

GIS AND OTHER SUBSTATION BUILDINGS DESIGN

TS 2.10.10

GENERIC ELECTRICITY SUBSTATION DESIGN MANUAL
FOR CIVIL, STRUCTURAL AND BUILDING ENGINEERING

SECTION NO : 10

TITLE : GIS AND OTHER SUBSTATION BUILDINGS DESIGN

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TABLE OF CONTENTS

1	INTRODUCTION	3
PART 1 – PROCEDURAL		5
2	BUILDING TYPES	5
3	BASIS OF DESIGN	6
4	GENERAL REQUIREMENTS FOR ALL BUILDINGS	8
5	SWITCH HALL BUILDING	14
6	ANCILLARY PLANT ROOM BUILDINGS	21
7	AMENITIES BLOCK	27
8	STORAGE & WORKSHOP UNITS	31
9	EXTERNAL SITE FEATURES	33
PART 2 – REFERENCES, DEFINITIONS AND DOCUMENT HISTORY		34
10	REFERENCES	34
11	DEFINITIONS	35
12	AMENDMENTS RECORD	36
13	IMPLEMENTATION	36
PART 3 – GUIDANCE NOTE AND APPENDICES		37

1 INTRODUCTION

1.1 Purpose and scope

- 1.1.1 This technical specification TS 2.10.10 defines National Grid's requirements in respect of building design at new and existing (i.e. retrofit) electricity substations and other relevant operational sites. It shall also apply, as appropriate and via agreement, to third party assets installed on National Grid owned land.
- 1.1.2 This specification details mandatory prescriptive and functional requirements relating to the construction of new and, where suitable, modifications to existing buildings and their associated infrastructure on 400kV and 275kV Gas Insulated Switchgear (GIS) substation sites and, where appropriate, Air Insulated Switchgear (AIS) substations.
- 1.1.3 These requirements shall not necessarily apply to 132kV GIS Substation Buildings (which are generally elevated to facilitate cable entry and have to incorporate third party organisations requirements, for example Distribution Network Operator (DNO) Companies) or multi-storey 400kV and 275kV GIS Substation buildings, for example those constructed in areas prone to flooding. This document shall be supplemented with additional specifications for such installations however wherever practicable the principles contained herein shall be adopted.
- 1.1.4 This specification forms part of a suite of documents, TS 2.10.xx, which define design requirements (including mandatory prescriptive and functional requirements and/or performance characteristics) relating to new build and existing 'Civil, Structural and Building Engineering' assets forming part(s) of substation construction projects. Refer to TS 2.10.00 for general introduction and description of the respective parts of the series.
- 1.1.5 These design requirements shall be used in conjunction with the construction specification which is included in the TS 3.10.xx series of documents. Refer to TS 3.10.00 for general introduction.
- 1.1.6 This specification shall be applied in conjunction with all relevant National Grid standards as appropriate. The Level 1 and 2 Specifications for substations, TS 1 and TS 2.01, cover high level requirements which are mandatory for all design and construction.

1.2 Statutory requirements

- 1.2.1 The Construction (Design and Management) Regulations 2015 (CDM 2015) applies to building works. When preparing or modifying designs, designers shall eliminate, reduce or control foreseeable risks that may arise during:
- Construction; and
 - The maintenance and use of a building once it is built.
- They shall provide information to other members of the project team to help them fulfil their duties.
- 1.2.2 As the works are for a Statutory Undertaker, they are technically exempt from the requirements of the Building Regulations however notwithstanding this or any other exemptions that may be applicable and unless specified to the contrary in this document, all building work shall be in accordance with the appropriate requirements of the Building Regulations. Where literal compliance is not possible the work shall be to an agreed standard that takes the Building Regulations as its basis.

- 1.2.3 The Equality Act 2010 applies to National Grid works. Reasonable provision shall be made for access to the Amenities Block, including for wheelchair access. Other buildings, including Switch Hall, Ancillary Plant Room Buildings, Storage Unit and Workshop Unit, should not be made fully accessible.

INFORMATIVE: The Equality Act 2010 brought together and replaced previous equalities legislation including the Disability Discrimination Act 1995 (DDA). The Equality Act requires reasonable adjustments to be made in relation to accessibility. In practice, this means that due regard must be given to any specific needs of likely building users that might be reasonably met.

