1. SCOPE

This Specification outlines SP Energy Networks (SPEN) technical requirements for the civil design and construction of existing and new ground mounted secondary substations. The Constructor is entirely responsible for all aspects of the civil design and construction process.

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 secondary 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 (ED&S) to any variation to the guidelines provided in this Specification. Development of proposals for site-specific variations that are acceptable to SPEN shall be the Constructor's responsibility.

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 ED&S, taking into account 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
February 2020	7	C Ritchie	Use of sustainably sourced and recycled materials incorporated, Section 10.4.3 Security requirements updated and security interfaces included throughout the document, Section 12.5.14 general updates to door requirements.
December 2023	8	G Rees	Section 10.5.2 added to consider sustainable design. Updates to flood section in line 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.

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Gareth Rees Principal Civil Engineer	Craig Young Engineering Design Manager	Fraser Ainslie Head of Engineering Design and Standards F. Ainslie Digitally signed by Fraser Ainslie DN: cn=Fraser Ainslie, o=SPEnergyNetworks, ou=Processes and Technology, email=fraser.ainslie@spenergynetworks.co.uk, c=GB Date: 2024.02.21 14:25:39 Z 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 SPD and SPM System Design Virtual Manuals and Construction Virtual Manual maintained by Document Control, but does not have a maintained distribution list. It is also published to the SP Energy Networks website.

6. CONTENTS

7. GLOSSARY

Adopt:	Transfer of title, ownership, operation and maintenance responsibilities as defined in the adoption agreement.
Approved:	Equipment that 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.
Company:	Refers to SP Distribution plc, SP Transmission plc and SP Manweb plc.
Container:	Approved prefabricated containerised housing for 11kV and/or 33kV Switchboard(s) together with associated Control and Ancillary equipment within a secure Prefabricated Enclosure.
Constructor:	The party, including SPEN or other Third Party 'Turnkey' Design-Build Contractors and Third Party New Connection Developers and Contractors (ICPs), having ultimate responsibility for provision of the 11kV Secondary substation, including design, construction and CDM. The 'Constructor' should also be read as the Designer or Contractor depending on the type of Contract.
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.
'D' Type or 'G' Type Substation:	Combined ring main unit and metering unit equipment with protection panel typically associated with third party generation connections.
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.
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 alternating current (AC) voltage exceeding 1000 volts measured between the phase conductors.
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.

IP:	Ingress Protection
Low Voltage (LV):	An 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 plc 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 deposits, abnormal condensation and frost.
Secondary Substation:	An assembly of High Voltage Switchgear and Transformers up to 11kV together with associated control and ancillary equipment where the lower voltage is 400/230V, all within a secure enclosure.
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.
SRA	Security Risk Assessment conducted by ScottishPower Corporate Security.
Switching Station:	A secondary substation containing only High Voltage Switchgear.
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 ScottishPower Energy Networks Holdings Ltd.
Third Party New Connection Contractors:	Suitably Lloyds/*National Electrical Registration Scheme* Accredited Contractors undertaking contestable work in the competitive connections market.
Transformers:	Reference to transformers shall mean transformers and reactors.
Unit Substation:	A Unit substation comprises an 11kV/400V transformer fitted with a directly mounted ring main unit and an LV fuse cabinet. Other combinations of directly mounted attachments to the transformer may also be used (e.g. cable box in lieu of HV switchgear or LV fuse cabinet).

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'.

8.1 Specific SPEN Documents

ASSET-01-021	Asset Inspection and Condition Assessment Policy
ASSET-01-023	Substation Security Policy
CAB-15-003	Handling and Installation of Cables up to and including 33kV
EART-03-003	Technical Specification for Earthing and Bonding at Secondary Substations
SUB-01-012	Substation Fire Protection Policy
SUB-01-018	Substation Flood Resilience Policy
SUB-02-006	Secondary Substation Installation and Commissioning Specification
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 Grid Substations
SUB-03-029	Substation LVAC Installation Wiring Specification for New and Refurbished Substation Sites
SUB-03-034	General Specification for the Civil Engineering and Building Design and Construction of 275kV and 400kV Substations

8.2 Iberdrola Networks Specifications

INS 50-40-11	Pre-fabricated Enclosures for Distribution Substations

8.3 National Grid 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.

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.

8.5 Other Documents

National Structural Steelwork Specification for Building Construction (BCSA Publication)
Standards for Highways – MCHW – Volume 1 – Series 0600 – Earthworks
PAS 2080 - Carbon Management in Infrastructure

9. INTRODUCTION

This document outlines SPEN technical specification requirements for the civil design and construction of existing and new ground mounted secondary substations. The Constructor is entirely responsible for all aspects of the civil design and construction process.

This technical specification shall be used for all secondary substation types including:

- Outdoor Equipment installed within a prefabricated GRP type enclosure.
- Indoor or Outdoor Equipment installed within a purpose built, discrete brick enclosure.
- Equipment installed within a customer owned building.

Certain sections within this specification may not be applicable to all aspects of a particular Secondary substation project. Furthermore, 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 where the Constructor can demonstrate, to SPEN's satisfaction, that they offer an equivalent or better technical and/or lower risk solution. All such deviations shall be fully discussed and agreed with ED&S.

9.1 Feasibility

Once the requirement for a Secondary Substation has been established and the type of substation agreed with SPEN, it is important that during the initial design stage SPEN requirements detailed within this and other referenced specifications are given due consideration.

In order to avoid possible abortive effort and subsequent delay; the Constructor shall confirm at the earliest opportunity how SPEN requirements are to be met. This should be undertaken by forwarding preliminary layout drawings for comment to SPEN that demonstrate in particular the proposed means of achieving:

- Minimised Outages, Outage periods and impact on Company assets;
- Plant access / egress, including access routes and the method by which plant will be installed / removed;
- 24-Hour access / egress for SPEN personnel (NB access via third parties is not acceptable);
- Emergency egress;
- Fire segregation;
- ScottishPower Corporate Security requirements;
- Cable entries / routes;
- Natural ventilation to Outdoor Equipment (in particular transformers);
- Unless expressly agreed otherwise with SPEN, avoidance of flood risk.

The preferred and optimum location for a substation is freestanding with access at ground level from the public highway. Freestanding substation enclosures shall have a minimum 1m clear level access around the sides and rear (inspection, maintenance and ventilation), a minimum 2m clear level access to the front (door opening and plant access). SPEN shall have bespoke rights of access, operation and maintenance over this. Where the frontage of the substation faces onto the public domain (e.g. abutting public highway or footpath), then only 1m back from the footpath is required to facilitate the installation of the substation earth. This is required to remove the risk of third party damage to the substation perimeter earth electrode in the public highway. If this is not achievable then a more complex earthing installation may be required. This shall be agreed with SPEN on a case-by-case basis prior to design.

Enclosed basement type substations will not be acceptable.

Proposals for drainage and/or flood defence systems that otherwise satisfy the above functional requirements but have a floor level set less than 150mm above the general surrounding ground level must be expressly agreed with SPEN at the feasibility stage of the process.

10. GENERAL REQUIREMENTS

10.1 Consents

Consents matters are outside the scope of this document, but the Constructor shall ensure that all necessary notices and permissions are in place and that any associated applicable conditions are discharged prior to commencement of construction with respect to the following, where they apply:

- Land Acquisition or Lease arrangements.
- Planning Approval.
- Building Control or Building Warrant Approval.
- Fire Authority Approval.
- Drainage discharge, including where applicable Controlled Activities Regulations (CARs) and legal rights to discharge for SPEN where this is other than direct to an adopted public system.
- Environmental requirements (such as newt licences and the like).
- Party Wall Etc Act.
- Any other statutory consents that may apply.

