved specialist installers.

12.5 Concrete

Concrete shall be designed to current standards, subject to the minimum strength classes and minimum standard of finish as indicated in Table 2. Exposure class and minimum cover to reinforcement shall be appropriate for the site and ground specific conditions in accordance with the civil design. Specified characteristic strength shall be verified by independent concrete cube tests.

A flat, level and smooth surface finish to floors and plinths is essential for the installation of plant to be acceptable to SPEN. The deviation from the underside of a 2m straight edge resting in contact with floors and plinths shall not be more than 3mm.

Exposed arrises to plinths shall be chamfered. Arrises to ramp transitions onto floors, vertical corners within cable trenches and the like over or around which cables could pass shall be rounded.

The use of recycled materials within concrete is preferred, where appropriate, and where specified within the detailed design the use of fibre reinforced concrete should be in accordance with BS EN 14889 Part 1 or Part 2.

To aid the transition to Net Zero, the use of CEM I concrete mixes is restricted across all SPEN projects. Low Carbon concretes (CEM II-V mixes) shall be used where feasible and practical. All concrete mixes should have an embodied carbon below the LCCG UK average defined by the MPA in the most recent Market Benchmark.

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To aid the curing process of lower carbon mixes, concrete strength can be specified as a 56-day strength. This shall be taken into consideration in the structural design and the construction programme. Where early strength is important, the use of admixtures to reduce curing times shall be considered prior to reverting to CEM I mixes.

12.5.1 Reinforcement

In general, where the structural design concludes that reinforcement of a concrete element is required to resist the loading conditions and serviceability requirements, traditional steelwork reinforcement (bars or mesh) shall be provided in the designed solution. However, in appropriate circumstances, the use of fibre reinforcement is acceptable in principle on the basis of this solution being entirely suitable for the intended purpose.

12.5.2 Concrete Foundations/Plinths to Outdoor Equipment Supports

Cast in situ concrete foundations shall incorporate a minimum 50mm thick blinding concrete. Precast concrete foundations shall incorporate a minimum 50mm thick blinding concrete or a minimum 50mm compacted blinding sand or gravel.

Exposed edges of plinths shall incorporate appropriate chamfers, which shall not be less than 25mm and shall be proud of surface finishes.

Upstand plinths shall be used for gantry and other large plan area foundations where there is personnel access (foot traffic) and the exposed top surface can be significantly reduced.

Where applicable, ducts and slots shall be incorporated within foundations and plinths to provide access for cables (multi-cores and power). Mounts for delivery systems shall be provided and haulage or jacking points shall be provided where necessary for installation and removal of transformers and reactors.

12.5.3 Concrete Superstructures

Where SPEN will subsequently adopt the civil fabric of the substation the exposed surfaces of reinforced concrete superstructures (e.g. fire barrier walls and concrete support posts) shall be treated with a protective surface impregnation system.

These works should be in accordance with DMRB CD 373, be undertaken not less than 7 days after the concrete has been poured and should comply with all H&S legislation including Control of Substances hazardous to Health (COSHH).

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Concrete Use	Minimum Strength Class (Grade) to: BS EN 206-1/ BS 8500-1	Max. Agg' Size (mm)	Type of Concrete Finish	
			Type	Description
Blinding Layer	C16/20	20	**BURIED UNFORMED SURFACE** Finish to buried worked surfaces produced without formwork	**BASIC FINISH**: Concrete shall be levelled & screeded initially for a uniform plain or ridged surface as required for subsequent work.
Mass Infill	C16/20	40		
Sub-structure (Below Ground Level) Buried Formed Finishes e.g. buried sections of buildings, bunds, equipment foundations	C32/40	20	**BURIED FORMED SURFACE** Finish to buried surfaces produced with formwork	**ORDINARY FINISH/ROUGH FINISH:** Forms designed to produce a dense smooth finish free from voids or honeycombing greater than 10mm and other large blemishes.
Sub-structure (Above Ground Level) Exposed Worked Finishes e.g. exposed top face of equipment plinths, floor slabs (finished with anti-slip paint)	C32/40	20	**UNFORMED SURFACE** Finish to exposed worked surfaces produced without formwork	**PLAIN FINISH/STEEL TROWEL/POWER FLOAT FINISH:** Wood float finish as below to be steel trowelled under firm pressure or preferably power floated to produce a dense uniform smooth polished surface free from trowel marks or other blemishes.
Sub-structure (Above Ground Level) Exposed Formed Finishes e.g. equipment plinth upstands, walls (bunds and others) (finished with anti-slip paint)	C32/40	20	**FORMED SURFACE** Finish to exposed surfaces produced with formwork	**PLAIN FINISH/FAIR WORKED FINISH:** Forms designed to produce a hard smooth surface with true, clean arrises. All surface blemishes and irregularities made good as specified (e.g. cement paste to green concrete). Concrete rubbed down after curing to produce a smooth and even surface.
Super-structure Exposed Worked Surfaces to tops of walls or roof slabs to receive waterproof systems	C32/40	20	**UNFORMED SURFACE** Exposed worked surfaces that will subsequently be covered produced without formwork	**PLAIN FINISH/WOOD FLOAT FINISH:** Basic finish as above to be wood floated under light pressure initially to eliminate surface irregularities then under firm pressure after moisture film has disappeared and the concrete cured sufficiently to prevent laitance being worked to the surface.
Super-structure Exposed Formed Finishes e.g.to tops of walls	C32/40	20	**UNFORMED SURFACE:** Exposed worked surfaces produced without formwork	**PLAIN FINISH/STEEL TROWEL/POWER FLOAT FINISH:** As above.
Super-structure Exposed formed finishes e.g. to walls, columns etc.	C32/40	20	**FORMED SURFACE:** Exposed surfaces produced with formwork	**PLAIN FINISH/FAIR WORKED FINISH** As above.
Pavements at Ground Level Exposed Worked Finishes e.g. footways, roads.	C25/30	20	**UNFORMED SURFACE** Finish to exposed surfaces produced without formwork	**SPECIAL FINISH/BRUSHED FINISH** Brushed textures applied with uniform pressure transversely across the slab while the concrete is still plastic. To produce even texture with no ridges being formed.
Others Not listed above or Precast e.g. equipment support posts, firewall panels, m/c trenches.			**UNFORMED AND FORMED SURFACES**	**BESPOKE FINISH** By agreement on a project-specific basis.

Table 2 – Concrete Mixes and Finishes

Internal Use

12.6 Masonry

12.6.1 Masonry Units

Masonry materials shall be selected to maximise durability consistent with the architectural or Planning Consent requirements for the substation.

The minimum acceptable standard for below ground masonry shall be High Density (HD) Category I clay brickwork of minimum 75N/mm^2 mean compressive strength, 7.0% maximum moisture absorption and durability designation F2 S2 (ex 'Engineering Class B' quality or equivalent functional unit).

External masonry shall be HD clay-facing brickwork of minimum 30N/mm^2 mean compressive strength, maximum 12% moisture absorption and durability designation F1 S1 or better.

SPEN acknowledge that there may be certain site-specific situations where it is essential to propose the use of lower quality external masonry to meet Planning Authority or other aesthetic requirements. In such circumstances it may be necessary to apply an appropriate coating system such as a siloxane hydrophobic impregnation to ensure that undue moisture penetration is prevented.

Internal load bearing masonry walls enclosing rooms that house High Voltage Equipment shall be designed such that the integrity of the building is not compromised by the overpressure that can develop during a disruptive failure.

Internal masonry shall be as part of the project, however; modular, cellular, hollow and some forms of perforated masonry units would not be acceptable. It is essential that walls to support equipment present a smooth plumb even surface.

12.6.2 Ancillary Items

Mortar grade shall be appropriate for the masonry type, including the use of sulphate resisting cement where necessary (e.g. below ground). In particular, mortar to internal concrete brickwork shall be Class iii.

Brickwork ties to cavity walls shall be stainless steel Type 1 or Type 2 construction evenly spaced and staggered in alternate courses. Where enclosing rooms house High Voltage Equipment spacing shall be at maximum 450mm centres vertically and 450mm centres horizontally.

Where utilised, masonry bed-joint reinforcement shall be stainless steel construction.

Where utilised, built-in wind posts shall be galvanised or stainless steel construction.

Damp proof courses shall be incorporated and shall be either High Density (HD) Category I clay brickwork of minimum 125N/mm^2 mean compressive strength, 4.5% maximum moisture absorption and durability designation F2 S2 (ex 'Engineering Class A' quality or equivalent functional unit) or proprietary high performance (high load/strength, high bond) pitch-polymer systems.

12.7 Roads and Footways

12.7.1 Road Crossings from Highways

Where vehicular crossings are required to highway footways or verges the design and construction shall be to the Local Authority's approval and the project team shall be responsible for all notifications and Consents which may be required together with any associated fees.

12.7.2 Temporary Access Roads

Where temporary access roads or haul roads are required these should be designed by the project team to suit the requirements of the project. The design should take cognisance of the actual ground conditions and anticipated loadings but shall not be less than 400mm overall construction thickness, inclusive of a structural geotextile membrane beneath sub-base where applicable. Drainage systems shall be incorporated into the design and constructed as part of the works to ensure surface water

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and silts are treated as required by the relevant national environment agency or applicable local authority.

12.7.3 Substation Access/Service Roads

275kV and 400kV Grid Substations shall have access roads that provide vehicular access and egress adequate for the safe operation and maintenance of the entire substation including access roads that facilitate; transformer and switchgear installation and future removal, access by mobile elevated working platforms (MEWPs) to AIS and GIS Compound areas and access by all other vehicles as necessary for general maintenance including gas trolleys where applicable.

Terminations to substation access roads that are within or offer entry into compound areas containing Outdoor Equipment with exposed Live conductors ('Live compounds') shall incorporate lockable barrier mechanisms to prevent access by unauthorised vehicles.

The substation should be designed to ensure that MEWP access can be taken, over both access roads and the general compound, to all applicable Outdoor Equipment for maintenance purposes.

Access roads leading to substation compounds, for transformer access and around buildings shall be a flexible pavement construction. The use of recycled plastics and other recycled materials is the preference. Kerbs should be provided where there is a requirement for an adjacent pedestrian footway and consideration to the use of recycled plastic kerbs should be given. Where the access to a substation is via a granular track, then on a site-specific basis and by agreement with SPEN, the access roads around the compound and buildings may also be of a granular construction.

Other substation access roads within 'Live compounds' shall be a granular Type 1 construction and incorporate kerbs or other design measure to clearly define safe vehicle routes such that these deter vehicle entry towards Outdoor Equipment except at designated safe entry points that are controlled by lockable barrier mechanism.

Substation access roads within 'Live compounds' shall incorporate height gauge barriers at approaches to overhead or 'over-sailing' conductor systems (e.g. overhead lines, cables or bus bars).

Parking Areas adjacent to buildings shall provide a minimum 4 No parking bays for vehicles and turning areas for general maintenance vehicles that design out the risk associated with reversing out of the site. Sufficient space shall be provided adjacent to the parking bays for the installation of EV chargers.

Overall substation design shall facilitate the use of all substation access roads outside daylight hours.