INFORMATIVE: Due to the generally physical and potentially hazardous nature of the majority of operational tasks necessary in substations it is considered unsafe and impractical to assign such work to individuals having certain types of disability. Moreover the broad spectrum of conditions covered by the Equality Act make it unviable to make advance provision for every potential employee. Consequently the Switch Hall, Ancillary Plant Room Buildings, Storage Unit and Workshop Unit shall not be required to include any specific or general provision for disabled users.

Where it is reasonable, and it can be confirmed that they will not endanger themselves or their colleagues, employees with disability may be asked to work in an operational substation environment. In such instances an assessment of the designated place of work will be carried out and the necessary building modifications made retrospectively to facilitate this.

The exception to this will be the Amenities Block which will make general provision for access including by wheelchair users because;

- a) It is considered more likely that such individuals (both employees and visitors) will use these facilities (for meetings etc), and
- b) To retrospectively make such provision would be prohibitive.

It is assumed that all visitors who are identified as disabled will be escorted by National Grid personnel while on site to ensure they are fully aware of the areas into which they may safely go.

- 1.2.4 In all instances consultation with the appropriate planning authority in accordance with the Town and Country Planning (General Permitted Development) Order shall be necessary with respect to the external appearance of the building.

- 1.2.5 Building structures shall comply with the requirements of the Construction Products Regulation (EU) No. 305/2011.

INFORMATIVE: Annex I of the Construction Products Regulation defines basic requirements for construction works against the following headings:

1. Mechanical resistance and stability
2. Safety in case of fire
3. Hygiene, health and the environment
4. Safety and accessibility in use
5. Protection against noise
6. Energy economy and heat retention
7. Sustainable use of natural resources

PART 1 – PROCEDURAL

2 BUILDING TYPES

2.1 Applicable buildings

2.1.1 For the purposes of this document it is assumed that a GIS or AIS substation comprises one or more of the four distinct groups of buildings described below. These building units shall be used individually or in combination as necessary to achieve the project objectives. Design and configuration shall be as economic as possible whilst achieving the required levels of functionality and durability (i.e. design life). On new build projects all of the building groups may be utilised whilst at existing sites only certain elements may be required to supplement existing facilities as necessary.

2.1.2 The four substation building groups are as follows:

(a) **SWITCH HALL (GIS Substation only)**

The primary function of the switch hall building shall be to act as a 'weather shield' for the Gas Insulated Switchgear and other equipment contained therein.

(b) **ANCILLARY PLANT ROOM BUILDINGS (GIS & AIS Substations)**

Comprising individual prefabricated modular buildings or a brick/block building housing one or more of each of the following facilities as necessary:

- i LVAC Supplies/Distribution Room;
- ii Protection Room;
- iii Battery Room;
- iv Telecoms Room;
- v Substation Control System/Permit Room;
- vi Dispersed Relay Room' (or block house).

(c) **AMENITIES BLOCK (GIS & AIS Substations)**

Comprising a single prefabricated modular building or a brick/block building containing one or more of the following spaces as necessary:

- i Entrance Lobby;
- ii Mess Room;
- iii WC;
- iv Disabled WC;
- v General Office;
- vi Shower;
- vii Changing/Locker Room;
- viii Meeting Room.

(d) **STORAGE & WORKSHOP UNITS (GIS & AIS Substations)**

Comprising two discrete modified ISO standard steel shipping containers as necessary or a brick/block building.

2.1.3 Barring the exceptions in 1.1.3 the requirements contained herein shall constitute the design standards for all GIS substation buildings and, where appropriate, the equivalent buildings on AIS substations. Project specific deviations from these principles may be permitted by agreement with National Grid where it can be proven that they offer a better technical, economic and/or lower risk solution. All such deviations shall be fully discussed and agreed within timescales that do not adversely affect any of the project objectives and shall follow

TP188 and be recorded in the design documentation appropriate to the project contract strategy.

- 2.1.4 Sections 3 and 4 of this specification contain general requirements which apply to all building types. Sections 5 to 7 provide supplementary specific requirements for particular building types.