10.2 Pre-Engineering Studies

The Constructor shall carry out adequate 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.
- That drainage discharge options are identified.
- That environmental risks are identified and independently verified including ecology, noise nuisance and flood related risks.

The Constructor shall carry out any other studies considered necessary or appropriate on a site-specific basis, in particular for substations located in complex situations including for example, brownfield sites, infilled sites, potentially contaminated sites, where piling or ground improvement may be required or 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. 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 flooding.

10.3 Existing Substation Sites

Additional visual inspection, non-destructive testing and intrusive testing/analysis shall be carried out as necessary to inform theoretical assessment such that suitability can be confirmed where it is proposed to utilise existing foundation plinths or superstructure supports as part of the new works.

10.3.1 Existing Buildings

Where it is proposed to utilise an existing building to house new plant / switchgear then a condition assessment of the building against the requirements of this Specification, shall be undertaken.

The assessment shall consider the structural design integrity of the building and ability to withstand a disruptive failure event. Additionally, the main design and technical requirements of this specification should be assessed, with cognisance taken of all design and technical requirements detailed in this document.

Upon completion of the assessment a whole life cost analysis should be undertaken to identify whether refurbishment or replacement of the existing building is the most appropriate solution. Consideration of deviations from this Specification, which offer an equivalent or better technical and/or lower risk solution will be reviewed on a project specific basis and should be agreed with the SPEN Civil Asset Manager.

10.3.2 Demolition of Buildings with Attached / Integral Substations

Where it is identified that demolition works are to be undertaken, that potentially impact on SPEN assets, discussions with SPEN should be undertaken at the earliest possible opportunity. This will allow SPEN to assess the network and advise of the future requirements for the substation.

The Constructor will be responsible for all works to ensure the integrity of the substation structure and allow the substation to remain in operation, without interruption to supply.

The Constructor will be responsible for all inspection, assessment, temporary works and construction works required to ensure that the remaining substation left is, where reasonably practicable, in accordance with the requirements detailed in this specification following the completion of any demolition works.

Upon the completion of the works SPEN shall be notified such that they can carry out an inspection, at the cost of the Constructor, to determine that the final condition of the substation is in accordance with this specification.

10.3.3 Substation Earthing

Substation Earthing Systems should be designed and installed in accordance with EART-03-003. 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.

10.4 Scheme Development (Detailed Submission)

Subject to preliminary layout (feasibility) drawings being acceptable in principle to SPEN, it shall then be the Constructor's responsibility 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 by the Constructor as follows:

- Site location plan showing the whole of the site and access route, together with surrounding landscape and land use.

- General arrangement drawing(s) for buildings and/or containers/housings that include details of floor layout(s) and indicate dimensional access, operation and maintenance clearances between and around equipment – dimensions shall not be less than the minimum requirements illustrated by Typical Layout Diagrams appended to SUB-02-006.
- 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 doors and any natural ventilation to equipment enclosures (buildings/containers/housings).
- Building services etc., e.g., small power, lighting, heating, ventilation, etc.
- Earthing.
- Signage.
- Other relevant information as applicable.

The constructor shall complete the design submission checklist and submit this along with any construction drawings that form part of the design submission pack.

Where applicable and considered appropriate by SPEN, typical deemed to satisfy substation layout drawings may be issued for guidance, either generic associated with this Specification or on a project-specific basis. Such drawings would indicate minimum dimensional requirements and would be based on optimum layouts for equipment, ventilation, plant/personnel access/egress and cable entry.

The Constructor shall make proper provision in the programme for both the design and construction and shall allow a minimum of 28 days for SPEN to comment on each design and drawing submission, including any proposed site-specific variation to this specification or associated typical deemed to satisfy details. The Constructor shall ensure that cognisance is taken of all such SPEN comments, however, acceptance of the Constructor's design submissions by SPEN shall not relieve the Constructor of any design responsibility or any generic functional obligation of this Specification, nor shall it imply any liability on the part of SPEN.

10.4.1 Equipment Enclosures (Buildings & Housings/Containers for indoor and outdoor rated equipment)

SPEN utilise proprietary prefabricated and traditional conventionally built enclosures that are deemed to relieve and/or contain an internal pressure rise due to a disruptive failure of the plant by means of pressure relief lifting roof or panel relief systems and/or structurally robust traditional construction.

SPEN will only install equipment into or formally adopt Approved Equipment installed by others within equipment enclosures that satisfy the requirements of this Specification and the specification for prefabricated enclosures 'INS-50-40-11 - Pre-fabricated enclosures for distribution substations'.

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

General functional requirements include:

- The requirements of SUB-02-006.
- Suitable access for and cover to high and low voltage (LV) cables.
- Security, in preventing intrusion as well as unauthorised entry.
- Designed natural ventilation cooling to heat generating transformers.
- Minimum 2-hour fire segregation where substations are attached to or integral within third party buildings.
- Design to eliminate flood risk, unless expressly agreed otherwise with SPEN.

10.4.1.1 Indoor Equipment

Functional requirements for enclosures to Indoor Equipment shall *additionally and/or alternatively* include:

- Weather-tight enclosure construction to prevent moisture ingress.
- Suitable internal enclosure environment, in particular with respect to:
  - Natural 'trickle' only ventilation and the elimination of moisture ingress or condensation.
  - Compliance with current thermal insulation requirements as detailed in Table 4.
- Sealed cable entries to prevent belowground ingress of moisture, gas and vermin.
- Preclusion of surface water run-off entry.

SPEN accept that in exceptional circumstances particular site-specific environmental situations may demand consideration of alternative enclosure types. In such situations, the same functionality requirements shall be factored into the enclosure design, together with any other relevant factors that are specific to the designed solution.

10.4.2 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.

10.4.3 "Deemed to Satisfy" Submissions

Detailed drawing submissions would not be required by SPEN where the Constructor proposes freestanding construction precisely in accordance with deemed to satisfy drawings that have been issued by and confirmed by SPEN as suitable on a project-specific basis, e.g. typically as listed in this specification – *provided* the Constructor confirms this in writing to SPEN together with written confirmation that proposed substations are on level sites with minimum clearance around in accordance with this Specification, that ground conditions are suitable and that there are no adjacent embankments, retaining walls, services or the like within influence distance of the substation.

10.5 Design

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 will subsequently adopt the civil and building fabric then life to first maintenance shall not be less than 20 years and the design and construction detail shall be such that ongoing maintenance is minimised.

Substation design shall take cognisance of Pre-Engineering Studies.

Substation design shall be such that no sprinkler systems, gas, water, drainage or other third-party service pipes, cables or heating and ventilation ducts are detailed within, through or under substations.

Typical Substation Layout Diagrams referenced in SUB-02-006 indicate minimum dimensional requirements. These standards are based on optimum layouts for plant, ventilation, plant/personnel

access/egress and cable entry. Constructors should note that where proposals for non-standard electrical layouts are acceptable in principle to SPEN these could lead to a dimensionally larger substation being required. Substation layout details with respect to non-standard electrical layouts, irregular shaped rooms and internal room projections such as columns or beam downstands shall be subject to the prior written acceptance of SPEN.

The Constructor shall adopt a design methodology that shall identify all significant factors in the design and ensure that proper attention is given to each factor at every stage in the design process.