The minimum clear width of substation access roads shall be as follows:

- 3.5m generally;
- 5.0m for grid transformer/reactor access, swept path analysis shall be used to determine suitable access bend radii and road width. For bends up to 90° general guidance is presented below:
    - Bends less than 20m radius – 8.5m road width
    - Bends between 20m to 40m radius – 7.5m road width
    - Bends greater than 40m radius – 5m road width

To encourage drainage the minimum recommended longitudinal gradient is to be maintained within the middle range 3-7%. The longitudinal gradient shall generally not exceed 8%. Where greater than 8%, the design should consider a bound surface. Vertical curves (sag and crest) will have a minimum radius of 250m. The Road shall be designed for the normal use is 44 tonnes gross and 12.5 tonnes per axle. To suit actual ground conditions site-specific designs maybe required based on the anticipated loadings but these shall not be less than 400mm overall construction thickness, inclusive of a structural geotextile membrane beneath sub-base where applicable.

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12.7.4 Access for Maintenance

Access roads to maintenance areas outside of the substation, i.e SUDs features, shall not use a route through the substation and shall not pass through secure access gates. As far as is reasonably practical, these areas shall sit outside of the security fencing.

12.7.5 Skidways for Transformers or Other Plant

Concrete skidways for transformers of other items of plant shall not be provided unless specifically agreed during the project feasibility stage.

Where it is agreed, on a project-specific basis, that skidways are required they shall be of reinforced concrete construction, level transversely with a minimum 1% and maximum 3% longitudinally gradient.

12.7.6 Oil Tanker Delivery Areas to Substation Access/Service Roads

SPEN will proactively manage oil tanker delivery to mitigate spillage risk by controlled methodology and no specific measures are normally required to be incorporated into the design. Where expressly required by SPEN in response to regulatory authority requirements on a project-specific basis, areas of substation access roads that are utilised for bulk oil transfer to 275kV and 400kV transformers or reactors shall incorporate measures to contain accidental spillage of oil. Spillage containment/ collection within the access road shall be by means of upstand road kerbs, proprietary integral road-drainage kerbs and/or proprietary road channel drain systems – the use of 'sleeping policeman' type retention shall not be acceptable.

Vehicle standing areas associated with bulk oil transfer shall not be sited under or close to overhead or 'over-sailing' conductor systems (e.g. overhead lines, cables or bus bars).

Road construction to these areas shall be such that significant seepage of accidental oil spillage through the surface is prevented, the preferred surface being reinforced concrete such that it is not unduly damaged by oil spillage.

12.7.7 Personnel Access

Enclosures shall incorporate approach and perimeter edged-paving surfacing to and between doors to facilitate personnel access.

Prefabricated paved areas shall comprise a maximum 600x600x50mm precast concrete paving slabs constructed on a minimum 50mm layer of sand-cement bed, constructed on a minimum 100mm compacted recycled Type 1 granular sub-base. Perimeters to paved areas that are not otherwise contained by buildings, structures or road kerbs shall be edged with a 200x50mm precast concrete edging kerb set in a concrete haunch and foundation.

Cast in-situ concrete, asphalt or other alternative paving systems shall be considered on a project-specific basis.

12.7.8 Cable Duct Crossings

Multicore cable crossings at roads within substations shall be robust rigid SPEN approved PVCu ducted systems with a minimum depth from finished road level to the top of the protective covers of 600mm. Where this depth cannot be achieved a 150mm concrete surround should be provided however no ducts should be installed with a cover of less than 500mm.

All ducts shall include draw cords and proprietary expanding foam or other approved temporary stop-ends to spare ways.

Ducted systems to each cable road crossing shall accommodate all cable requirements, including trefoil formations where applicable and cable requirements for identified 'Future' circuits/installations, together with not less than 10% overall spare capacity or three additional ducts of the same type and diameter (i.e. whichever is the greater).

Details of approved equipment can be found in the Approved Equipment Register.

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12.8 Drainage

Drainage systems shall meet the requirements of and be approved by relevant local authorities, utility companies and environment agencies.

The drainage schemes are adequately sized to accommodate flow rates that properly reflect the sources serviced by the system with pipes running un-surcharged at self-cleaning non-scouring velocities. The design of SUDs features shall be undertaken with guidance from Ciria C753F. The project Civil Asset Management Plan shall incorporate a Drainage Management section which shall provide details of all drainage infrastructure and highlight any critical or exceptional infrastructure. It should include details of the inspection and maintenance regimes required for each element of the infrastructure.

“Emergency Drainage Plan(s)” should be created as part of the Civil Asset Management Plan and shall be provided and mounted within substation control buildings. Where appropriate as part of this plan, manhole covers and gullies shall be clearly marked on site by colour coding, red for foul/oily or combined water systems and blue for surface water only. Emergency Drainage Plan Drawings and “As-built” Site Drainage Drawings shall be similarly colour coded and noted accordingly.

12.8.1 Surface Water

Surface water drainage systems shall be designed to ensure:

- There is no flooding of the drainage system during the 1:25 return period event. The system shall be designed to include an allowance for Climate Change in accordance with the requirements of the relevant national environment agency;
- There is no standing water that could impact on the operation, inspection and maintenance of the substation during the 1:1000 return period event, including an allowance for climate change.
- It is in accordance with local planning guidance.

These requirements need to be considered in association with the requirements detailed in Section 10.4.2 “Flood Mitigation” of this Specification.

Storm water run-off from buildings and building roofs shall be collected by an appropriate system of rainwater goods that shall positively discharge to a surface water drainage system in a controlled manner. Where a positive discharge cannot be achieved the installation of a rainwater harvesting system should be considered.

The system shall be designed to ensure the minimum self-cleansing velocity in any pipe is 0.75m/s and the maximum velocity in any pipe is 2.5m/s.

12.8.2 Foul Water

Foul water drainage systems shall be connected to mains foul drainage wherever practicable. Where this is not practicable and SPEN will subsequently adopt the civil fabric then foul water drainage systems shall be the least cost, minimum maintenance system in accordance with the requirements of the relevant national environment agency (e.g. proprietary septic tank systems).

Cesspools shall be avoided as part of SPEN adopted systems, however, where these are accepted by ED&S as the only practicable option then they shall not be less than 4,000-litre capacity and shall incorporate alarms connected and commissioned to the substation local alarm and SCADA system. All cabling (power and alarms) and connection to power supply shall be designed and installed by the project team but final connection and commissioning of alarms to the substation SCADA system shall be by SPEN.

12.8.3 Oily Water

Oily-water drainage systems shall be capable of safely containing a major escape of oil from transformers, reactors or storage oil tanks. Rainwater build-up within oil containment bunds shall not

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be discharged directly into the system but shall be directed into an oily-water drainage system via a sump. It shall be the project team's responsibility to ensure that the relevant national environment agency and any appropriate local authority guidelines have been incorporated into the design of the oily-water drainage system.

Drains to oily-water drainage systems shall be designed to carry fluids at 80^0C.

12.8.3.1 Synthetic & Natural Ester Insulating Fluids

Although Ester Insulating Fluids are fully biodegradable there is still a potential for pollution to occur if discharged to ground or a controlled water during the biodegradation period.

Where Ester Insulating Fluids are used in place of traditional mineral oil these are to be treated in the same way as mineral oil. However, the chemical properties of ester fluids are very close to those of water therefore where ester insulating fluids are to be used the suppliers of bund dewatering units or separators shall provide written confirmation that the product has been type tested using that ester fluid and that a Class 1 discharge is guaranteed.

Where oil is referred to in this document it shall be read as meaning either mineral oil or ester fluids.

12.8.3.2 Oil-Petrol Separators

Oily-water drainage systems shall incorporate an Oil-Petrol Separator prior to discharge from the substation. Oil-Petrol Separators shall be full retention Class 1 Separators with integral silt collection and quality of discharge sampling facilities, together with integral coalescing and automatic closure 'dead-stop' mechanisms to prevent the flow through the unit in case of excessive oil levels.

Coalescer units shall comprise oil resistant fire-retardant material and be capable of removal for maintenance or replacement.

Oil-Petrol Separators shall be vented such that the build-up of potentially flammable or explosive vapour is prevented (as a minimum in accordance with the manufacturer's recommendations) and shall incorporate alarms connected and commissioned to the substation local alarm and SCADA system. Alarms for the system should include an excessive oil level alarm and a system cleaning alarm and be installed such that they alert the control room.

All cabling (power and alarms) and connection to power supply shall be designed and installed by the project team but final connection and commissioning of alarms to the substation SCADA system shall be by SPEN.

Separators shall have been type-tested to verify the stipulated design requirements for nominal flow rating, residual oil content of the discharge and water-tightness. A certificate stating details of its type-test, rating and class shall be provided with each unit.

By-pass type separators shall not be used.

Below ground / buried separators should not be used.

Alternative systems will be acceptable including omission of a separator where:

- Expressly required on a project-specific basis and agreed with ED&S or;
- Justified through a site-specific risk assessment with written confirmation from the national environment agency or other applicable local authority to ED&S that formal consent to discharge direct has been granted.

Where used these alternative systems shall incorporate an oil separation/sampling chamber upstream of the point of discharge.

12.8.3.3 Oil Separator Design Note

Separators shall be designed to accommodate the applicable run-off area or the worst case event of all bund pumps operating in unison, subject to relevant national environment agency minimum size requirements as applicable – NGTS minimum size requirements shall not apply.

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12.8.4 Oil Separation/Sampling Chambers

Where consent has been confirmed by the relevant national environment agency or other applicable local authority to omit the Oil-Petrol Separator, discharge water from bunds shall pass through a sampling chamber.

These sampling chambers shall as a minimum measure incorporate an integral oil separator plate and shall be of sufficient size to allow collection from flowing discharge, e.g. by means of raising inlets 100mm above outlets.

Where oil draw off comprising segregated sump, fire-trap and draw-off/sampling chambers are required on a project-specific basis by SPEN or shown to be necessary by a site-specific risk assessment the design and method statements for operational use shall be subject to agreement with ED&S.

12.8.5 Oil-Petrol Spillage to Substation Access/Service Roads

Where substation access roads incorporate positive drainage systems and Oil-Petrol Separators are provided in association with pumped discharge from bunds enclosing oil containing Outdoor Equipment, then such road drainage consideration shall be given to draining to the oily-water drainage system via the separator.

12.8.6 Road Channel Drain Systems

Where road channel drain systems are used to collect accidental oil-petrol spillage to roads these shall be proprietary heavy duty corrosion resistant grated top systems that incorporate precast polymer concrete or fibreglass channel sections.

12.8.7 Vented Battery Rooms

Requirements for drainage to bespoke Battery Rooms containing vented unsealed batteries shall as a minimum incorporate:

- Natural ventilation such that these rooms are not designated as hazardous areas to BS EN standards;
- Where connecting services to adjacent rooms cannot reasonably be routed externally these shall be kept to an essential minimum with robust durable seals that are fire-stopped and gas-tight;
- Floors shall be of tanked acid resistant construction internally and graded such that they fall towards a sump facility for spillage collection;
- Belfast Sink with potable cold water supply and eye wash kit.

It should be noted that where sealed batteries are used then these requirements do not apply.

12.8.8 Soakaways

Soakaways shall be proprietary infiltration storm water management systems or as a minimum measure, in non-trafficked areas, infill pits or herring bone drainage systems filled with approved recycled 32-40mm graded aggregate, all enclosed within a free-draining geotextile wrap.

Where necessary based on risk assessment, soakaways shall additionally be lined with oil absorbent matting contained between geotextile membranes.

12.9 Oil Containment

All oil containing Outdoor Equipment (e.g. transformers and reactors) and oil storage areas (e.g. associated with oil filled cables) shall be sited within oil-tight bund systems. Where practical, no part shall be sited within 50m of any borehole or well used for water extraction, within any Source

Protection Zone, 10m of any surface watercourse or 5m of any drain through which oil could enter and discharge directly into controlled waters.