3 BASIS OF DESIGN

3.1 Applicable standards

- 3.1.1 Design work shall comply with this standard and where appropriate, the suite of National Grid Technical Specifications (NGTSS and TSs), European Standards and National Annexes, British Standards and Codes of Practice as appropriate. Where the requirements of this document or any other relevant project specifications are in conflict those specifically detailed within this document shall take precedence otherwise National Grid shall be informed and will instruct accordingly.
- 3.1.2 Design work shall be in accordance with recognised analytical methods.
- 3.1.3 New structures, structural parts and elements shall be designed in accordance with the suite of structural Eurocodes BS EN 1990 to BS EN 1999 and associated documents including National Annexes and relevant BSI Published Documents.
- 3.1.4 Geotechnical design and the design of foundations shall be in accordance with TS 2.10.03 Piling and Foundations. This requires the use of BS EN 1997, the associated National Annexes and where appropriate BSI Published Documents. For design of the foundation structural elements the relevant material design codes listed above shall also be applied.
- 3.1.5 The design of strengthening, alterations and repairs to existing elements where possible should satisfy Structural Eurocodes. However, the designer may need to consider additional or amended provisions outside the scope of the structural Eurocodes in order to justify the retention or reuse of existing structures. This may include, for example, the use of historic or superseded standards which were used in the original design. DH15 shall be used to assess the reuse of existing structures.
- 3.1.6 This specification contains supplementary information to the Eurocodes giving specific application to substation buildings.

3.2 Design Working Life

- 3.2.1 All building systems shall have a 50 year design working life unless noted otherwise. Life to first maintenance shall be 15 years minimum unless noted otherwise.

3.3 Supplementary Environmental Conditions

- 3.3.1 Where necessary icing conditions shall be designed in accordance with the guidance provided in CP 3: Chapter V-2:1972, 'Code of basic data for the design of buildings. Loading. Wind loads', Appendix F, 'Ice formation on structures'.

INFORMATIVE: The relevant Eurocode (BS EN 1991-1-4) and the related National Annex does not give specific guidance on the effects of ice on the geometry of a structure.
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3.4 Materials

- 3.4.1 For general material requirements refer to TS 3.10.02 Generic Technical Specification for Civil, Structural and Building Engineering- Section 02 - Materials

3.4.2 Steel reinforcement shall only be used in concrete for structural reasons or to control early thermal cracking. Where alternatives to steel (e.g. fibre reinforced concrete) are proposed a trial area having the same cross sectional area as the proposed permanent works element shall be constructed on site to demonstrate the efficacy of the methods of batching, delivery, placement, compaction and curing.

3.4.3 Glass Reinforced Plastic (GRP) shall NOT be employed as a structural material or component for any substation buildings, enclosures or other constructions whose integrity is a direct function of the operation of the HV Electricity transmission system. Kiosks and cubicles may, with the agreement of National Grid, be manufactured from GRP provided an appropriate material specification is produced.

3.5 Fire protection

3.5.1 Refer to TS 2.10.06 for general requirements for limitation of fire risk at substations. This section provides requirements for buildings.

INFORMATIVE: TS 2.10.06 provides fire design requirements and information on the relationship between fire resistance and test requirements.

3.5.2 Building materials shall meet the minimum criteria specified in Table 1 when tested in accordance with BS 476, except where greater fire resistance is required, for example where:

- The elements of a building are required to act as a Fire Barrier;
- A Fire Hazard is contained within the building or compartment (refer to TS 2.10.06);
- There is a boundary condition in accordance with the Building Regulations.

Element	Requirement
Control buildings	1 hour fire resistance
Buildings housing GIS (except where such buildings share walls or other dependent elements with control buildings)	½ hour fire resistance
Other buildings (outside to in)	0 hour fire resistance
Other buildings (inside to out)	½ hour fire resistance
Surfaces of walls, ceilings, floors	Class O as defined by the Building Regulations
Internal walls, floors (above ground), internal doors to rooms housing operational equipment	½ hour fire resistance
Ceilings and Floors in Battery Rooms	½ hour fire resistance

Table 1 – Fire resistance requirements

4 GENERAL REQUIREMENTS FOR ALL BUILDINGS

4.1 Building Layout

- 4.1.1 Guide drawings showing key building layouts of a generic GIS substation designed in accordance with the requirements of this Handbook Specification are included in the appendices.