Dead, imposed and dynamic loadings/actions for approved equipment are available from the manufacturers.

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.

10.5.1 Integral & Attached Substations

The optimum location for a secondary substation is free standing. In the limited instances where there is a compelling reason that it is not practicable to construct a free standing substation, and that a substation that is attached or integral with other buildings is required, then this shall be first agreed in principle with ED&S/NP&R prior to any design submission by the Constructor. Where any non-standard requests are agreed in principle then this specification document shall form the basis of such non-standard designs with final approval to be provided by ED&S. Designers shall ensure that consideration of all details of this specification are followed where reasonably practicable with particular consideration to the structural design, fire mitigation, roof construction and ventilation requirements detailed further in this specification.

Acceptance of third-party designs by SPEN shall not relieve the Constructor of any design responsibility or any generic functional obligation of this Specification, nor shall it imply any liability on the part of SPEN.

Basement substations or substations that are embedded where access to the substation is not from the public highway shall not be acceptable.

10.5.2 Sustainability / Net Zero

SPEN is 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.

10.5.3 Flood Risk

Wherever practicable, Secondary Substations shall be located outside of the flood risk zones as detailed in Table 1.

As far as is reasonably practical the Constructor’s substation design shall eliminate or adequately mitigate against the risk of such a flood adversely impacting the operation of the substation (loss of supply or damage to equipment).

SPEN accept that it will not always be practicable to eliminate flood risk in Secondary Substation locations, in these instances the extent to which the design addresses this shall be agreed with SPEN Network Planning & Regulation (NP&R) on a cost-benefit analysis basis.

In the instances where it is accepted by NP&R that it is not appropriate to locate the substation outside flood risk zone, then on a project-specific basis and as far as is reasonably practical the substation concrete plinth should be raised to a level above the relevant flood level shown in Table 1.

License Region	Risk of Flooding		
	Pluvial	Fluvial	Tidal
SPD	0.5% (1 in 200)	0.5% (1 in 200)	0.5% (1 in 200)
SPM	1% (1 in 100)	1% (1 in 100)	0.5% (1 in 200)

Table 1 – Flood Risk Zones

The designed flood level shall include an allowance for climate change for a 50-year design life and 300mm freeboard to allow for uncertainties in data and modelling. Where climate change guidance is not available then a minimum of 200mm shall be applied.

It is considered unlikely to apply, but such schemes shall incorporate any requirement for compensatory storage as required by the Flood Risk Assessment (FRA) and accepted in principle by the National Environment Agencies.

The Constructor shall obtain the prior written acceptance of ED&S to all proposed design measures to mitigate flood risk prior to construction.

10.5.4 Watercourses / Bore Holes

Where practicable, no part shall be sited within 50m of any borehole or well used for water extraction, 10m of any surface watercourse or 5m of any drain through which oil could enter and discharge directly into controlled waters. Where this is not possible, this shall be agreed on a site-specific basis with ED&S.

10.5.5 Structural Design

The structural design of the civil and building fabric is entirely the Constructor's responsibility and shall be prepared, checked and approved to professionally recognised design Quality Assurance procedures by appropriately qualified and experienced engineers, preferably Chartered Civil or Chartered 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.

LV distribution boards are wall mounted and therefore apply eccentric lateral dead load on supporting walls in addition to horizontal imposed loads arising during normal operational (link removal) or fault conditions (electrical trip).

10.5.6 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 the Constructor shall ensure that substation designers are aware that considerable internal overpressure and fireball may be produced when this condition occurs.

Rooms within buildings (etc.) enclosing High Voltage (HV) 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. Whilst it is not possible to measure or reasonably quantify the magnitude of any potential overpressure, experience over many

years has demonstrated that the approved prefabricated Container housings and the typical robust traditional (masonry/reinforced concrete) construction enclosure details indicated by this Specification are generally adequate to relieve and/or reasonably contain this overpressure and are therefore the preferred and most appropriate forms of construction.

Designers shall give due consideration to the potential for such disruptive failure in locating egress routes and in structural civil design, in particular wall panels. Designers shall note that masonry panels to traditional construction enclosures housing HV switchgear or transformers may require secondary steelwork support (e.g. wind posts) or other lateral structural reinforcement and that structural concrete slab roof construction may be necessary to provide lateral restraint to the tops of wall panels, even where this may be as a sub-roof beneath a superimposed pitched roof over.

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 and *every effort shall be made by the Constructor to comply with this requirement*. Where a substation that is integral with other buildings has been agreed with ED&S / NP&R, designers shall ensure that the nature of the construction is such that progressive collapse and/or fire spread does not ensue in the event of a disruptive equipment failure.

10.5.7 Fire Risk

The Constructor 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 or close proximity.
- The substation type and location with respect to property types and public areas.
- The transformer, plant, and insulation type.
- The access/egress arrangements for members of staff/contractors.

The Constructor shall assess the fire risk and shall provide no less than the minimum mitigation measures to enclosures for Indoor HV Equipment and to oil containing Outdoor Equipment (e.g., transformers) in accordance with this Specification and SUB-01-012.

10.5.8 Drainage Discharge

Where discharge is not fully contained within land over which the Company has rights or is other than direct to an adopted public system, the Constructor shall confirm formal discharge consent approvals to SPEN and these shall be included where the CDM Health & Safety File is handed over to SPEN (i.e. legal rights to discharge for SPEN).

10.5.9 Site Layout

Constructors shall note that pedestrian safety barriers may be required where the site layout is such that emergency egress from the substation is towards a vehicular traffic route, and that these barriers would be required to be demountable if this were also a plant access route for the substation.

Constructors shall note that vehicular crash barrier protection 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 drawings where the Company have or will subsequently take freehold or leasehold possession of the land on completion.

10.7 Construction

It is incumbent upon the Constructor to comply with all relevant legislation, including future updates and publications in keeping with industry good practice.

Typical Drawings listed in this Specification may be available from SPEN. These outline typical deemed to satisfy construction details for various Secondary Substation types. Constructors shall note that unless otherwise expressly instructed by SPEN where issued these guide details are generic only with respect to such aspects as dimensions, handing, cable entries, etc.

The preferred construction details are SPEN's "deemed to satisfy" construction details.

Some basic civil engineering and building technical compliance information is given in 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.

The Constructor shall ensure that civil engineering and building contractors engaged to carry out works under this Specification are competent, qualified and experienced with respect to the nature of electricity substation construction. Civil and building 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 standard of workmanship shall be in keeping with industry best practices and not less than that specified by BS 8000. The Constructor shall ensure that civil engineering and building contractors engaged to carry out works under this Specification 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.

The Constructor shall notify SPEN prior to commencement of substation construction works.

Substation construction shall be such that no sprinkler systems, gas, water, drainage or other third-party service pipes, cables or heating and ventilation ducts or are built within, through or under substations.

SPEN will not install equipment into purpose-built substation enclosures until and unless all building works, except post-commissioning finishing works, are complete and are in accordance with this Specification. Unless variation has been agreed in writing by SPEN prior to construction, a delay in plant installation or energisation could result if works are not in accordance with this Specification.

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

10.8 As-Built Information

Operating Manuals and CDM Health & Safety Files shall be submitted to SPEN in an agreed electronic format.

10.9 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 Constructor is responsible for and shall ensure that all the listed duties of The Contract Administrator are carried out and completed with respect to civil quality assurance in accordance with NGTS 3.10, in particular approval and sign-off of Inspections, Hold & Notification Points, Testing, Manufacturing Processes, Specialist Operative requirements and Document Submission – including off-site visits. This Clause shall not grant any right to the Constructor to vary the requirements of either this Specification or NGTS Specifications, nor shall it detract in any way from SPEN's rights.