No drainage, earth strip, cable or other service nor any duct or pipe shall pass through bund systems to the transformers. Power cables to associated auxiliary transformers and reactors should avoid passing through bund systems, where this is considered to be unavoidable, these shall be situated within ducts and the cable entries shall be fully sealed to the satisfaction of SPEN (within and around ducts).

12.9.1 Bund Systems

Oil containment bunds shall be designed to safely contain a minimum of 115% of total oil content or where bunds contain more than one oil containing item of Outdoor Equipment (e.g. transformer or reactor) 125% of the capacity of the largest. In addition, oil containment bunds shall be designed to also safely contain a minimum 100% of total oil content plus 150mm freeboard. The volume of voids within gravel shall be ignored for the design of the oil storage volume.

Oil containment shall otherwise satisfy all relevant national environment agency guidelines as applicable. Bund enclosures should be of reinforced concrete construction or other proprietary systems subject to prior acceptance by ED&S.

Where bunds are of reinforced concrete, they shall be not less than 225mm thick designed and constructed to retain aqueous liquids such that crack width is controlled by the reinforcement to limit this to 0.2mm. Wherever practicable, reinforced concrete bunds shall be of monolithic construction integral with support plinths. Where movement joints cannot be avoided then these shall incorporate proprietary cast-in hydrophilic seals or water-bars, non-absorbent joint filler and oil-resistant perimeter sealant. Where construction joints are necessary these shall have continuous reinforcement and incorporate proprietary hydrophilic seals cast-in centrally. Penetrations for services are not permitted.

A sump shall be incorporated into the bund and sized to accommodate a bund pump or discharge pipe to oil interceptor. This should be sized based on the bund pump manufacturer's requirements to ensure efficient operation of a bund water control system. If manufacturer's guidance is unavailable the minimum sump dimensions should be 900mm x 900mm (or equivalent internal area on plan) with a sump down stand of not less than 450mm.

Bund layout shall be such that, as far as is reasonably practical, any 'spigot' or jetting' type flow is retained in the event of malicious damage or disruptive failure and that 'personnel' accessing completed bund structures do not compromise electrical safety clearance to exposed Live conductor and/or Insulator. The inner face of bund walls shall not be less than 1m clear on plan of oil containing parts.

Reinforced concrete transformer bund walls should be designed to accept future installation of a proprietary noise enclosure mounted on the bund walls, including appropriate positioning of bund walls such that resonance does not occur.

Above ground bund walls shall not be less than 300mm above the adjacent internal and external finished surface level. Walls with an upstand of over 500mm to either side shall incorporate integral access and egress steps with anti-slip treads and demountable galvanised steel or GRP handrails on each side of the wall. If appropriate, walls that are relatively flush with ground level on each side (or buried) would be acceptable, for example, bunds comprising 'moat' type below ground only containment.

Where moat type below ground only containment installation is utilised to achieve electrical clearances and/or as an enhanced fire mitigation measure this shall be designed to be maintenance free for the design life period. All metal supports shall be of stainless construction and the layout shall be configured to prevent routine personnel access to the below ground areas, however; lockable flame-trapped man access and egress points (i.e. not less than two number in total) of not less than 600mm square shall be incorporated to facilitate inspection, either directly by personnel access or remotely by camera.

All bund systems shall be water tested on completion, prior to post-commissioning finishing works.

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Post-commissioning stone infill to bunds shall be a minimum depth of 300mm of approved recycled 14-20mm angular stone and shall incorporate appropriate protection to cables running within. The stone infill shall be at or below the bottom of chamfers to plinths.

12.9.2 Bund Water Control Systems

Oil containment bunds shall be designed such that build-up of rainwater does not compromise design capacity.

Where discharge is direct to a separator this shall be via an inverted pipe arrangement and shall incorporate a fire trapped sump.

Where removal of rainwater build-up is by means of propriety bund water control system and there are no drainage outlets this shall have National Grid 'Type Registration Certificate and be either:

- A bund water control (intelligent pump) systems to discharging to an oily-water drainage system (i.e. to separator);
- A complete Class 1 Certified Bund Dewatering System.

These shall incorporate a point of isolation local to the control unit, anti-siphon device and alarms connected and commissioned to the substation local alarm and SCADA system, including power or pump failure and high oil level alarms. The pump shall automatically deactivate if the sensor system detects oil during a normal water removal cycle, thus ensuring that no oil will be pumped out of the bunded area.

All cabling (power and alarms) and connection to power supply shall be designed and installed by the project team but final connection and commissioning of alarms to the substation SCADA system shall be by SPEN. The bund pump shall be capable of operating continuously without interruption. Assessments for the suitability of solar and battery systems shall be undertaken where these are proposed for use. Where there is a possibility of interruption due to solar power or battery systems a hardwired alternative shall be provided.

Alternative discharge systems may be acceptable subject to compliance with the requirements of this specification for oil water drainage.

12.9.2.1 Skimmer Pumps

As oil containing plant ages this may lead to oil leaks which may result in an increase in the number of the separator alarm being activated. To minimise the number of alarms in the separator the installation of skimmer pumps shall be considered.

Skimmer pumps shall be installed within the sump and will pump any excess oil into an intermediate bulk container located within the transformer bund, with a minimum volume of 1000L, and shall incorporate alarms connected and commissioned to the substation local alarm and SCADA system. Alarms for the system should include an excessive oil level alarm and a system cleaning alarm and be installed such that they alert the control room.

All cabling (power and alarms) and connection to power supply shall be designed and installed by the project team but final connection and commissioning of alarms to the substation SCADA system shall be by SPEN.

12.9.3 Water Test to Bund Systems

All bunds shall be water tested on completion as follows:

- Seal all cracks exceeding 0.2mm in width using a resin injection or other approved proprietary system;
- Temporarily remove the bund water control system;
- Plug the sump outlet and fill the bund with clean water to the maximum height permitted by SPEN but not less than equipment plinth level – record this level as datum;

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- Monitor and record the level of water over successive periods of not less than 48 hours until the fall in level over a period of 24 hours is less than 3mm, making allowance for both rainfall and evaporation;
- At any point where the aggregate net fall exceeds 75mm the level of the water shall be topped back up to the datum level before resuming the test;
- Allow for rainfall and evaporation by monitoring water levels in a suitable watertight control container of not less than 200 litres capacity filled approximately 50%;
- Oil containing bunds shall be deemed to have failed the Water Test if the specified water retention has not been achieved within 7 days. In the event of failure remedial works shall be carried out as necessary to adequately seal the bund, which shall then be re-tested;
- All test materials shall be removed from site on completion of successful water test, including environmentally controlled recovery or disposal of test water from within the bund.

Water Tests should be witnessed and signed off on site as part of the project's Quality Management plan.

12.9.4 Fire Risk within Bund Systems

Subject to a fire risk assessment being undertaken during the detailed design, as detailed in SPEN Substation Fire Protection Policy SUB-01-012, alternative and/or additional fire containment measures may be necessary as follows:

- Fire-trapped discharge into sumps with fire-sealed covers;
- Fire-trapped discharge into moat systems (oil storage below plinth/ground level);
- Active Fire Detection/Extinguishing Systems;
- Synthetic Ester Insulant to transformers.

Fire-trapped construction shall have minimum 4-hour fire resistance.

12.9.5 Fire-Traps

Fire traps shall as a minimum measure comprise a pit or chamber containing a 300mm depth of approved recycled 32-40mm graded aggregate. A metal grating supporting this loose stone infill shall be designed such that it requires no maintenance for the design life of the works and does not restrict the flow oil or loose a significant proportion of its strength in the event of a fire.

Design details and method statements for access/egress shall be agreed with SPEN on a project-specific basis where provision for planned access to below ground containment areas is required.

12.9.6 Protection to Cables within Bund Systems

Wherever practicable multicore cables shall be run on wall or compound surface mounted cable tray that does not present a trip hazard.

Power cables and where necessary multicore cables routed within stone infill shall be protected from mechanical damage by ducting or by a minimum of 150mm sand cover with structural geotextile over (to prevent migration of stone through the sand).

12.9.7 Emergency Spill Kits

Where SPEN own or will subsequently adopt oil containing Outdoor Equipment a freestanding mobile (wheeled) proprietary oil spill kit capable of managing spills up to 750L of oil shall be provided. This shall be at new sites and at existing sites where such facilities are not already in place.

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12.10 Transformer Tank Enclosures – General Requirements (Fire & Noise Enclosures)

Fire and Acoustic enclosures to transformer tanks shall be weather resistant proprietary demountable enclosure systems.

Where alternative solutions are proposed, or where otherwise deemed necessary, proposals shall be submitted to ED&S for comment and agreement in principle prior to procurement and shall as a minimum incorporate:

- Four walls and a roof that are structurally independent with no reliance on connections to the enclosed equipment for its stability and integrity, physically isolated from any vibrating parts of the equipment.
- A line of weakness in the overall construction immediately above the support where enclosures are mounted on bund walls, to ensure that the bund remains intact in the event of a disruptive failure.
- Min. two personnel access doors. These shall be positioned diagonally opposite each other as far as reasonably or at least spaced appropriately to provide sufficient safe egress in the event of an emergency
- A demountable design such that it can be installed and dismantled without the need to remove any part of the electrical system, either outside or within the enclosure.
- Weathering that is an intrinsic part of the enclosure design such that there is no reliance on products such as membrane systems or sealants that are applied post installation.
- A non-slip oil-resistant roof surface that is positively drained to the transformer oil containment bund area via guttering and downpipes such that oil resulting from a turret bushing failure is contained.
- A stainless steel plate detailing the enclosure manufacturer's name and address together with the acoustic performance characteristics shall be fixed to the external face of the enclosure in an accessible and viewable location.
- Demountable and easily removable access panels to facilitate plant maintenance as required.
- Connection of metallic parts to the substation earthing system.
- Internal lighting with a minimum maintained illuminance of 150 lux at floor level, together with 3-hour self-contained maintained emergency lighting with test key-switches that achieves 2.5 lux at floor level.
- External lighting.
- All lighting shall be controlled by an external IP 65 rated light switch positioned adjacent to each personnel access door.
- An externally rated (IP 65) double 13 amp 240 volt switched socket outlet within the enclosure.

12.10.1 Fire Enclosures & Fire Barrier Walls etc to Outdoor Equipment

The requirements for fire enclosures and walls and the protection of key plant and buildings shall be in accordance with the current SPEN Fire Protection Policy. Where no space constraints apply, transformers or reactors shall be segregated as detailed in Table 3.

Enclosures and/or fire barrier walls shall be provided as a minimum measure where segregation distances are less than those given in Table 3. The use of Synthetic Ester filled transformers should also be considered where space constraints or risk to adjacent property is an issue.

Fire enclosures and fire barrier walls shall provide a minimum 4-hour fire segregation.

Fire barrier walls shall as a minimum extend:

- for a distance of at least 2m on either side of oil containing parts or explosion vents, or shall alternatively incorporate appropriately designed return walls;
- for a distance of at least 1m above oil containing parts or explosion vents, however, electrical clearances shall not be prejudiced.

Subject to the outcome of the site-specific Fire Risk Assessment it may be appropriate or necessary to provide alternative or additional fire mitigation measures to Outdoor Equipment such as fire-trapped sumps to bunds, below-ground fire-trapped oil catchment (moat system), Active Fire Extinguishing Systems or the use of Esters.