4.2 Building Frame and Cladding

- 4.2.1 Refer to TS 3.10.06 Building Works for installation requirements.
- 4.2.2 Refer to TS 3.10.02 for material requirements.
- 4.2.3 The building frame shall be designed to resist all relevant actions in accordance with Section 3.
- 4.2.4 Where the external wall of a building forms part of a substation site boundary – i.e. is not contained within a perimeter security fence – additional measures shall be taken to ensure the level of security at that interface is not less than that of the adjacent substation perimeter security fence(s).
- 4.2.5 All buildings shall be appropriately sealed to prevent vermin entry. Additionally trench and/or cable entry points shall be designed to facilitate the prevention of water and vermin ingress without compromising the capacity of that system for future cable installation.
- 4.2.6 Where required earthing systems and connections shall be designed in accordance with NGTS 3.1.2, 'Earthing'.

4.3 Foundations and Floor Slabs

- 4.3.1 Refer to TS 2.10.03 Piling and Foundations for foundation design requirements.

4.4 Drainage

- 4.4.1 Site drainage design shall be in accordance with TS 2.10.07 Site Drainage.
- 4.4.2 Internal guttering and rainwater pipes shall not be permitted.

4.5 Doors

- 4.5.1 For general requirements for doors, refer to TS 3.10.02 Section 2.32.
- 4.5.2 All door lock barrels shall be suitable for replacement with National Grid master key barrels.
- 4.5.3 The external doors (including the vehicular access door) and opening windows of all buildings shall be fitted with intruder detection systems with an audible alarm. There shall be two independent systems, one covering the Amenities Block only with the control panel in that building and one for the Switch Hall and Ancillary Plant Room buildings with the control panel in the Substation Control System/Permit Room.

INFORMATIVE: The principle of the intruder detection and alarm systems shall be such that a visitor to the site may utilise the Amenity Block facilities without compromising the security of the operational buildings.

INFORMATIVE: The design principles of this document are based on the assumption that at 400kV, cable, transformer or Air Insulated Switchgear (AIS) connections shall be via Gas Insulated Busbar (GIB) tubes through the wall of the Switch Hall building to outdoor sealing ends, bushings or transformer GIB connections and not through a cable basement.

4.6 Building Finishes

- 4.6.1 The external colour of the building shall be agreed to suit local planning restrictions. There is no standard NG colour.
- 4.6.2 Exposed concrete floors shall be sealed against dust via the application of a chemical, abrasion, stain and slip resistant heavy duty epoxy resin sealer. The colour shall be light grey, RAL No 7035.
- 4.6.3 The surface finish of exposed concrete floors shall be compatible with the epoxy system manufacturer's requirements.

4.7 Building Services Distribution

- 4.7.1 Refer to TS 3.10.13 for Minor Electrical Works for general requirements for distribution and the other headings below.
- 4.7.2 All equipment, switches, sockets, distribution boxes, junction boxes, alarm marshalling kiosk, distribution board, MCB, isolator, relay, etc. shall carry a permanent label identifying their function in accordance with TS 3.10.13 Minor Electrical Works. Any necessary warning labels shall be fixed directly, or adjacent to them in an easily visible location.

4.8 Small power

- 4.8.1 General requirements are provided in TS 3.10.13 for Minor Electrical Works.

4.9 Lighting

- 4.9.1 General lighting shall comprise fluorescent luminaries with high frequency control gear. With the exception of the LVAC room this shall be controlled in each room via switch initiated occupancy sensors to ensure the lighting cannot be left on inadvertently.

4.10 Telephone points

- 4.10.1 General requirements are provided in TS 3.10.13 for Minor Electrical Works.

4.11 HEATING AND VENTILATION

- 4.11.1 The ventilation, humidity and heating of rooms shall be controlled within the following limits. Calculations shall take account of heat gain from any contained equipment and/or plant.

Telecoms and Substation Control System/Permit Rooms (individually or combined);

Min +18°C, Max +27°C for either of the ambient temperature ranges below.

Relative humidity shall be maintained within a range of 20% and 75%

INFORMATIVE: These values are extracted from TS 1, 'Ratings and General Requirements for Plant, Equipment and Apparatus for the National Grid System' current at the time of writing. Please refer to the latest version to ensure the building design compliments equipment requirements.

All other rooms;

Min +5°C, Max +35°C for the daily average ambient temperature range below.

Min +5°C, Max +40°C with an average value not exceeding +35°C over a 24h period for the extreme ambient temperature range below.