SPEN shall have the right to inspect any aspect of the construction process. The Constructor shall ensure that all civil design and testing outputs are available for audit inspection by SPEN.

11. STANDARDS

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

- SPEN Policy documents.
- SPEN Specification documents.
- NGTS 2.10 and NGTS 3.10.
- 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 Constructor's responsibility to ensure a holistic and compliant overall design solution (e.g., in relation to earthing).

National 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 ED&S that takes the Building Regulations as its basis.

12. CIVIL TECHNICAL REQUIREMENTS

12.1 Security

Substation security is of prime importance and buildings generally shall be designed and detailed to minimise the potential for vandalism and unauthorised entry. Any additional security measures over and above the requirements of this Specification shall be determined by the SRA carried out by ScottishPower Corporate Security who shall be consulted on a project-specific basis.

Where substation locations are identified as being at risk from vandalism or unauthorised entry, the security requirements shall take precedence over considerations of appearance, cost and local environment. In these circumstances any boundary fencing shall be security standard, doors shall be proprietary metal security doors and additional security measures over and above those indicated by typical or deemed to satisfy details may be necessary by express agreement with SPEN.

Corporate Security shall be involved at the earliest stage when the substation is being planned. This should be when it is either an internal design or 3rd party built substation that will subsequently be taken over by SPEN.

12.2 Access

Constructors shall note that reliance on recourse to third parties for compliance with the SUB-02-006 requirement for unrestricted 24-hour access for SPEN operatives would not be acceptable; this must be controlled by standard Company suited locks.

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

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

12.3 Earthworks

A list of acceptable and unacceptable earthworks materials, including recycled materials, are detailed within Standards for Highways – MCHW – Volume 1 – Series 0600. To align with SPEN's sustainability goals the preference is for proposed earthworks materials to be from reused or recycled sources however it is recognised that this may not be achievable in all situations.

All foundations shall be set on undisturbed inorganic strata that provide the required minimum design safe ground bearing capacity.

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 water from whatever source and the reinforced concrete foundations shall incorporate a minimum 50mm thick layer of blinding concrete.

12.4 Stone Chipping Compound Surfacing

Stone chipping surfacing shall not be less than 225mm overall depth of construction comprising an approved build-up of:

- A minimum 75mm layer of approved recycled 14-20mm graded aggregate;
- On a minimum 225mm layer of approved recycled Type 1/Type 3 granular layer compacted in a minimum of two layers.

12.5 Concrete

Unless expressly confirmed otherwise by the Constructor's civil design, concrete shall be designed mixes of strength class not less than those 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.

With the aim of working towards Net Zero the use of lower carbon concrete such as GGBS maybe considered, however this shall be suitable for the proposed application without reducing the required strength and/or durability requirements stated in Table 2.

Concrete containing additions such as fly ash and GGBS will exhibit lower relative early age strengths than those containing Portland Cement only. In these cases, it is possible to specify 56-day strength provided this has been considered in the structural design and the construction programme.

Where early strength is important, some compromise on the level of cement replacement may be needed.

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.

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.

Concrete Use	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:** 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		
Substructure (Below Ground Level): Formed finishes e.g. buried sections of buildings, bunds, equipment foundations.	C32/40	20	**Buried Formed Surface:** Buried surfaces produced with closely-jointed formwork.	**Ordinary/Rough Finish:** Forms designed to produce a dense smooth finish free from voids or honeycombing greater than 10mm and other large blemishes.
Substructure (Above Ground Level): Worked finishes e.g. to exposed top surface of equipment plinths, floor slabs (finished with anti-slip paint).	C32/40	20	**Unformed Surface:** Exposed worked surfaces produced without formwork.	**Plain/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.
Substructure (Above Ground Level): Exposed formed finishes e.g. to equipment plinth upstands.	C32/40	20	**Formed Surface:** Exposed surfaces produced with close-tolerance formwork.	**Plain/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.
Superstructure: Exposed worked finishes to in-situ or screeded roof slabs to receive waterproofing systems.	C32/40	20	**Unformed Surface:** Exposed worked surfaces that will subsequently be covered produced without formwork.	**Plain/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.

Table 2 – Designed Mixes of Concrete

12.6 Masonry

12.6.1 Masonry Units

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

The minimum acceptable standard for below ground masonry shall be High Density (HD) Category I clay brickwork of minimum 75N/mm² mean compressive strength, 7.0% maximum moisture absorption and durability designation F2 S2 (ex-'Engineering Class B' quality designation or equivalent).

External masonry shall be HD clay-facing brickwork of minimum 30N/mm² 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 masonry enclosing rooms that house HV Equipment shall be light coloured solid smooth fair-faced clay or concrete facing brickwork of minimum 20N/mm² compressive strength and maximum 12% moisture absorption.

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., in certain below ground conditions). 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 that house HV 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/mm² mean compressive strength, 4.5% maximum moisture absorption and durability designation F2 S2 (ex-'Engineering Class A' quality designation or equivalent) or proprietary high performance (high load/strength, high bond) pitch-polymer systems.

12.7 Drainage

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

The Constructor shall ensure that 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.

Surface water drainage systems shall be designed for storm conditions to an appropriate return-period plus climate change for the substation.

12.8 Footways

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 or recycled plastic edging kerb set in a concrete haunch and foundation.

Cast in-situ concrete, asphalt or other alternative paving systems shall be subject to prior acceptance by SPEN.

12.9 External Site Finishes

Proposals for external site finishes shall be submitted to SPEN for comment.

Concrete surfaces shall be avoided over cable entry areas unless appropriate adequate proposals for ducting beneath or cable trenching through have been formally accepted in writing by SPEN.

12.10 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.

As part of working towards Net Zero, steel suppliers should be able to meet any or a combination of the following:

- Steel produced by a steelmaking site where the steelmaker has a science-based emissions target, SBTi or equivalent.
- ResponsibleSteel™ Certified Steel, or equivalent.
- ‘Lower Embodied Carbon Steel’.

12.11 Metering Rooms/Cabinets

The preferred location for metering is within an integral or attached fully compartmented segregated enclosure that is accessed via a third-party door.

Where alternative built-in ‘hole in the wall’ metering cabinets are acceptable to SPEN in lieu of segregated meter rooms these enclosures shall be secure and weathered to offer a degree of protection not less than that of IP44 to BS EN 60529. Furthermore, the construction of these cabinets 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.

In addition, these shall be:

- Robust, vandal and corrosion resistant construction with metal sub-frames and housings. Metal sub-frames shall be built-into masonry.
- Bonded to the substation earth system.

Door construction to metering rooms/cabinets shall meet the requirements of this Specification and be fitted with cylinder type night latch locks that will accept Company suited barrels on completion. Doors shall be fully weathered including appropriate seals to the external perimeter of frames.

12.12 Prefabricated Building Enclosures

12.12.1 Outdoor Type Equipment

Prefabricated GRP enclosures to Unit Substations shall meet the requirements of SUB-02-006 as specified by SUB-03-018.

Finished plinth level shall not be less than 75mm or more than 225mm above adjacent finished ground level.

12.12.2 Indoor Type Equipment

Prefabricated enclosures *shall not be* acceptable to substations that incorporate wall mounted LV distribution Boards.