Fire enclosures to transformer tanks shall be weather resistant proprietary demountable enclosure systems. The preferred construction type for fire walls is solid in situ (or precast panelled) reinforced concrete or proprietary demountable steel structures.

Where alternative solutions are proposed, or where otherwise deemed necessary, proposals shall be submitted to ED&S for comment and agreement in principle prior to procurement.

Coolers to transformers shall not be enclosed to the extent that the detrimental effect on natural ventilation is unacceptable to SPEN. Forced electro-mechanical ventilation for cooling to transformers shall not be acceptable.

Transformer or Reactor Type	Liquid Volume (litres)	**CLEARANCE** Between Bund & Adjacent Oil Containing Parts or Other Oil Containing Equipment (m) [1]	**CLEARANCE** Between Bund & Combustible [2] Building Surface (m)
Oil Insulated Transformers	> 1,000 < 2,000 [3]	3.0	7.5
	> 2,000 < 20,000	5.0	10.0
	> 20,000 < 45,000	10.0	20.0
	> 45,000	15.0	30.0
Less Flammable Liquid Insulated Transformers	All Volumes	0.9 Horizontal & 1.5 Vertical	

Table 3 – Fire Segregation Requirements for Outdoor Equipment

12.10.2 Acoustic Enclosures and Barriers

The substation layout shall incorporate acoustic enclosures or barriers where noise studies conclude that transformers or other equipment (e.g. compressors, filters, etc.) would give rise to a noise complaint. Calculations shall be provided, confirming that the acoustic design is such that a noise complaint would not arise subsequent to the installation of acoustic enclosures or barriers.

Coolers to transformers shall not be enclosed to the extent that the detrimental effect on natural ventilation is unacceptable to SPEN. Forced electro-mechanical ventilation for cooling to transformers shall not be acceptable.

Where required by SPEN on a project-specific basis the substation design layout shall be such that it can facilitate installation of future acoustic enclosures or barriers where there is the potential for

[1] It is not necessary to segregate or screen transformers (or reactors) up to 11kV or 33kV auxiliary transformers *from* higher voltage equipment, the required segregation parameters for the lower voltage equipment would apply therefore in these circumstances.

[2] A combustible building is defined as one that is constructed of a predominantly combustible material such as timber. The distance to the building does not include the attached Switch Room but does include other SPEN substation buildings and 3rd party buildings.

[3] Subject to site–specific Fire Risk Assessment, oil insulated equipment containing less than 1,000 litres may require fire mitigation measures to be applied in high risk locations or situations.

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transformers or other equipment to give rise to a noise complaint from possible future developments adjacent to the substation site.

Enclosures shall be designed on a project-specific basis to limit noise levels to meet the recommendations of associated pre-engineering Noise Studies and shall achieve an insertion loss of not less than 20dB at 100Hz.

It is known that the design of ventilation within these enclosures can be problematic. To achieve the design criteria detailed in Section 13 the use of finite modelling is the most appropriate way to ensure that a practical solution is designed and constructed.

Enclosures shall incorporate an acoustically absorptive inner surface that shall minimise internal reverberation and shall have adequate natural ventilation, which shall not promote corrosion of the equipment or of the enclosure elements nor compromise the overall acoustic performance.

The bund layout to 275kV and 400kV transformers shall be designed to accept installation of a future proprietary noise enclosure mounted on bund walls such that resonance does not occur within the enclosure.

12.11 Fencing to Substation Enclosures

All security systems, including fencing, shall be in accordance with ASSET-01-023 – Substation Security Policy and as a minimum measure 275kV and 400kV substations shall be enclosed by Security Fencing such that there is a minimum 3.0m overall height clearance to perimeter security fencing within 2.0m external to the line of the fence. Security Fencing shall be a minimum of 2.4m overall height above any potential climbing aid (horizontal climbing aids, anti-dig security kerb or bund wall).

Anti-climb measures shall be incorporated within Security Fencing systems where this presents ‘internal corners’ (less than 135° between fence sections) external to the fence, abuts substation buildings or, where agreed with ED&S as an alternative to raised fencing, external fences or potential climbing aids within 2.0m external and internal including earthworks or elevated ground. Substations classified by ScottishPower Corporate Security as high-risk sites with respect to the potential for unauthorised entry (e.g. theft or vandalism) may necessitate additional security requirements. These will be identified by ScottishPower Corporate Security on a site-specific basis and agreed between Corporate Security and the Civil Asset Manager. Where a Site is identified as CNI, additional security requirements may be specified by ScottishPower Corporate Security on a site-specific basis and agreed between Corporate Security and the Civil Asset Manager. Specification of this is outside of the scope of this Standard,

All fencing shall be hot dip galvanised steel in accordance with this Specification. Hot dip galvanised materials should not be post drilled. Fixings to be made after galvanising shall be made with clamped fixings unless otherwise agreed with ED&S.

All fencing should be in accordance with current standard designs and notwithstanding the minimum requirements of these drawings and this Specification, structural performance shall be determined based on site-specific conditions including the nature of the ground, topography, applied lateral loading and overall fence height.

Earthing and all signage to fence panels shall be installed by the project team.

All signage including, but not limited to, “property” and “danger notices” should be clamped to the fence panels.

Construction of security fencing immediately adjacent to the position of a transformer or reactor shall be such that it is readily demountable to allow equipment to be removed for maintenance or replacement.

The design and fabrication of fencing systems shall make allowance for appropriate connection of earthing.

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12.11.1 Gates

Gates shall provide the same (minimum) level of security as, and be compatible with, the associated fence to either side.

The entry sequence shall be such that single personnel gates are accessed first, with no external locking mechanisms to double vehicular gates (i.e. opening from the inside only). Personnel gates should be located as close to the main vehicle gate as possible.

Locks, handles and cut-outs shall incorporate integral shrouds such that they do not present potential climbing aids.

Gates shall be designed such that failure of a single hinge does not allow the gate to fall. Hinge mechanisms shall be tamper-proof and hidden such that they do not present potential climbing aids. The spigot of the top hinge shall be reversed to point downwards to prevent the gate being lifted off.

Vehicular gates shall have clear openings not less than the width of the associated road or 4.0m whichever is the greater. Personnel gates shall have clear openings appropriate for their required operational use subject to a minimum of 900mm.

Where an Integrated Security System is being installed a 50mm PVCu duct maybe required below the gates to accommodate cables. This requirement should be confirmed between the project team and Corporate Security during the detailed design phase.

The arrangement of gates must take cognisance of the road design where a camber or crossfall is incorporated such that the maximum clear space beneath a gate in the closed position shall not exceed 70mm.

Where Power Fences are to be installed gate posts shall extend to the same overall height as the electric pulse system.

12.11.2 Palisade Fencing Systems

The required security rating of a fence system is defined in ASSET-01-023. The construction of palisade fencing to substations shall be inline with SP (security) standard of fixings and pale details to BS 1722 Part 12 that incorporate:

- Tamper resistant bolt and shear nut fence panel fixing;
- Heavy duty 4.0mm thick ‘D’ section pales with single point or Heavy duty 3.0mm thick ‘W’ section pales with tamper resistant swaged pin and collar grooved fasteners having special formed heads to suit pale profile;
- Maximum 85mm clear space between pales;
- Maximum 50mm clear space beneath pales;
- Minimum 65 x 50 x 6mm rail sections, or minimum 75 x 50 x 6mm to gradients exceeding 1 in 6 over more than two panels;
- Vertical posts to be minimum 102x44x7kg/m, or equivalent, post sections.
- 3 No horizontal rails 50x50x6mm with countersunk holing and V slot for pale insertion;
- Vertical posts to be minimum 127x76x13kg/m UB Pointed, or equivalent, with 150x100x10mm baseplate.

12.11.3 Mesh Fencing Systems – Security & Enhanced Security

The required security rating of a fence system is defined in ASSET-01-023. Security mesh fencing systems shall be open mesh steel panel systems with Category 4 (Higher security fences) standard of fixings and mesh panel details to BS 1722 Part 14 that incorporate:

- Tamper resistant cup headed bolts into full height flat metal plate fixing strips bolted full depth through posts to nuts on inner rear face;

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- Welded mesh type panels with maximum 12.5 x 75mm mesh spacing, minimum 4mm thick wire;

  Or

- Expanded metal type panels with maximum 10mm x 70mm mesh spacing with 3mm thick strand (5.5mm wide main strand);
- Minimum 80 x 80 x 3.5mm thick square hollow section posts.
- Individual fence panels (not continuous construction);
- Additional stiffening wires to welded mesh panels to avoid 'bowing' (not applicable to expanded mesh panels);
- Minimum 100 x 100 x 4.0mm thick square hollow section posts (appropriate weep holes are to be installed on the substation side of the post).

12.11.4 Post Pockets

Ground mounted posts to Security Fencing shall be set within in situ concrete minimum 0.9 x 0.9 x 0.3m deep pads or minimum 0.45 x 0.45 x 0.9m deep pockets.

Ground mounted posts to Enhanced Security Fencing shall be set within in situ concrete pockets minimum 0.6 x 0.6 x 1.0m deep.

Where posts are set within or atop reinforced concrete walls (including to bunds) these walls shall not be less than 300mm thick.

Post foundation design shall allow for any height/load increase associated with attached or proposed future anti-climb barriers or electric pulse Power Fence in addition to any site-specific conditions.

12.11.5 Anti-Dig Security

Security fencing shall incorporate anti-dig measures below the fence and gate panels. This shall be a concrete beam not less than 200mm wide x 300mm deep, incorporating 25mm chamfers to top edges and set a maximum of 50mm beneath the fence panels.

12.11.6 Anti-Vandal Scaling Barriers (Anti-Climb Mechanisms)

Anti-climb mechanisms shall be approved rotating proprietary anti-vandal anti-scaling barriers, fixed such that support brackets are set one vane in from exposed ends to avoid presenting a climbing aid. Barbed wire or barbed tape anti-climb measures shall not be acceptable.

12.11.7 Coloured Fencing Systems

Appropriate painted systems may be applied after erection but pre-coated systems that impair electrical continuity for earthing purposes shall not be acceptable unless continuity is provided at connections.

Where SPEN will subsequently adopt the civil fabric of the substation and paint systems to galvanised fencing are necessary then these shall comprise:

- Etch coat and wash preparation, including spot priming with one coat zinc phosphate primer to any areas where the galvanising has been damaged or bare ferrous metal is exposed;
- 65 microns: single-coat quick drying water-based metal primer designed to provide excellent adhesion to the surface of new bright or weathered galvanised metal surfaces;
- 80 microns: two-coat build-up of gloss finish specially formulated for metal with a quick drying solvent-based formulation that can be over-coated within 4 to 6 hours (depending upon conditions).

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12.12 Power Fence Systems

Where it has been identified through a site-specific Security Risk Assessment (SRA) that a Power Fence is required this shall be installed, connected and commissioned by ScottishPower Corporate Security. The project team shall provide a point of connection at a location that should be agreed by the project team and ScottishPower Corporate Security during the detailed design.

Where a power fence is supplied from the substation LVAC Distribution Board and the substation has an independently earthed fence, the power fence control cabinet and earthing of the AC supplies shall be designed and constructed such that the separation of the fencing and main substation earthing systems is maintained as detailed in EART-03-002.

12.12.1 Electric Pulse Fence Systems

Electric pulse fence systems shall be separated into a minimum of four zones to facilitate identification of the location of faults or unauthorised entry.