INFORMATIVE: The temperature limitations in these areas relate to human occupation and use rather than equipment operation which is typically assumed to be tolerant of wider limits however this assumption must be confirmed on a design by design basis.

4.11.2 For design purposes UK ambient temperatures shall be assumed as follows;

- Daily ambient temperature range +30°C to -10°C
- Extreme ambient temperature range +35°C to -25°C

4.11.3 In order to maintain internal room temperatures between the ranges defined in Clause 4.11.1 heating, ventilating, and air conditioning (HVAC) systems shall only operate during periods when the internal room temperature is a direct function of the ambient external temperatures being outside the 'daily ambient temperature range' stated in Clause 4.11.2, i.e. allowance shall be made for 'thermal lag'. Due to their narrower range of acceptable operating temperatures the rooms occupied by indoor equipment to which the 'special service conditions' defined in clause 1.3 of TS1, issue 7 apply (typically telecoms and substation control system/permit rooms) are excluded from these specific operating time requirements but not those relating to HVAC systems below.

4.11.4 The design life of any proposed HVAC system, based on its estimated total run time during that period, shall be at least equal to the design life of the equipment whose continuous operation they are designed to facilitate and ensure. Where this cannot be achieved the design shall incorporate a backup system configured to automatically operate on failure of the primary HVAC system and which is to the same standard as that primary system.

4.11.5 All HVAC systems shall be fitted with operational failure alarms routed via the Substation Control System and shall enunciate 'CTRL SYS ABNORMAL' to the Transmission Network Control Centre.

4.11.6 The thermal performance of each building/room type shall be subject to an agreed proof of concept (POC) forming an integrated part of the Principal Contractors quality management system. This shall be a 'HOLD' point as defined in TS 3.10. The POC may (but not necessarily) involve some form of testing, for example validating a computer model against measured internal and external temperatures or, in the case of more established and proven building designs, evidence from previous constructions of the same type and function. For modular or pre-fabricated building systems the POC shall occur prior to delivery to site.

4.11.7 Ventilation ductwork shall comply with BS 5720, 'Code of practice for mechanical ventilation and air conditioning in buildings', and shall be terminated in louvres which are self-closing in the event of fire. Wall penetrations shall be adequately sealed to ensure that the fire resistance of compartment walls are maintained.

INFORMATIVE: As the building/room units are not regularly occupied by personnel it is unlikely that the majority of operational and maintenance activities will coincide with an extreme ambient temperature condition. For this reason it is not considered economically viable to install control devices that can consistently maintain temperatures below 30°C (i.e. within the 'zone of thermal comfort' advised by HSE) and consequently the acceptable limits stated above are, at their high end, governed by ambient conditions. This does not mean the rooms will be maintained at those levels merely that it is acceptable should they rise to them. In the event that work activities are programmed during periods of high ambient temperatures portable environmental control systems may be necessary.

- 4.11.8 Re-circulating ventilation systems shall be designed to shut off the re-circulation in the event of a fire and maintain the extract function of the ventilation system.
- 4.11.9 Rooms shall incorporate measures to avoid deterioration due to the working environment and these shall include the use of anti-condensation heating, ventilation etc where appropriate.
- 4.11.10 Arrangements shall be included to prevent ingress of insects and small rodents.
- 4.11.11 The ventilation requirements of battery rooms shall be calculated in accordance with Annex A of BS 6133.
- 4.11.12 All air conditioning units shall not be mounted above SCS cubicles. This is to avoid water ingress into the SCS when the air condition malfunctions or due to leaks.

4.12 Plumbing

- 4.12.1 Refer to individual building sections below for specific requirements. Installation requirements are provided in TS 3.10.06.

4.13 Fire detection, alarms systems and extinguishers

- 4.13.1 Refer to TS 2.10.06 Limitation of Fire Risk in Substations for general requirements for fire detectors, alarms, signage and automatic fire protection systems, where relevant.