Prefabricated enclosures that meet the requirements of SUB-02-006 as specified by INS 50-40-11 shall be acceptable to HV only Switching Stations, provided insulation levels to walls and roofs comply with the thermal insulation values set out in Table 4.

Alternatively, for other types of Indoor Equipment such as 'D'/'G' Type Substations where the civil fabric of the substation will remain the responsibility of a third party Constructor or end-user and will not be adopted by the Company (SPM/SPD/SPT), SPEN will consider alternative, less costly, enclosure designs (including GRP) – subject to their performance being warranted by the proposer to provide an environment that is suitable for the safe and long term operation of Indoor type equipment. SPEN require a performance warranty before it will adopt and/or install its equipment in such enclosures, which shall satisfy the functional requirements listed below:

- Provide a robust enclosure with a high level of security against unauthorised entry, including door furniture and locking mechanisms – Indoor Equipment presents a significantly greater risk of injury or fatality in the event of unauthorised entry than Outdoor Equipment.
- Provide a dry (~50-80% RH), temperature stable environment (5-20°C for 95+% of time with a max of 30°C), similar that which would exist in a brick enclosure. Typically, this will require thermal insulation, control of solar gain and heating for the winter – note: active systems such as air conditioning will not be acceptable.
- Provide insulation levels to walls and roofs that meet the thermal insulation values set out in Table 4.
- Incorporate a sealed floor/substructure (sealed cable ducts, etc.).
- Provide adequate natural ventilation.
- Provide sufficient access around the equipment to facilitate installation, maintenance, repair or replacement – or be such that it can be lifted off easily without compromising subsequent environmental control. Guidance on minimum dimensions can be found in the Typical Layout Diagrams appended to Specification SUB-02-006.
- Include facilities for wall mounting of heavy equipment (units weighing approximately 100-150kg).
- Withstand an internal design guide overpressure as described in this Specification (wall panel design) OR facilitate the controlled release of pressure (e.g., pressure release panels, tethered lifting roof system, etc.).

12.12.3 Performance Warranty

SPEN will only accept proposed dimensions and security arrangements for alternatively constructed enclosures. SPEN will NOT assess the likely performance of enclosures in terms of the functional requirements stated above. Constructors or their customers/end-users who receive a 'point of connection' from the Company's distribution network at the customer substation will remain

responsible, for the life of the connection, for providing an environment for the Company's equipment that meets the functional requirements detailed in this document.

Parties supplied from or connected to substations utilising such enclosures should be aware that a clause will be included in their connection agreement indicating that a condition of their connection remaining energised is that the internal enclosure environment remains compliant with the functional requirements stated above.

13. TRADITIONAL BUILDING ENCLOSURES

Substation buildings shall be fully weatherproof, paying particular attention to design and construction details with respect to wind driven rain and storm 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 acceptable.

Substation enclosures shall not have windows.

13.1 Substation Layout

A clear passage of not less than 750mm wide shall be provided behind and around HV switchgear and HV metering units. This passage shall be clear of all obstructions including wall-mounted equipment.

13.2 Fire

Buildings shall be designed to prevent the propagation of fire generally and in particular in the event of an electrical failure from internal HV switchgear or power cable faults.

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 3.

Room Type Containing	Building Regulations Purpose Group	Travel Distance – One Direction Only (m)	Travel Distance – One or More Direction (m)
Oil filled plant/ generator/battery room	Purpose Group 7 – Place of special fire hazard	9	18
Other rooms	Purpose Group 6 – Industrial, normal risk	25	45

Table 3 – Maximum Travel Distances

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; or
- The nearest available final exit.

Notwithstanding the table above, 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 switchboards.

In addition, a minimum of two exit doors shall similarly be provided where SPEN deem this necessary for the safety of its operatives, e.g., as indicated in its typical “deemed to satisfy” substation layout drawings listed in this Specification.

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 agreed with SPEN on a project-specific basis.

The use of readily combustible materials within substation buildings is not acceptable; all internal lining and structural surfaces shall be 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 should meet the requirements of National Building Regulations Class O with respect to surface spread of flame.

Where it is required, fire protection to steel frame construction shall be by means of a reinforced concrete surround or proprietary intumescent paint or spray system, not fireboard that could be displaced in the event of a disruptive failure.

Substation buildings 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.

Risk assessment with respect to fire and smoke spread to property surrounding substations is entirely the Constructor’s responsibility.

Portable fire extinguishers shall not be provided.

Where a substation that is integral with other buildings has been agreed with SPEN Network Planning & Regulation compartmented construction shall be increased to a minimum 2-hour fire segregation. In addition, it is accepted that the Constructor’s risk assessment could demand measures over and above those required by SPEN, in which circumstances it is important that such risk is addressed, in particular for integral substations that are within the boundaries of third-party properties offering personnel access or housing valuable contents. In such circumstances, design and construction detail that adequately mitigates fire risk within these substations would be acceptable in principle to SPEN, subject to the following minimum requirements:

- Minimum 2-hour fire segregation.
- Any appropriately greater period of fire resistance necessary to substation roofs having personnel access over shall be achieved by means of the design/construction of the concrete roof slab and not by fire boarding or the like that could be displaced in a disruptive failure.
- The sheaths of traditionally used types of cable are either highly combustible or produce noxious gases and smoke once ignited, which increases respectively the probability of fire starting/propagating along cable routes and the potential impact to human life and property once fire is established. Low smoke and zero halogen (LSOH) sheathed cables shall be used therefore to significantly reduce this risk. Such cable routes shall have robust 1-hour fire segregation that is capable of withstanding accidental mechanical damage.

- The presence of insulating oil within transformers increases the risk posed from fire and smoke therefore an approved alternative dielectric insulating fluid such as Synthetic Ester Insulant (e.g., Midel) shall be used to significantly reduce this risk. The Constructor shall note that Midel is more difficult to ignite than mineral oil, produces only approximately 30% smoke density and all combustion products are non-toxic.
- Incorporation of third-party owned and maintained fire and/or smoke detectors.

13.3 Oil Containment

The Constructor shall be responsible for compliance with any local authority and/or national Building Control requirements with respect to oil containment generally within substations that are attached to or integral within other buildings.

13.4 Earthing

13.4.1 Substation Floors

Reinforcement within substation Switch Room floors shall facilitate connection to substation earthing systems after construction. The Constructor 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 the Constructor has a bespoke site-specific Earthing Study Report that 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 SPEN

13.4.2 Earthing to Metal Door Sets

The Constructor 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 leaves.
- 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.

13.5 Floors

Wherever practicable, floors should be full bearing monolithic in situ concrete slabs. The required finish and permitted tolerances for floor finish given in this Specification are important for plant installation and operation.

Structural floor slabs shall be continuous at doorways. Sand fill with screed topping or suspended cover systems will not be acceptable to trenches at these locations.

Screed finishes to concrete floors shall not be acceptable.

Precast 'beam and hollow pot or block' type floor construction will not be acceptable.

Once cured, concrete floors to enclosures containing Indoor Equipment shall be prepared and painted with two coats of a proprietary anti-slip Epoxy Resin floor paint system strictly in accordance with manufacturer's recommendations.

With the exception of HV only Switching Stations, galvanised steel haulage eyes shall be cast into the floors of traditional construction building enclosures to facilitate the safe installation of plant. Haulage eyes shall be located such that they do not present a trip hazard.

Damp proof membranes shall be incorporated within enclosures housing Indoor Equipment.