Electric pulse fences shall extend 1.0m above the top of Security Fencing.

The maximum clear horizontal gap in any part of the electric pulse system when operational shall be 50mm. Additional wire loops shall be introduced to extend the system as necessary.

Electric pulse fences shall incorporate heavy-duty 2.5mm high tensile bezinal coated wires.

4mm thick steel lugs shall be welded to the internal face of fence support posts prior to the complete fabrication being hot dip galvanised; to receive minimum 2mm thick steel support posts (installed on site). Shot fired nail or similar systems that would damage galvanising shall not be used.

Security Fences supporting electric pulse fences shall incorporate extra-over height gate posts, straining posts and additional posts at changes in direction as required by the Power Fence design.

Security or Enhanced Security Palisade Fences supporting electric pulse fences shall additionally incorporate a mesh screen to prevent accidental contact with electrified wires (i.e. between pales from outside) – not applicable to Mesh Fences.

12.12.2 Traffic Signal Control Systems (to Electric Pulse Fences)

Entry to and exit from the substation site and the associated operation of the electric pulse fence shall be controlled and visually indicated via a vertical stack, three aspect (red, amber and green) traffic signal system. The lamps shall be configured to operate as follows:

- Red aspect only – indicates that the Power Fence is correctly armed;
- Green aspect only – indicates that the Power Fence is correctly disarmed;
- Amber aspect only – indicates that the Power Fence is reporting a zone fault.

Traffic signal systems shall be a minimum IP44 rated and operation of electric pulse fences shall be from a key pad appropriately located inside a substation building.

Traffic signal systems shall be located inside the perimeter security fence in a location that is viewable by pedestrians and vehicle drivers (as appropriate) who are situated outside and in reasonable proximity to the main entrance to the substation site.

Traffic signal systems shall comprise black, self-colour, UV stable polycarbonate housings incorporating signals with 100mm diameter Fresnel lenses, 240V LED (light emitting diode, equivalent to 40W incandescent) lamps and integral hoods to prevent other light source interference. All fixings shall be tamper-proof.

Vertical stack traffic signals shall incorporate a clear Perspex screen adequate to protect the lenses from damage by vandalism, e.g. from projectiles either thrown or fired from air rifles.

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12.13 Fencing to Areas External to Substation

Post and wire or post and rail fencing minimum of 1.2m tall is required to reduce accessibility to the crest of earthwork slopes and SUDs ponds. Appropriate signage is required to be affixed to these identify any significant risk, “Danger Deep water”, “Danger Drop” etc.

12.14 Temporary Fencing Systems for Site Segregation

12.14.1 Segregation of Authorised Operatives

Where SPEN does not otherwise provide formal demarcation under the ScottishPower Safety Rules and the site operatives are appropriately authorised and supervised under these Rules, temporary barriers shall be installed to segregate those areas of compounds that are “under Rules” (‘Live’) but where general access is not necessary for the purpose of the works. Temporary barriers shall be Department for Transport Traffic Signs Manual “Chapter 8” twin-rail red/white PVCu barrier or minimum 1.2m high fencing (e.g. proprietary block and mesh).

12.14.2 Segregation of Unauthorised Operatives

The project team shall be responsible for ensuring that the appropriate CDM safety measures are in place to ensure compliance with the requirements appropriate to areas of compounds that are “under Rules” (‘Live’).

Where operatives are not appropriately authorised or supervised under the ScottishPower Safety Rules, fixed-position temporary fencing shall be installed to prevent entry to those areas of compounds that are “under Rules” (‘Live’). Where Heras fencing is used to provide this separation, and this is agreed with the SAP, consideration to the security of joining straps and adoption of anti-tamper joining straps should be given.

Appropriate signage including Danger Live notices should be placed upon plant inside the Live area and “Danger of Death” notices erected on the temporary fence along with “No admittance authorised personnel only” notices.

Any gates between the 2 areas should be locked with an authorised person substation access lock and any conductive fence needs to be connected to the substation earthing system.

Insulating panels between separately earthed systems, e.g. substation and perimeter security fencing earth systems shall be 2.0m long ‘floating’ or solid timber sheet panels. Floating panels shall incorporate a 50mm air gap at each end.

Where temporary security fencing to the Works encloses areas containing outdoor plant or equipment that is not otherwise protected by a permanent standard Security Fence as specified or other approved permanent barrier then this temporary fencing shall be of equal standard to permanent Security Fencing as specified.

12.15 Metalwork

All steelwork, including members internal to substation buildings, shall be hot dip galvanised and shall facilitate fixings for earthing tape.

A minimum thickness of 85 microns is required. This should be increased where necessary to take account of any site-specific factors that may accelerate the corrosion rate.

As required by the National Structural Steelwork Specification for Building Construction, nuts to galvanised bolt systems shall be of a higher grade than the bolts.

In line with Iberdrola’s commitment to SteelZero, steel suppliers shall meet any or a combination of the following:

- Steel produced by a steelmaking site where the steelmaker has a science-based emissions target (or equivalent).
- ‘Lower emission steel’ (aligning with ResponsibleSteel Decarbonisation Progress Level 2)’

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12.16 AIS (Outdoor) Equipment Support Structures

Equipment support structures shall be hot dip galvanised steel or aluminium construction with welded or bolted joints. Due to the risk of ice jacking, steel hollow sections shall not be used for supporting outdoor equipment.

Bolted connections shall comprise a minimum of two bolts each except bracing members where this requirement may be reduced to one bolt with locknut or self-locking nut. All bolted connections subject to vibration shall incorporate self-locking nuts, lock nuts or high strength friction grip fasteners. Washers shall be detailed at slotted holes. Earthing is required to be bonded across these bolted connections.

Gusset plates, stiffeners, flanges and elements of built up sections shall not be less than 6mm thick.

As far as is reasonably practical, equipment support structures shall be detailed such that they cannot be readily climbed without the use of aids.

Wherever practical, equipment support structures shall be delivered to site complete with all predrilled holes for the fixing of earth tapes, cables and all other relevant attachments.

Where structures are designed to convey fault current they should be designed and constructed in accordance with the requirements of EART-03-002 and ENA TS 41-24.

Equipment support structures shall be bonded to the substation earthing system.

The underside of base plates to equipment support structures shall be set a nominal 25mm above foundations and the void between the two fully filled with proprietary non-shrink grout finished flush at 45° to the underside of the baseplate. Holes of not less than 20mm shall be incorporated within base plates to facilitate grouting where required.

Cast in situ holding down bolt systems shall be used and in all cases to large or heavily loaded structures (e.g. strain gantries). Where post drilled systems are formally accepted in principle by ED&S these shall be subject to an agreed testing regime as part of the project's Quality Management plan. This should include agreed inspection and witness points and be signed off on site.

12.17 Woodwork

Timber should be sourced from a recognisable forest management certification body such as the PEFC or FSC. The use of timber from fast growing tree species is also preferable.

13 BUILDING ENCLOSURES

Substation buildings shall be freestanding and be fully weatherproof, paying particular attention to design and construction details with respect to wind driven rain and surface water run-off.

Substation buildings shall be designed and detailed such that the potential for vandalism and theft is minimised.

Where exposed metalwork within is acceptable in principle to SPEN this shall be bonded to the substation earth system with adequately sized insulated conductor.

Basement construction shall not be permitted without the express agreement of ED&S.

13.1 Pre-Fabricated Enclosures

Prefabricated enclosures shall be in accordance with the principles defined within SUB-03-041. Lock mechanisms to doors shall be suited to SPEN site-specific requirements. Lock keepers/lock protectors must be fitted on any access doors. Fire exit doors should be fitted with multi point locking systems. Where prefabricated enclosures have cables exposed below floor level these shall incorporate galvanised steel mesh or other acceptable anti-vermin barrier between sub-frame and ground level.

Where stepped access into prefabricated enclosures is greater than 225mm demountable GRP personnel/plant access steps/platforms external to doorways, inclusive of removable handrails, shall

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be provided. Alternative reinforced concrete access steps/platforms incorporating removable galvanised steel or GRP handrails would be acceptable where SPEN confirm that these are not required to be demountable to facilitate access for future installations or for excavation in the event of a fault.

Foundations to support Enclosures for Indoor Equipment that do not have floors (Housings) shall be in situ reinforced concrete construction. These foundations shall be of bespoke design to meet the Enclosure manufacturer's requirements and the requirements of this Specification (e.g. tolerances for flatness and level) such that a suitable environment for Indoor Equipment is maintained within the enclosure and all service entries are fully sealed against moisture ingress (e.g. ducts and cables/earth strip within ducts).

13.2 GIS Buildings

GIS Buildings shall be steel portal frame design, unless otherwise highlighted by the Corporate Security Site Risk Assessment, and shall incorporate the following features, to facilitate the safe installation of equipment:

- General:
    - Clear level hardstanding area immediately outside the plant access doors, of adequate ground bearing capacity, for unloading of substation equipment. This area should be sized in accordance with the GIS manufacturer's requirements but should not be less than 60m^2 unless agreed with ED&S.
- Access for 275kV and 400kV Indoor GIS Switchgear:
    - An internal 'lay down' area shall be provided immediately inside 275kV and 400kV switchgear plant access doors to facilitate the assembly, installation and maintenance of the GIS plant together with storage of materials, gas cart and bottles. This area should be sized in accordance with the GIS manufacturer's requirements and should facilitate access to an overhead crane. It should not be less than 4m deep by the full width of the building, unless agreed with ED&S;
    - Travelling overhead crane system to facilitate maintenance and future installation or removal of 275kV and 400kV switchgear.

13.3 Building & Equipment Layout

Sufficient space shall be provided within buildings to facilitate access for all necessary construction, testing and commissioning, inspection, maintenance and removal activities. The arrangement shall make allowance for future bays where required and a 1m x 0.8m main security cabinet in the control room.

A clear passage of not less than 750mm wide shall be provided behind and around floor-mounted equipment where access for operation, maintenance or replacement of equipment is required and where access for maintenance or redecoration of the building fabric is required.

Where two rows of equipment face each other (control panels and/or switchgear) the clear distance between front faces shall not be less than 1.8m, increased as necessary to facilitate access for test gear and for removal for replacement of equipment.

The clear distance in front of equipment shall provide operators with a full view of instruments and indications to the unit under consideration and to the units immediately to either side and shall not be less than 1.2m.

Requirements for clear passage and operating distance shall be clear of obstructions such as wall-mounted equipment or tools, radiators, services, structural projections and the like as well as equipment door openings unless these are either removable or will open through approximately 180˚. All doors shall open onto clear passages and routes of safe egress.

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13.4 Telecoms Rooms

To improve security and resilience of telecom systems, telecoms systems in all 275/400kV substations shall be installed in separate partitioned rooms, as highlighted by the Corporate Security Site Risk Assessment. Telecoms rooms shall be locked to prevent unauthorised entry.

13.5 Fire

Buildings shall be designed to prevent the propagation of fire and in particular in the event of an electrical failure from either external sources (e.g. outdoor power transformers) or from internal High Voltage switchgear or power cable faults. The provision of fire alarm systems within buildings is covered in Section 14.4.

Although substation plant is extremely reliable and the probability of a disruptive failure is very low a fireball may be produced when this condition occurs and considerable heat and smoke can be generated as a result.

The maximum travel distance to a place of reasonable safety shall be in accordance with Table 4.