Detailing for fire protection

- 4.13.2 Cavity barriers shall be formed in roof spaces or beneath computer flooring to form a continuous barrier such that the cavity does not exceed 20m in any direction. The cavity barriers shall have a minimum Fire Resistance of 1 hour.
- 4.13.3 Doors giving access from a corridor to a room housing operational equipment shall be designated Fire Doors. These doors shall be automatically self-closing.
- 4.13.4 Unless otherwise agreed with National Grid, emergency lighting shall be of the self-contained, self-maintained type. This shall clearly show the route to the nearest exit.
- 4.13.5 Ventilation ductwork shall comply with BS EN 1886 and shall be terminated in louvres which are self-closing in the event of fire. Wall penetrations shall be adequately sealed to ensure that the Fire Resistance of compartment walls is maintained.
- 4.13.6 Re-circulating ventilation systems shall be fitted with automatic smoke detectors designed to shut off the re-circulation and maintain the extract function of the ventilation system. However in areas where automatic gas extinguishing systems are installed, the extract function shall also be shut down on the activation of the detection equipment.
- 4.13.7 The manual control and lock-off features for automatic ventilation of fire extinguishing systems shall be located so that they are protected from the effects of fire and can be operated from outside the protected area.
- 4.13.8 Battery rooms shall be adequately ventilated so as to prevent accumulation of gas generated by the battery charging process.
- 4.13.9 For guidance on the prevention of explosive atmospheres forming, and on other safety aspects of operating stationary cells and batteries (unsealed type) reference should be made to BS EN 50272.
- 4.13.10 Where sealed cell batteries are installed only normal ventilation is required.

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- 4.13.11 Where cables pass between floors of a building, any ducts or slots in the floors shall be sealed to prevent possible spread of fire. The sealant shall have equal Fire Resistance to that of the floor through which the cables pass.
- 4.13.12 Cables and pipes passing through external walls of switchhouses or substation buildings shall have suitable seals to prevent the ingress of manufactured or natural gas. They shall additionally have a fire resistance appropriate to the building.
- 4.13.13 All trenches or cable ducts shall be effectively sealed to prevent the spread of fire, smoke, CO₂ etc, into adjoining compartments. Those entering a building shall be effectively sealed whether or not cables have been installed. Where ducts and trenches pass under, over or through compartment walls, the sealing of the opening shall have a Fire Resistance equal to that of the compartment wall.

4.14 Modular construction

- 4.14.1 Where modular construction is used, each building/room unit shall be of pre-fabricated welded steel construction suitable for accommodating all room equipment.
- 4.14.2 The building structural elements shall be designed to resist all relevant actions in accordance with the requirements contained in Section 3.
- 4.14.3 As a minimum each building/room unit shall comprise:
- i Steel framework;
 - ii External and internal cladding sheets;
 - iii Building lifting and handling facilities;
 - iv High integrity paint finish internally and externally;
 - v Undersealing;
 - vi Thermal insulation to floor, walls and ceiling;
 - vii Transport fixing cleats;
 - viii Doors for equipment and personnel access inclusive of any necessary supplementary removable sections to facilitate installation;
 - ix Cable entry detail;
 - x All ancillary items to complete inclusive of cable tray/ ladder rack equipment, internal ducting for control / auxiliary cables;
 - xi Substation Room Name Label mounting facility;
 - xii Jacking points and skid plates;
 - xiii Non slip floor paint or Anti-static Vinyl floor covering, light grey colour. The exception is the Battery Room which requires acid resistant finishes;
 - xiv External landings, steps and handrail;
 - xv Building Services – Lighting, small power, ventilation/cooling, heating, fire detection alarms, intruder alarms, distribution boards and alarm marshalling kiosk, etc.

INFORMATIVE: Windows and roof lights shall not be provided.

INFORMATIVE: Fire protection in the form of gas suppression systems – as detailed in TS 2.10.06 Limitation of Fire Risk in Substations – shall not be provided.

5 SWITCH HALL BUILDING

5.1 Building layout

- 5.1.1 Refer to Guide Drawings 1 & 2 contained in the Appendix.
- 5.1.2 The GIS Switch Hall building shall consist of a single room sized to accommodate the proposed GIS equipment and associated Local Control Cubicles (LCC's). There shall be sufficient space to facilitate access for all necessary construction, testing and commissioning, inspection, maintenance and removal activities. The arrangement shall make allowance for the installation of future bays where specified.
- 5.1.3 An internal 'lay down' area shall be provided immediately adjacent to the vehicular access door (see below) to facilitate the assembly, installation and maintenance of the GIS plant, for storage of materials and SF6 gas cart and bottles and to access the gantry crane for maintenance. This area shall be a minimum of 4m long by the full width of the building.
- 5.1.4 Unless alternative provision is agreed with National Grid 3 no. individual steel cages (nominal dimensions 1.8m x 1.8m x 1.8m) each with separate access gates shall be provided in the 'lay down' area for the storage of SF6 gas bottles, portable earths and hoists/lifting equipment respectively.
- 5.1.5 There shall be a continuous, clear route having minimum dimensions of 1.6m horizontally and 2.2m vertically from floor level around the internal perimeter of the switchgear 'footprint' (i.e. between the GIS equipment and the building frame) to facilitate gas cart access.