13.5.1 Floor Design Note

While dead, imposed and dynamic loadings/actions on floors for approved plant and equipment are available from the manufacturers for detailed structural design purposes, in particular with respect to applied concentrated loads – equivalent imposed uniformly distributed loading (UDL) to floors from plant and equipment typically will not exceed 5kN/m^2 applied over the full floor area for the purpose of foundation design.

13.5.2 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.

13.6 Cable Trenches

Cable trenches within enclosures housing Indoor Equipment shall have continuous reinforced concrete bottoms and reinforced concrete or masonry sides.

Cable pits and ramps to substations containing Indoor Equipment shall be sand filled with minimum 50mm granolithic thick screed over flush to floor level on completion, paying particular attention to achieving full compaction of dry sand in layers and sealing of cable entry points in order to ensure that potentially hazardous cavities cannot develop beneath the screed.

Constructors shall fit and remove upon completion temporary timber covers to trenches as necessary to facilitate safe access prior to installation of Equipment.

13.6.1 Cable Entries

Cover to cables external to substation buildings shall have minimum statutory ground cover.

Cable pits and ramps to substations containing Indoor Equipment shall be sand filled with minimum 50mm granolithic thick screed over flush to floor level on completion, paying particular attention to achieving full compaction of dry sand in layers and sealing of cable entry points in order to ensure that potentially hazardous cavities cannot develop beneath the screed.

Ducts shall be provided to the express requirements of SPEN where there is concrete surfacing over, or other potential obstruction within cable entry areas that cannot reasonably be avoided.

13.7 Masonry / Wall Construction

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

Solid walls or inner leaves of cavity walls that enclose HV Equipment (switchgear or transformers) or support LV boards shall be solid brickwork construction minimum 215mm overall thickness. Walls shall be fair-faced plumb and smooth to the interior.

SPEN accept that double stretcher collar-jointed construction may be necessary where differing masonry units are utilised to inner and outer faces of single leaf solid 215mm thick walls to LV board/transformer substations, or where the dimensional tolerance of the required brick units is such that an acceptable even surface finish cannot be achieved with bonded construction either internally (equipment mounting) or externally (appearance). Nominal collar-joints to double stretcher construction shall have solid mortar infill between skins.

External walls to enclosures housing Indoor Equipment shall be cavity construction providing an appropriate internal environment that avoids moisture ingress via condensation, in particular external walls shall provide as a minimum standard thermal insulation values in accordance with Table 4.

Given the potential for disruptive failure, the use of such cavity wall construction shall either incorporate an inner supporting skin of minimum solid 215mm thick brickwork construction or the Constructor shall confirm by structural design calculation to the satisfaction of ED&S that a proposed cavity wall panel construction has adequate lateral strength to withstand the design guide overpressure values given below (e.g. for proposed designs incorporating alternative structural steel frame, wind-post or other masonry reinforcement system).

Double-stretcher collar-jointed and cavity wall construction enclosing HV Equipment 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 and flexibility for movement. In all cases, ties shall be evenly distributed at maximum 300mm centres vertically and 375mm horizontally, staggered in alternate courses with additional ties at openings.

The use of blockwork construction shall not be acceptable unless the Constructor has confirmed by structural design calculation to the satisfaction of ED&S that the proposed wall panel construction has adequate lateral strength to withstand the design guide overpressure values given below (e.g. for proposed designs incorporating alternative structural steel frame, wind-post or other masonry reinforcement system).

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

13.7.1 Masonry Design Note – Disruptive Failure

Whilst it is not possible to measure or reasonably quantify the magnitude of any potential overpressure, experience over many years has demonstrated how typical substation construction types behave (or fail) in containing and/or relieving the associated overpressure. The guidance given here is based upon that experience, where the greater wall panel design requirements for increasing panel size appear to be offset by the increase in room volume available to dissipate overpressure.

For guidance information only, with respect to possible alternative masonry panel design options referenced above, Constructors may wish to note that the lateral design resistance offered by the construction details given in this Specification typically equate to an applied lateral UDL in the order of:

- 3.5kN/m^2 for wall panels of 10/m^2 or less.
- 1.5kN/m^2 for wall panels of 40/m^2 or more.
- A linear interpolation value between 3.5kN/m^2 and 1.5kN/m^2 for wall panels between 10/m^2 and 40m^2.

The minimum 215mm solid brickwork internal wall/inner leaf cavity wall requirements given in this Specification shall be enhanced as necessary for long unrestrained wall panels (e.g., by incorporation of wind posts), such that the lateral design capacity is adequate for this applied design guide overpressure. This is the Constructor's design responsibility.

While experience indicates that this design guidance may be adequate to prevent collapse, structural damage is likely still to occur.

13.8 Roof Construction

Roofs to enclosures housing Indoor Equipment shall provide as a minimum standard thermal insulation values in accordance with Table 4.

Roofs shall be designed such that they eliminate or protect against the risk of failure due to vandalism or theft; in particular in relation to traditional construction pitched roofs where moisture ingress could lead to disruptive failure if associated with Indoor HV Equipment. For this reason or in relation to the potential for disruptive failure of plant and provision of adequate lateral restraint to the tops of wall panels, traditional construction pitched roofs may require incorporation of a waterproofed structural reinforced concrete slab or other equal approved robust sub-roof construction beneath (not applicable to steel-framed clad building construction).

13.8.1 Standard Concrete Roofs

Wherever practicable, roofs should be cast in situ reinforced concrete construction with a fair-faced soffit finish. Slip joints shall be incorporated at wall bearings, polysulphide sealed externally.

Where alternative preformed solutions are essential these shall be composite construction either:

- Proprietary precast pre-stressed beam and in situ concrete screed topping systems with a fair-faced soffit finish, sealed joints and with reinforcement to screed where applicable.
  or,
- Proprietary metal soffit shutters and in situ reinforced concrete topping systems.

Precast 'beam and block or pot' type roof construction shall not be acceptable.

Where permanent structural metal soffit shutters are used as part of a composite roof system these shall be corrosion resistant and the Constructor's proposals for screening or tagging for earthing purposes shall be expressly agreed with SPEN prior to construction.

13.8.2 Flat Roof Design Note

In certain site-specific situations flat roofs to secondary substations may be subject to 'unusually high' imposed ('crowd') loading from unauthorised personnel access (malicious gatherings or groups seeking a visual vantage point) – it is the Constructor's responsibility to assess and if necessary design for this risk.

13.8.3 Superimposed Pitched Roofs

Where a pitched roof is required this shall be traditional construction superimposed over the concrete sub-roof and incorporating cross-flow ventilation to the roof space. Alternative proprietary GRP (glass-reinforced plastic) construction pressure relief (lifting) roof systems would be acceptable to substations enclosing Outdoor Equipment (*only*).

Concrete sub-roofs to substations enclosing Indoor Equipment shall have a nominal waterproof covering applied and a means for rainwater to run-off external to the substation enclosure, to eliminate the risk of moisture ingress related disruptive failure of plant associated with possible failure of the pitched roof.

Facia, bargeboards and the like shall be PVCu construction.

The use of natural slate or lead to pitched roofs should be avoided unless essential for Planning purposes, in order to limit the potential for vandalism and theft.

All timber to pitched roofs shall be vacuum process preservative treated.

13.8.4 Integral Substation Roofs

Where a substation that is integral with other buildings and has been agreed with SPEN Network Planning & Regulation, the substation roofs that form the floor to building space over these shall be tanked construction or otherwise incorporate a suitable superimposed waterproof barrier system that is acceptable to SPEN.