Room Type Containing	**Building Regulations Purpose Group**	**Travel Distance** One Direction Only (m)	**Travel Distance** More than One Direction (m)
Rooms with Oil filled plant, generators, batteries	Purpose Group 7 – Place of special fire hazard	9	18
Other rooms	Purpose Group 6 – Industrial normal risk	25	45

Table 4 – Maximum travel distances to a reasonable place of safety

A reasonable place of safety shall be:

- A protected stairway enclosure (a storey exit);
- A separate fire compartment from which there is a final exit to a place of total safety;
- The nearest available final exit.

In addition, rooms enclosing switchboards in excess of 6m in length shall have a minimum of two exit doors, opening outwards, on or at opposite ends of the Switch Room, to allow egress in either direction from behind or over switchboards.

Escape route passages shall have a minimum clearance width of 900mm and the clear opening width and height of doors forming part of this escape route shall not be less than 750mm and 2000mm respectively. Emergency exit doors shall open outwards, external doors by means of panic bars without the use of a key, which shall be clearly marked with a suitable notice explaining the operation of the opening device.

Signage indicating escape routes and self-contained emergency lighting shall be installed.

The use of readily combustible materials within substation buildings shall not be acceptable; all internal lining and structural surfaces shall be non-flammable material of limited combustibility such that they adequately resist the spread of flame over their surfaces. In addition, but with the exception of external doors, civil fabric finishes internal to the substation enclosure shall meet the requirements of the national building regulations for low surface spread of flame and low fire propagation index (e.g. Euroclass B).

Where required, fire protection to steel frame construction shall be by means of a reinforced concrete surround or proprietary intumescent paint or spay systems or Vermiculite-type fireboard which cannot be displaced in the event of a disruptive failure.

Substation building enclosures shall be fully compartmented construction with minimum 1-hour fire segregation, including below floor trenches and ducts passing between rooms, such that spread of fire to other internal areas shall not occur for a minimum period of 60 minutes in the event of a fire initiating.

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Where internal wall vents are considered essential, they shall be the intumescent fire block type that will operate automatically in the event of fire to ensure that there is no spread of smoke or fumes.

Portable fire extinguishers shall not be provided.

Fire blankets shall be provided to Mess Room areas.

Subject to the outcome of the Fire Risk Assessment for the project, or where otherwise deemed necessary by SPEN for the safe operation of the substation, it may be appropriate or necessary to provide alternative or additional fire escape/mitigation measures with respect to rooms or buildings enclosing High Voltage switchgear.

13.6 Earthing

13.6.1 GIS Switch Room Floors

Reinforcement within GIS Substation Switch Room floors shall facilitate connection to substation earthing systems after construction. The project team shall be responsible for:

- Connecting reinforcement together to ensure electrical continuity throughout by welding or mechanical techniques at a minimum of two connection points per mesh sheet or re-bar, ideally on diagonally opposite corners of the building;
- Installation of fully rated appropriately sized flexible insulated copper cable connections projecting from cast in situ concrete such that these can be safely routed to a minimum height of 750mm on adjacent walls, including across the invert of multi-core trenches where applicable.
- The copper earth to steel rebar connection shall be by exothermic weld or mechanical clamp wrapped to prevent moisture ingress, e.g. bitumastic tape wrapping.

Where a bespoke site-specific Earthing Study Report confirms that this connection of floor reinforcement to substation earth is not necessary then this may be omitted subject to the prior written acceptance of ED&S.

13.6.2 Metal Door Sets

The project team shall be responsible for the provision of earthing connections to metal door sets as follows:

- Appropriately sized (minimum 70mm^2) flexible anti-fatigue braided copper connections top and bottom between frames and leafs;
- Appropriately sized (minimum M10) stud projections to each side of frames at a height of approximately 1.2m above finished floor level.
- In the area where the doors open the horizontal buried ring Earth Electrode shall be extended to 0.5 m beyond their open position.

13.6.3 Raised Access (computer-type) Floor Systems

Raised access floor systems shall be connected to the substation earthing grid by appropriately sized flexible insulated copper connections at a minimum of one within each group of four adjacent support posts.

13.6.4 Lightning Protection to Steel Framed Clad Buildings

The building frame shall be suitably connected to the substation earthing grid by appropriately sized copper connections at the bottom of every column stanchion and at the top of each column at the corners of the roof (or highest level roof where there is more than one height).

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13.7 Substructure

Damp proof membrane systems shall be provided to fully enclose below ground masonry substructure construction to operational rooms with below floor cable access or multicore trenches, incorporating membrane protection where these are externally applied. This damp proof system may be omitted to reinforced concrete substructure construction in appropriate site-specific situations and is not applicable to cable riser areas to 275kV and 400kV GIS buildings of any construction type.

Sub-floor infill to ground bearing floor slabs shall be weak-mix cast in situ concrete.

Cable trenches formed within solid floor construction shall have reinforced concrete bottoms and sides; alternative masonry sides would be acceptable where these are above structural reinforced concrete rafts.

The cable riser areas of 275kV and 400kV GIS buildings shall have compound construction finish surfacing with protection from mechanical damage to cables passing through it.

13.8 Floors

As a minimum GIS control room and GIS building floors shall be capable of achieving an overall thermal transmittance U Value as detailed in Table 6.

Floors shall be pre-cast, reinforced concrete, proprietary raised access systems or, where agreed with SPEN, on a project-specific basis, another appropriate system.

The required finish and permitted tolerances for floor finish, including deflection to suspended floors, shall comply with the manufacturer's requirements for plant installation and operation.

Raised access floor systems shall incorporate tiles with cores that are fully enclosed by galvanised steel and have a durable non-slip vinyl tile anti-static surface finish. Supports to floor mounted equipment panels within raised access floors shall be independent galvanised steel pedestals, panels shall not be free-standing or supported on proprietary raised access systems.

Trench work within solid concrete construction shall incorporate rebates cast within floors to receive trench covers.

Reinforcement to solid concrete floor slabs within GIS Substation Switch Rooms shall be bonded to the substation earth system in accordance with the requirements of this Specification.

Structural floor slabs shall be continuous at doorways, including suspended slab construction over trenches where applicable. Sand fill with screed topping or suspended trench cover systems shall not be acceptable to trenches at these locations.

Precast 'beam and hollow pot or block' type floor construction or screed finishes to concrete floors will not be acceptable in rooms with floor-mounted equipment.

Once cured, as a minimum measure concrete floors to all operational areas shall be prepared and painted with 2No. coats of a proprietary slip-resistant Epoxy Resin floor paint system strictly in accordance with manufacturer's recommendations. Slip-resistant floor paint systems to Battery Rooms with sealed batteries (valve-regulated) shall additionally be acid resistant.

Floors to GIS Switch Rooms shall comply with any additional requirements of the switchgear manufacturer for plant installation and operation.

Floor finishes to Battery Rooms containing vented batteries shall incorporate an acid resistant finish and spillage containment appropriately drained to a sealed underground storage tank.

13.8.1 Floor Fixings

All floor mounted substation equipment shall be suitably fixed and supported in accordance with the manufacturer's recommendations. Where switchgear / plant is to be supported over open cable pits by additional steel beams then these shall be designed to withstand the operational loadings of equipment and be suitably spaced to align with all feet fixings.

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13.9 Covers to Cable Trenches, Pits and Slots

Cable trench and pit covers shall be loose-laid solid anti-slip GRP covers or galvanised steel or aluminium chequer plate construction covers, including to spare and future bays.

Where required during the construction works temporary covers should be fitted to facilitate safe access and egress prior to installation of the Equipment.

13.9.1 Cable Support Structures

Where tails are incoming and the cable trench is to be left void then the cables shall be supported by an appropriate cable restraining support system to support the cables and protect against damage during a cable fault.

Support systems shall be galvanised steel construction of bespoke design to meet the cable and termination manufacturer's requirements.

13.10 Cable Entries into/within Buildings

Where practicable all cable entries to cable trenches and pits shall be constructed to allow use of a SPEN approved mechanical cable duct sealing system, or alternative which is proposed and acceptable to SPEN.

Where it is not practicable for existing cable ducting to utilise an appropriate mechanical duct sealing system that is acceptable to SPEN, the cable pit shall be sand filled and screeded (with visqueen membrane and minimum 50mm thick granolithic screed) flush with finished floor level wherever practicable but not less than a minimum depth to adequately cover all duct entries. Particular attention shall be paid to achieving full compaction of dry sand in layers and sealing of cable entry points in order to ensure that cavities cannot develop beneath the screed.

13.11 Cladding Systems to Steel-Framed Buildings (Walls and Roofs)

Steel-framed clad buildings shall have a life to first maintenance of not less than 20 years and:

- Provide a wind and watertight envelope to protect all sensitive plant and equipment installed within the building;
- Be capable of withstanding the effects of any corrosive substance present within or outside the building;
- Be sufficiently robust to withstand the effects of all loading combinations that may occur throughout the operational life of the substation;
- Incorporate if necessary provision of pressure-relief panels or vents to walls and/or roofs enclosing 275kV and 400kV GIS equipment;
- Be capable of achieving sufficient thermal insulation as necessary to provide an appropriate internal environment and avoid moisture ingress via condensation. In particular external walls and roofs shall be capable of achieving an overall thermal transmittance U Value as detailed in Table 6. There is no requirement for insulation to walls enclosing ground floor cable riser areas beneath Switch Rooms;
- Shall be a minimum 150mm above finished floor level and facilitate minimum 90˚ opening to external doors;
- Shall incorporate masonry or acceptable alternative internal wall structures – for wall-fixing purposes.
- Ground floor cable riser areas beneath Switch Rooms may alternatively utilise Category 4 standard security mesh or other appropriate security barrier that is acceptable to SPEN.

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13.11.1 Future Maintenance and Redevelopment

Where SPEN will subsequently adopt the civil fabric of steel-framed clad buildings these shall additionally:

- Offer flexibility to allow for future expansion of the building such that this causes minimal disruption to the operation of the plant and external facilities;
- Be readily available and replaceable should damage occur by whatever cause;
- Be readily maintainable, in most cases this will require a self-finished minimum maintenance surface with self-cleaning capability and minimal inspection requirements;
- Be of such a material as to provide a consistent finished surface colour throughout its working life and offer an acceptable appearance when viewed from a distance.

13.12 Masonry Walls

Masonry units and associated ancillary items shall be as detailed in Section 12.6 “Masonry” of this Specification.

External walls to enclosures housing Indoor Equipment shall be cavity construction providing a maximum overall thermal transmittance U Value as detailed in Table 6.

Irrespective of the building’s purpose or generic construction type, where internal walls and the inner leafs of cavity walls are masonry construction these shall be of solid masonry units, fair-faced, plumb, smooth and even within rooms in order to be suitable for fixing wall-mounted equipment.

Walls shall incorporate any movement joints and additional reinforcing measures necessary to accommodate and/or resist post-construction movement, internal and external, such that they withstand all loading combinations without undue cracking, deflection or distortion.

13.12.1 Masonry Walls Enclosing Switchgear or Transformers – Disruptive Failure

Walls that enclose switchgear or transformers shall be designed such that progressive collapse does not ensue in the event of disruptive failure.

Irrespective of the design requirements with respect to non-electrical forces (e.g. wind forces, including associated internal pressures), internal masonry walls and the inner leafs of cavity masonry walls to traditionally constructed masonry buildings that house High Voltage switchgear or transformers shall be minimum 215mm overall thickness solid brickwork construction utilising clay or concrete bricks. Unless required for security reasons, this minimum requirement *would not apply* to the external walls of steel-framed clad buildings, similarly alternative segregating internal wall construction would be acceptable to these buildings where the design takes cognisance of and mitigates the potential overpressure forces and fire spread risk associated with disruptive failure.