13.8.5 Waterproof Coverings to Roofs

Single membrane systems that are vulnerable to accidental damage from impact and concentrated point loads or from deliberate vandalism (objects thrown onto roofs, malicious use of sharp objects) shall not be acceptable without protective coverings over, in particular where manufacturers typically describe these products as “suitable for limited foot traffic and light loads” or requiring that “care should be taken to avoid sharp objects or concentrated loads”.

Where SPEN will subsequently adopt the civil fabric of the substation, waterproof covering systems shall include an independent insurance backed guarantee to warranty both materials and workmanship for a period of at least 20 years.

The use of coping stone edge systems shall be avoided as these are particularly susceptible to vandalism.

13.8.5.1 Liquid applied waterproofing paint systems

Liquid applied waterproofing paint systems to exposed concrete roofs shall comprise preparation and two coat high performance (aliphatic) polyurethane systems (flat roofing grade) with purpose designed glass fibre mat reinforcement embedded into the initial coat.

13.8.5.2 Built-up felt waterproofing systems

Built-up felt waterproofing systems to concrete roofs shall comprise preparation, vapour barrier and minimum two-layer polyester reinforced high-tensile high-performance elastomeric felts with mineral surface finish top sheet taken, where applicable, full width over parapet upstands.

Where applicable, roof-edge trims shall be GRP construction.

13.8.5.3 Insulated systems to HV only Switching Station & ‘D’/‘G’ Type Substations

Insulated systems to HV only type Switching Stations shall additionally incorporate a venting base layer over insulation board. Insulated systems shall not be installed to substations with designed ventilation for cooling purposes (e.g., cooling to transformers).

13.8.5.4 Mastic asphalt waterproofing systems

Mastic asphalt waterproofing systems to concrete roofs shall comprise preparation and two-coat roofing grade mastic asphalt not less than 20mm thick overall, laid to break joint and incorporating sheathing felt underlay beneath.

Upstands and apron downstands shall not be less than 12mm thick overall, incorporating fillets and galvanised metal backing fixed to the substrate.

Asphalt systems shall receive two coats of solar reflective paint finish.

13.8.5.5 Built-up GRP waterproofing systems

GRP waterproofing systems to concrete roofs shall be proprietary built-up systems, proposed details of which shall be submitted to ED&S for comment and acceptance prior to commencement.

As a minimum, built-up GRP systems shall comprise preparation, exterior quality treated timber decking mechanically fixed to the concrete sub-roof, pre-formed GRP edge trims, lamination with GRP 450gsm fibreglass matting to decking joints, GRP 450gsm fibreglass mat between two layers of polyester resin to form the main waterproof barrier and protective polyester topcoat.

13.9 Rainwater Goods

Wherever practicable, designs incorporating rainwater goods should be avoided where the Company will subsequently adopt the civil fabric of the substation.

Where rainwater goods are provided these shall be PVCu construction or other acceptable robust corrosion resistant systems by express agreement with SPEN.

Gutters and down pipes shall be external to buildings.

Down pipes may require anti-climb and/or anti-vandal guards, subject to the site-specific location.

13.10 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.

13.11 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.

Doors shall be of robust construction that offers a high degree of security against unauthorised entry.

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).

Doors shall open outwards.

Doors shall not open over public highway (i.e. including footways).

Subject to site layout, external doors may be required to open through 180^0 to facilitate the installation of Equipment.

Doors shall be fully weathered including appropriate seals to the external perimeter of frames, cover plate to meeting styles and weather bar to thresholds. Weather bars shall be corrosion resistant

construction, built-into concrete thresholds to form weathered faces not exceeding 15mm and flush with finished floor level to avoid presenting a trip hazard.

Where new build or replacement external doors are being installed at substations classified as 'High' and 'Higher than Normal', as defined in ASSET-01-021, these should be metal security doors.

Where the substation is classified as 'Normal' or 'Lower than Normal' then the doors should be metal security doors but in instances where the current doors are timber then a like for like replacement can be used.

All external access lock mechanisms to substation doors that utilise padlocks shall incorporate integral security shrouds to prevent malicious access to locks. Subject to the SRA this may require the fitting of more than one padlock on the entry door.

Proposed door construction details shall be submitted to ED&S for comment and shall be subject to SPEN acceptance in principle prior to procurement, however; irrespective of location and risk, metal security doors are the preferred option type for external substation doors.

13.11.1 External Metal Security Doors (preferred type)

External metal security doors shall be sourced through an approved SPEN supplier. Should the Constructor wish to source doors through their own third-party suppliers then these shall be certified by the LPCB with a minimum rating of LPS 1175 C5. Details of third-party doors shall be submitted to ED&S for approval prior to ordering.

External metal security doors shall be proprietary corrosion resistant and maintenance free steel or aluminium units.

Door leaves to be finished with an anti-vandal GRP facing. Door cores to be formed from 2 interlocking trays of 2mm aluminium / steel filled with non-hygroscopic closed cell foam of minimum compressive strength 500kPa.

Solid stainless steel cill plate. Door leaves to be hung on full height continuous stainless steel piano hinges.

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.

13.11.2 External Timber Doors

Where external timber doors are necessary for aesthetic reasons (e.g., a planning requirement or to match adjacent existing) these shall be constructed in durable hardwood that is resistant to decay, dimensionally stable and well-seasoned to attain a moisture content within +/- 10% of average equilibrium moisture content.

Timber doors shall be double ledge and brace framed tongue and grooved board construction using the best commercial grade Eucalyptus Grandis or British Oak. Alternative timbers may be used on a project specific basis in agreement with SPEN. Alternative timbers shall have equivalent properties for strength and durability as the approved timber. Any alternative timber shall be sustainably sourced and have PEFC or FSC certification.

Frames shall be built-in to all new work using galvanised fishtail or ragged right-angled lugs. Frames shall be built-in to existing work using proprietary corrosion resistant frame fixings, pelleted or similarly sealed on completion.

External timber doors shall receive a protective decorative finish that is consistent with specified time to first maintenance, comprising as a minimum two-coat preservative basecoat and two-coat high performance wood stain system or; primer coat, undercoat and two-coat high performance paint system – all with an additional preservative basecoat or primer to all end grain. Protective decorative finishes shall be complete proprietary built-up external wood stain or paint systems that are water repellent and have appropriate designed levels of 'moisture vapour permeability'.

Typical deemed to satisfy external timber door construction guidance drawings are available from SPEN but Constructors shall note that these are generic only and are not indicative of any project-specific requirements such as dimensions, handing, locking etc.

13.11.3 External Composite Doors

The use of Wood Polymer Composite (WPC) doors may be used in agreement with SPEN on a project specific basis. WPC composition shall be 60% FSC certified reclaimed wood, 30% recycled High Density Polyethylene (HDPE) and 10% bonding agent.

13.11.4 Internal Doors

Where a substation that is integral with other buildings has been agreed with SPEN Network Planning & Regulation, internal doors shall be proprietary timber or steel fire doors certified as having a fire resistance rating of at least 2-hour and shall facilitate emergency egress.

13.11.5 Door Furniture

The Constructor is responsible for the supply and installation of all fixed door furniture, which shall be robust heavy-duty construction and corrosion resistant. The Constructor shall agree the type and designated category of user access for locking mechanisms with SPEN 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 or other mechanisms to receive padlocks shall be hardened galvanised or stainless steel high-security lock-brackets, tamper resistant and non-removable without access into the substation.

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.

Mechanisms for emergency egress shall be high-security multi-point locking mechanisms with emergency exit override 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 device must not restrict panic function.

Bolts to fixed leafs 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° or, 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 180°.

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.

Where transom rails are required, access to the full height of the aperture should be provided via hinged upper door leaves. Lift down panels will not be acceptable.

13.11.6 Door Louvres

Louvre ventilation within door leaves must comply to SPEN standards and must be specifically approved prior to use.

Full door height louvres shall not be acceptable as this increases the security risk of the substation due to unauthorised entry.

Louvres must protect from rigid body penetration and high pressure water ingress, must offer no line of sight through the louvre and be protected with vermin mesh.

13.11.7 Door Design Note

Site-specific requirements for door dimensions, handing and furniture may vary from that indicated in typical guidance drawings listed in this Specification or that indicated in any additional layout or construction detail drawing(s) that may be issued for guidance with respect to external doors. These design matters are the entirely Constructor's responsibility.

13.12 Internal Finishes (Decoration)

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

- Preparation & minimum two-coat proprietary anti-slip paint to floors (typically colour grey).

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, including any necessary 'top-up' decoration to make good in the event of damage incurred during installation and commissioning of Equipment.

The use of materials to wall and ceiling finishes that present a dust risk shall be avoided therefore decoration to these should not be necessary.

14. BUILDING SERVICES TECHNICAL REQUIREMENTS

14.1 Heating & Ventilation

The Building Services shall be designed and constructed such that they provide an environment suitable for the electrical plant to operate and function in accordance with the manufacturer's requirements.

Where it is proposed to utilise an existing building to house new switchgear then the existing building should be assessed against the requirements detailed below or the specific switchgear requirements, whichever are more onerous.

14.1.1 Heating

Buildings housing indoor rated equipment where a transformer is not present shall be designed to control heating within the following limits for a daily average ambient external temperature range of -10°C and +30°C:

- Minimum +5°C and maximum +30°C within dehumidified rooms.
- Minimum +17°C and maximum +30°C within non-dehumidified traditionally heated rooms.

SPEN recognise and accept that it is not economically viable to limit internal temperatures in all circumstances. In extreme weather situations where the external ambient temperature range is outside the range -10°C and +30°C as a short-term and infrequent occurrence the above limits on internal temperatures may be relaxed as follows:

- Minimum +5°C and maximum +35°C within dehumidified rooms.
- Minimum +5°C and maximum +35°C within non-dehumidified traditionally heated rooms.

Substations that do not contain heat generating plant shall be heated via electrical heaters installed and controlled, to achieve the minimum temperatures stated above, by thermo-switches. The heaters shall be locked off against tampering with a manual override switch, with a 2-hour maximum timer, fitted to allow an increase in ambient temperature to 21°C during occupation.

14.1.2 Insulation

Insulation shall not be provided to heat generating transformer substations, thermal transmittance values to these buildings shall be nominal only to the extent that problems associated with condensation are prevented (i.e., given the transformer is a heat source).

Insulation shall be provided to the walls and roofs of substations that contain Indoor Equipment but have no heat generating plant (e.g. HV only Switching Stations or 'D'/'G' Type Substations) such that these have, as a minimum, thermal insulation values to walls and roofs in accordance with Table 4.

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

Table 4 – Thermal Insulation Requirements

14.1.3 Ventilation

Ventilation design shall control humidity such that this ensures 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.

Relative humidity shall be maintained between 20% and 75% and the preferred method to control humidity in HV only Switching Stations or 'D'/'G' Type Substations that have no heat generating plant is natural ventilation. Ventilation shall be nominal trickle ventilation only to prevent problems associated with condensation. Typically, airbricks or the like providing natural air flow across the room from low to high-level through outside walls.

Adequate natural ventilation shall be provided to dissipate heat generated by transformers and/or to prevent condensation, which requires location against outer walls.

Designers should refer to SUB-02-006 for typical heat generation values for 500kVA and 1000kVA transformers.

There should be a minimum 1m clear external to walls incorporating vents. 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.

Ventilation shall be achieved by natural airflow through outside walls across heat generating plant and shall not be less than the equivalent areas indicated by the typical guidance drawings given in SUB-02-006 and as listed in this Specification. Experience over many years has demonstrated that this level of natural ventilation is adequate in the majority of situations; however, designers should note that certain supply conditions might require additional or alternative ventilation arrangements.

Ventilation arrangements that short-circuit the airflow would not be acceptable.

Ventilation units shall be of robust vandal and corrosion resistant construction.

Ventilation units shall incorporate appropriate seals to the external perimeter.

Intumescent vent units shall be provided where segregation in the event of fire is required.

Vents to enclosures housing Indoor Equipment shall be secure and weathered to offer a degree of protection not less than that of IP 35D to BS EN 60529 and evidence of type testing for ingress protection shall be available. 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. Galvanised or stainless steel 'Z' vent construction details indicated by typical "deemed to satisfy" guidance drawings listed in this Specification satisfy SPEN's performance requirements with respect to such vents.

14.1.3.1 Ventilation for Integral Substations

The optimum position for an integral substation is on the corner of a building so that two elevations can be fitted with ventilation louvres. Should the Constructor not be able to provide a corner location then the substation footprint / ceiling height shall be increased accordingly to allow for an alternative means of cross flow ventilation. This shall be achieved by creating a ventilation corridor or plenum space within the substation. The minimum room dimensions for operation of the plant / switchgear shall be maintained at all times.

14.2 Electrical Services

14.2.1 General

Electrical installation schemes shall be compliant with SUB-03-029 and entirely suitable to the intended purpose in the substation building.

The scheme shall conform in all respects to the requirements of the relevant British 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 shall be in accordance with the appropriate CIBSE publication.

The Constructor shall submit proposals to SPEN for approval prior to commencing work.

The Constructor shall make available for inspection a valid electrical test certificate for the works in accordance with the current IEE regulations, including where applicable incorporation within CDM H&S File handover to SPEN.

Internal cabling shall be run through surface-mounted conduit.

14.2.2 Small Power

Buildings shall incorporate complete electrical installations for lighting and small power schemes including 400V, 230V and 110V outlet sockets as required by SPEN.

LV systems will be designed to be compatible with the LV installation for the requirements of the plant operation.

14.2.3 Internal Lighting

Internal lighting shall allow safe movement of personnel and safe operation of equipment. Lighting shall be operated by wall switches positioned adjacent to doorways. Where operatives are required to work inside the substation enclosure then lighting levels shall be a minimum of 300 Lux at floor level. Where no accurate task is required, this can be reduced to 200 Lux.

Internal lighting schemes generally shall be designed such that the positions of all light fittings and associated switches, etc. take due cognisance of the locations of all equipment and access/egress routes within the building.

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

14.2.4 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. The use of air conditioning shall be avoided.

14.3 Security Alarm Systems

Where it is 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.

15. POST-COMMISSIONING (RETURN) SITE VISIT

Programming is outside the scope of this document, but Constructors shall note for information that civil works return visits to sites are necessary typically between one and six 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:

- Sand fill/screed to cable trenches within buildings.
- 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.

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

16. DRAWINGS

Generic guidance drawings are available showing SPEN's typical layout and construction details.

These typical guidance plans are deemed to satisfy SPEN's functional civil and building requirements for Secondary Substations. These drawings may be used to assist designers in designing substations, however it shall be noted that these drawings are for reference only and shall not supersede the requirements set out within this document.

Refer to SUB-03-017 (Appendix 1), published separately on the SP Energy Networks website.