Cavity masonry walls that enclose High Voltage switchgear or transformers shall incorporate Type 1 or Type 2 stainless steel wall ties or other proprietary system specifically designed to ensure adequate transfer of lateral load between masonry skins. If necessary, ties shall be a greater density than the minimum centres given by the requirements as detailed in Section 12.6 “Masonry” of this Specification.

Where applicable, walls enclosing transformers shall additionally comply with the requirements as detailed in Section 12.10 of this Specification.

Walls shall incorporate, as necessary, any combination of structural framing, enhanced cavity ties, bed-joint reinforcement, wind posts or enhanced lateral restraint (including that from roofs) to mitigate the impact of disruptive failure.

Alternative proposals for masonry walls enclosing switchgear or transformers that incorporate blockwork or other variation of specified construction detail will not be acceptable unless it is confirmed by structural design calculation to the satisfaction of ED&S that such alternative construction has equivalent lateral strength (or better) than that required by this Specification (e.g. by incorporation of structural steel frames, wind-posts or other masonry reinforcement systems).

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13.13 Roofs

Roofs shall be pitched and provide a maximum overall thermal transmittance U Value as detailed in Table 6.

Roofs shall be designed such that they eliminate or protect against the risk of failure due to vandalism or theft; in particular where moisture ingress could lead to disruptive failure if associated with Indoor High Voltage Equipment.

Roofs shall be designed to allow the installation of PV systems.

Traditional construction roofs are not applicable to transformers. Refer to Section 12.10 of this Specification.

13.13.1 Roofs Enclosing High Voltage Equipment – Disruptive Failure

Roofs that enclose switchgear shall be adequately robust and/or incorporate designed pressure relief such that progressive collapse does not ensue in the event of disruptive failure, including providing adequate lateral restraint to walls where necessary.

Roofs that enclose High Voltage Equipment shall be adequately robust and/or incorporate pressure relief panels such that potentially hazardous roofing material is not discharged to adjacent public areas in the event of disruptive failure.

13.14 Building Drainage

Where SPEN will subsequently adopt the civil fabric of the substation, rainwater goods shall be PVCu construction or other acceptable robust corrosion resistant systems by express agreement with ED&S.

Gutters and down pipes shall be external to buildings.

Gutters and down pipes to rainwater systems shall be a minimum 140mm and 100mm respectively.

Rainwater down pipe installations may require anti-climb and/or anti-vandal guards, subject to the site-specific location and environment.

13.15 Doors

It is essential that SPEN personnel can access and properly secure on egress all doors at all times. Any door material/construction type that may bind, shrink, warp, wind, corrode or distort will not be acceptable.

External doors shall be metal security doors of robust construction that provide security against unauthorised entry and shall incorporate protective surface finishes that are durable and maximise periods between maintenance. As a minimum, external doors shall have a security rating of C5 in accordance with LPS 1175.

Where the site-specific Security Risk Assessment highlights security concerns then this security rating maybe increased, when agreed between ED&S and Corporate Security, to mitigate the identified risks.

With the exception of bespoke Store Rooms, all doors shall be emergency escape doors, including doors providing access internally.

The number of doors having external locking to access buildings shall be kept to a minimum consistent with adequate safe operational use (to limit opportunities for unauthorised entry). Only one leaf of double doors shall provide emergency egress, with the other being fixed by means of robust bolts top and bottom.

Emergency escape doors shall open outwards.

400/275kV GIS switchgear access doors shall be electrically operated proprietary roller shutter doors (C5 or equivalent).

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Subject to site layout, other external doors may be required to open through 180^0 and/or incorporate removable panels over to facilitate the installation of plant.

Doors shall be fully weathered including appropriate seals to the external perimeter of frames, cover plate to un-rebated meeting styles and weathering to lintels over and to thresholds below. Weather bars shall be corrosion resistant construction, preferably built-into concrete thresholds to form 12mm weathered faces that are flush with finished floor level on the inside. Proprietary threshold weather bars shall not exceed 15mm upstand height to avoid presenting a trip hazard.

Wherever practicable design layouts shall avoid locating emergency escape doors such that they open into high risk areas such as HV Switch Rooms and AIS compounds with exposed live equipment or into areas where different types of Safety Rules Authorisation may apply.

13.15.1 External Metal Security Doors

External metal security doors shall be LPS security rated with proprietary corrosion resistant steel or aluminium units and shall have a fire rating equivalent to the building wall construction materials. Subject to the Security Risk Assessment at the site this may require the fitting of multiple padlocks on the entry door.

Corrosion resistance shall satisfy the specified requirements for design life and time to first maintenance.

Manufacture shall be such that these are sealed against water entry but allow discharge of condensation.

Metal security doors shall be bonded to the substation earth system in accordance with the requirements of this Specification.

13.15.2 External Roller Shutter Doors to GIS Buildings

Roller shutter doors for plant access shall be galvanised steel construction with a minimum C5 security rating and shall be constructed such that they can only be operated from within the building. They shall be sized to facilitate the installation, future inspection, maintenance and replacement of equipment. Over-sized door openings designed solely to suit the construction works shall not be acceptable.

13.15.3 Internal Doors

Internal doors shall be proprietary timber or steel fire doors. Internal doors to operational areas and to mess rooms shall be certified as having a fire resistance rating of at least 1 hour and facilitate emergency egress.

13.15.4 Door Furniture

The project team are responsible for the supply and installation of all fixed door furniture, which shall be robust heavy-duty construction and corrosion resistant. They shall determine the type and designated category of user access for locking mechanisms on a site-specific basis. SPEN will provide approved locksmith contact details for the supply of SPD, SPT and SPM suited locking mechanisms.

Doors designated as normal points of access shall be minimised (i.e. those having external locking), all other doors shall not have mechanisms for external access.

Lock bracket mechanisms shall be suitable to receive the appropriate SPD, SPT and SPM suited padlocks and shall be hardened galvanised or stainless steel high-security lock-brackets that are tamper resistant such that these are non-removable without access into the substation. Where SPEN require the use of other similarly suited lock mechanism types the detail of these shall be agreed on a project-specific basis.

Lock bracket mechanisms to receive padlocks shall incorporate integral shrouds such that padlocks are protected against unauthorised removal. All external door furniture shall be anti-climb in profile.

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Mechanisms for emergency egress shall be high-security multi-point locking mechanisms operated by means of full width panic bars. If emergency escape mechanisms are fitted to access doors with external locking then the panic bars must operate when the doors are locked. Padlock access devices must not restrict panic function.

Bolts to the fixed leafs of double doors shall be solid heavy-duty 16mm square section bow handle galvanised steel or other similar robust corrosion resistant construction.

Doors shall be fitted with appropriate proprietary garage type restraint stays to fix doors open at 90^0; in addition, where access for plant installation is restricted, doors shall be fitted with heavy duty galvanised or stainless steel cabin hooks systems to restrain doors open at approximately 180^0.

Hinges shall be stainless steel construction.

Where provided as essential external pull handles shall be appropriately designed heavy-duty galvanised or similar corrosion resistant construction. Pull handles shall be avoided where these have the potential to assist forced unauthorised entry.

13.16 Internal Finishes

Dust can be a significant contributory underlying cause of disruptive failure and minimum internal decoration shall be carried out to operational areas to reduce this risk as follows:

- Preparation & minimum two-coat proprietary anti-slip epoxy resin paint to concrete floors, colour typically grey;
- Preparation & minimum two-coat vinyl silk emulsion to masonry walls, colour typically magnolia;
- Preparation & minimum two-coat vinyl silk emulsion to concrete ceilings, colour typically magnolia.

Other decoration shall be carried out as necessary to ensure the adequate ongoing safe operation of the substation and to minimise the requirement for maintenance access, inclusive of any necessary ‘top-up’ decoration to make good in the event of damage incurred during installation and commissioning of Equipment.

13.17 Internal Fixtures and Fittings

Where required fixtures and fittings shall be incorporated within a building at 275kV and 400kV Grid Substations and as a minimum shall include:

- A Mess Room incorporating table and 4 chairs, sink, electrical sockets and worktop;
- Toilet Room incorporating WC and hand wash basin;
- Relay Room to include a twin pedestal desk, ergonomic chair, table suitable for A1 layout drawings and lockable filing cabinet;
- A small Store Room to house equipment;
- Where a separate battery room is required, to house vented batteries, this should include a Belfast sink and eye wash kit;
- Where available, potable direct mains cold water supply to the Mess Room, Toilet and Battery Room;
- Means of providing hot water to the Mess Room and Toilet.

13.18 Landscaping Works

Landscaping and other external site finishes, including those required under Planning Approval, shall be agreed with SPEN on a project-specific basis. These elements should be designed to ensure minimal ongoing maintenance. Where there is a requirement for future maintenance this should be

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agreed with SPEN for each project and the details of these requirements highlighted to SPEN such that the appropriate procedures can be put in place.

14 BUILDING SERVICES

14.1 Building Heating, Ventilation and Air Conditioning (HVAC)

Buildings shall be designed to control ventilation, humidity and heating for a daily average ambient external temperature range of -10˚C and +26˚C.

In order to maintain internal room temperatures between the ranges defined in Table 5, heating, ventilation, and air conditioning (HVAC) systems shall only operate during periods when the internal room temperature is a direct function of the ambient external temperatures being outside the 'daily average ambient temperature range' as stated above and allowance shall be made for 'thermal lag'. This performance should be proved through modelling and calculation as part of the detailed design stage.

The internal design temperature limitations are stated in Table 5. Where plant is co-located in a shared space then the more onerous of the conditions listed in Table 5 should be used.

Location	Summer	Winter
Control/Relay Room	30ºC (35ºC)	15ºC (±2ºC)
Telecoms Room	30ºC (35ºC)	15ºC (±2ºC)
Battery Room	Uncontrolled	15ºC (±2ºC)
LVAC Room	30ºC (35ºC)	15ºC (±2ºC)
Switchgear	40ºC	5ºC (±2ºC)
Workshop	Uncontrolled	15ºC (±2ºC)
Store Room	Uncontrolled	15ºC (±2ºC)
WC	Uncontrolled	15ºC (±2ºC)
Mess Room	Uncontrolled	15ºC (±2ºC)
Corridors	Uncontrolled	15ºC (±2ºC)
Cable Basement	35ºC	Uncontrolled

Table 5 – Internal Design Temperature Limitations

SPEN recognise and accept that it is not economically viable to limit internal temperatures to 30˚C in all circumstances. In extreme weather situations where the external ambient temperature range is between -25˚C and +35˚C as a short-term and infrequent occurrence, the above limits on internal temperatures may be relaxed to those indicated in brackets in Table 5.

14.1.1 Heating

Rooms within the buildings shall be heated to achieve the minimum temperatures specified in Table 5. This shall be via electrical heaters installed and controlled by thermo-switches.

In each room the thermostat controlling the heaters shall be set to deliver minimum winter temperatures detailed in Table 5 and locked off against tampering. A manual override switch with a 2-hour maximum timer shall be fitted to allow an increase in ambient temperature to 21°C during occupation.

14.1.2 Ventilation

Ventilation shall be provided to achieve the maximum temperatures specified in Table 5 and to ensure a minimum of four complete air changes per day within rooms in the building. Natural ventilation should be used whenever possible. Mechanical extract ventilation should be provided in the Mess Areas and WC's, in accordance with Building Standards/Regulations.

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Within the Switch Rooms of GIS Buildings ventilation shall be by means of high level fixed louvres with fly screens provided at both ends of the room unless the design demonstrates to SPEN's satisfaction that either more or none at all is necessary.

14.1.3 Humidity

Humidity must be controlled to ensure the safe, efficient operation of the substation and to prevent any undue deterioration of the plant, equipment or fabric of the enclosure, in particular to prevent problems associated with condensation, typically by providing dehumidification or alternative natural air flow across the room from low to high-level through outside walls.

Relative humidity shall be maintained between 20% and 75%. Control of relative humidity is to be done by means of natural ventilation, wherever possible (a minimum of four complete air changes per day to unsealed rooms is required).

14.1.3.1 Humidity Control by Dehumidification

Where utilised, dehumidifiers shall be high-level wall-mounted units capable of efficient operation between the temperature range of +5˚C and +30˚C. Discharge pipes shall be taken directly through walls at high-level to drop externally within robust vandal and corrosion resistant protective downpipes to safely condensate and discharge at ground level. Low loss trace heating shall be provided on the dehumidifier drain.

Rooms utilising dehumidification shall be draught-sealed and shall not incorporate ventilation units.

The dehumidifier drying cycle shall be controlled by a humidistat, suitably located away from the dehumidifier airflow but forming an integral part of the unit. The switching point shall be capable of being set over the range of 40% to 80%, but factory set at 50%.

A second humidistat shall be provided in a similar position for use as a high relative humidity (RH) level alarm, which shall be pre-set at 70% and factory sealed. The auxiliary contacts of this humidistat shall be set to open at 70% RH and above, such that when the level is below 70% RH the auxiliary contacts are closed, giving a constant healthy signal to the SCADA system. The contact ratings shall be suitable to meet the rating of the dehumidifier.

Both humidistats shall be clearly labelled to indicate their function and RH level setting range.

The refrigerant shall be CFC free.

The defrosting cycle shall be controlled primarily by an auto-defrost device of the temperature sensing type.

14.1.3.2 Dehumidifier Design Note

Dehumidification shall be capable of extracting at least 75ml/hr of moisture from the sealed room environment at 10ºC / 50% (RH) – more than one unit may be required per room. The following conditions shall be assumed:

- Ambient humidity 80%RH;
- Ambient temperature +20°C;
- Design humidity 50%RH.

14.1.3.3 Humidity Control by Ventilation

Where it is proposed to control humidity by means of natural ventilation this shall achieve a minimum of four complete air changes per day to unsealed (non-dehumidified) rooms and there should be a minimum 1m clear external to walls incorporating ventilation units. These walls shall be located such that they are adequately clear of areas that may be a fire risk, be dusty or have potentially hazardous gas or chemicals in the air.

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Ventilation units shall be of robust vandal and corrosion resistant construction such as masonry air bricks or galvanised steel louvres.

Ventilation units shall be secure and weathered to offer appropriate protection against moisture ingress and shall incorporate appropriate seals to the external perimeter. They shall conform to BS EN 13030 and provide a discharge loss coefficient of Class 2, a water repellent classification of Class A and a classification of A3 up to 0.5m/s.

Furthermore, the construction of these ventilation units shall be such that long object probes of any type and cross-section do not have the potential to infringe safety clearance distances from hazardous parts.

Intumescent ventilation units shall be used where segregation in the event of fire is required.

Substation enclosures shall not have windows.

14.1.4 Battery Rooms

Ambient temperature to bespoke Battery Rooms shall be controlled such that it is maintained within the manufacturer's recommended upper and lower limits for optimum performance and lifespan, however, wherever practical the use of air conditioning schemes shall be avoided

Where a separate battery room is required, to house vented unsealed cell batteries, natural ventilation only shall be provided to Battery Rooms with designed such that these rooms are not designated as hazardous areas under applicable BS EN specifications. Overall substation design shall be such that services passing through internal substation walls to these Battery Rooms are kept to an essential minimum and, in addition to fire-stop requirements seals shall be durable and gas-tight.

14.1.5 Insulation

Buildings shall be capable of achieving sufficient thermal insulation as necessary to provide an appropriate internal environment and avoid moisture ingress via condensation. In particular buildings shall provide, as a minimum standard, thermal transmittance U Values as detailed in Table 6. There is no requirement for insulation in cable basements.

Region	Roof U (W/m²K)	Walls U (W/m²K)	Floor U (W/m²K)
Scotland	0.2	0.27	0.22
England & Wales	0.25	0.35	0.25

Table 6 – Thermal Insulation Requirements

14.2 Building Electrical Systems

Electrical installation schemes shall be entirely suitable to the intended purpose of each room within buildings, including LV AC supply distribution board and if applicable design to satisfy requirements for use in potentially explosive environments in Battery Rooms with unsealed batteries. These schemes shall conform in all respects to the requirements of the relevant BS/BS EN Standards and the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers (IEE) or its successor organisation. In addition, lighting design shall be in accordance with BS EN 12464-1.

The following should be provided as part of the building services works:

- Design proposals for review and acceptance prior to commencing work, including loading calculations to verify the design for all aspects of the works.
- A valid electrical test certificate for the works in accordance with the current IEE regulations. These should be included, where applicable, within the CDM H&S File that is handed over to SPEN.

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- 'As-Installed' schematic and layout drawings showing the installed LV AC distribution system. Internal cabling shall be run through surface-mounted conduit.

14.2.1 Small Power

Buildings shall incorporate complete electrical installations for lighting and small power schemes including 400V, 240V and 110V outlet sockets as required by SPEN.

3 phase power sockets shall be provided within GIS Building Switch Rooms to facilitate the use of gas cart processing plant. These sockets should be either 240V 63 amp or 400V 63 amp depending on the manufacturers gas cart. Where required 240 volt 63 amp sockets shall be provided at the same locations for the connection of test equipment.

Low Voltage systems shall be designed for the requirements of plant commissioning, operation and maintenance.

14.2.2 Electro-Mechanical Heating, Ventilation & Air Conditioning Systems

Where provided electrical installations for heating, ventilation and air conditioning schemes to buildings shall incorporate control and instrumentation, interlocking and cabling systems necessary to maintain appropriate operational conditions. Wherever practical the use of air conditioning schemes shall be avoided.

14.2.3 Internal Lighting

Internal lighting levels shall, where practicable, be LED type and as a minimum be in accordance with Table 7 and the general requirements of BS EN 12464-1. It shall be operated by wall switches positioned adjacent to doorways, including outside at the entrance to rooms and/or at more than one doorway if appropriate. It shall also incorporate a 4 hour timer manual override switch.

Internal lighting shall allow safe movement of personnel and safe operation of equipment and shall be designed such that the positions of all light fittings and associated switches etc. take due cognisance of the locations of and access to all equipment within the building.

Emergency lighting shall also be provided in accordance with BS 5266: Part 1. A key test wall switch shall be installed adjacent to the entrance door.

For lighting calculations purposes, a maintenance plan method with a maintenance factor of 0.67, corresponding to a clean room 3 years maintenance cycle, shall be used. Room surfaces reflections are considered as follows: Ceiling 0.7, Walls 0.5, Floor 0.2.

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Location	Lux (lx)	U_o	Workplane
Control Room and Offices	500	0.7	at 0.75m above floor level
Telecoms/Relay Room	300/200[4]	0.6	at floor level
LVAC/Battery Room	200	0.4	at floor level
GIS Switchgear	300/ 200[5]	0.6	at floor level
Mess Room, Entrance Hall	200	0.4	at floor level
Workshop/Store/Corridors	150	0.4	at floor level
WC and Lockers	200	0.4	100 lx min at floor level
Stairs/Cable Basement/Walkways	100	0.4	at floor level
Building Access Doors[6]	20 (6 min)	0.3	at floor level
Building Perimeter	6 (2.5 min)	0.25	at floor level

Table 7 – Substation Lighting Levels

14.2.4 Exterior Lighting

Exterior lighting shall allow safe access and emergency egress for personnel (including from buildings) and safe operation of equipment, subject to the following minimum requirements:

- Maintained average illuminance 6.0 lux at ground level;
- Minimum maintained point illuminance 2.5 lux at ground level.

Where SPEN expressly require frequent access to or increased security lighting within compounds containing Outdoor Equipment these levels shall be increased locally to an average of 100 lux and minimum of 50 lux respectively.

Lighting columns shall be bolted to their foundations and designed to be lowered for maintenance by one person. Lighting columns shall be sized and positioned such that they cannot fall onto High Voltage Equipment. Luminaires shall, where practicable, be LED type with directable light output to minimise light pollution. Earthing of lighting columns shall be designed and installed as part the construction project.

Exterior lighting to buildings shall incorporate IP 65 wall mounted LED luminaires to illuminate all pathways surrounding the building and shall be controlled via integral PIR detectors (minimum detection range of 12m and minimum detection angle of 110 degrees).

An internal wall mounted manual override switch, with a 4 hour maximum timer, shall be fitted adjacent to the main entrance/exit door to allow control of external lights, when required. Note that a non-maintained IP 65 emergency bulkhead LED luminaire shall be mounted above each emergency exit doors.

14.3 Intruder Detection Systems

Where it has been identified through a site-specific SRA that an Intruder Detection System is required this shall be installed, connected and commissioned by Corporate Security. The project team shall provide a fused spur at an agreed location that will allow Corporate Security to test, commission and connect their Intruder Detection System back to the ARC.

The security system operating panel shall be located adjacent to the main access door.

[4] 200 lx where no accurate task is required, 300 lx @ 0.75 m AFFL at the front of the panels

[5] 200 lx where no accurate task is required, 300 lx @ 0.75 m AFFL at LCC area

[6] Final escape route exits to be provided with emergency features lighting fixtures

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14.4 Fire Alarm Systems

Where determined in Section 10.4.5 “Fire Risk” of this Specification and in consultation with the ScottishPower Corporate Security Fire team highlights the requirement for fire systems it shall be installed to the ScottishPower Corporate Security ‘Fire Specification’ (available from SPEN), connected and commissioned to the substation local alarm and SCADA system for remote alarm indication.

All cabling (power and alarms) and connection to power supply shall be designed and installed by the project team but final connection and commissioning of alarms to the substation SCADA system shall be by SPEN.

14.5 EV Chargers

Electric vehicle chargers are required to be installed adjacent to the vehicle parking bays. A minimum of 4 chargers are required to be installed at transmission sites with the total number scaling based on the size of the site. The requirements of the EV charger are to be confirmed with Transmission Operations.

15 POST-COMMISSIONING (RETURN) SITE VISIT

Programming is outside the scope of this document but it should be noted for information that civil works return visits to sites are necessary anything between one and twelve months after substantial completion (i.e. after handover for equipment installation) to complete post-commissioning finishing civil and building works that may include but may not be exclusively limited to:

- Sealing cable entries against moisture and vermin entry where this has not otherwise been completed as part of equipment installation and commissioning works;
- Making-good original decoration within buildings where this has been damaged during installation of Equipment;
- Making-up ground levels as necessary and stone chipping topping or other agreed finishes to compounds;
- Sand/geotextile or other agreed protection to cables and stone chipping infill to Transformer bunds;
- Kerbs, bituminous surfacing and drainage to internal roadways.

Where the substation has become operational under SPEN Safety Rules all operatives subsequently working at the substation shall have appropriate ScottishPower Authorisation(s).

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