INFORMATIVE: The width of 1.6m is based on the assumption that this will provide a minimum clear pedestrian access of 700mm around a 900mm wide gas cart. This assumption shall be reviewed on a site by site basis and the width increased accordingly where necessary however it should be noted that this dimension is the absolute minimum measured between (typically) the internal face of the steel columns of building portal frame or LCC and the closest item of GIS equipment. The clear distance will increase between column positions and at the bus section so provided the gas cart is appropriately located during operation it is not envisaged there should be significant problems maintaining pedestrian access around it.

5.2 Building frame and cladding

- 5.2.1 The Switch Hall building should comprise a single storey pitched roof steel portal frame design unless agreed otherwise with National Grid. It shall be of economic design such that it provides a 'weather shield' to the gas insulated switchgear and Local Control Cubicles (LCCs)
- 5.2.2 All structural steelwork shall be galvanised. Refer to TS 2.10.12 for requirements for Structural Steelwork and Aluminium.
- 5.2.3 The building frame shall be designed to support the Gantry Crane Loading, where relevant (see Section 5.14).
- 5.2.4 The building frame shall be suitably connected to the substation earthing grid at the bottom of every column stanchion. No other specific lightning protection measures shall be provided.

Cladding - general

- 5.2.5 The cladding system shall have a life to first major maintenance of 20 years.

- 5.2.6 The cladding system shall be designed in accordance with BS 5427 'Code of practice for the use of profiled sheet for roof and wall cladding on buildings. Design'. It shall be designed to resist all relevant actions acting on it, including wind and ice and meet acceptable limits on deflection.
- 5.2.7 The cladding system shall be designed to be completely weatherproof and shall be air-tight to the extent that gaps between components shall be closed with filler blocks or seals. Side laps shall be arranged to face away from the direction of prevailing winds.
- 5.2.8 Cladding sheets shall be configured to minimise laps. Where required, laps and their fixings shall be continuous and shall coincide with the edges of large openings for doors and other major features. Flashings shall be secretly fixed wherever possible.
- 5.2.9 The cladding system shall be designed and detailed to take account of variations in dimensions and shape due to changes in temperature and humidity without deterioration in performance. Coatings shall not suffer mechanical or chemical breakdown under extremes of temperature and humidity.
- 5.2.10 The component parts of all joints and fastenings shall be selected to prevent bi-metallic corrosion.
- 5.2.11 To avoid electrolytic corrosion between incompatible materials they shall be separated by a suitable barrier (e.g. paint, isolation tape, thermal pads etc).

Wall cladding

- 5.2.12 The wall cladding shall be specified by the designer such that it mitigates any risk of condensation in the building adversely affecting the electrical equipment or the health and safety of operatives during installation, commissioning, operation and maintenance – i.e. this may be either single or double skin as deemed necessary. All building cladding may be steel or aluminium as specified. This shall incorporate translucent sheets to provide diffused natural daylight uniformly within the building. The translucent sheets shall, as a minimum, represent 5% of the total wall area of the building and be no lower than 2.4m above the adjacent ground level. They shall be fully compatible with the aluminium cladding system and shall incorporate UV light stabilisers to prevent yellowing.

INFORMATIVE: The only exception to the above would be where a wall is required to provide fire resistance due to the close proximity of an adjacent hazard or boundary or where a wall forms, for example, the perimeter of a substation and is required to provide a specific level of security.

Roof

- 5.2.13 The roof should be a built up or composite insulated profiled metal cladding system to prevent condensation forming on the internal surfaces, unless otherwise agreed with National Grid.

INFORMATIVE: Experience has shown that aluminium cladding is susceptible to pulling off at fixing positions where an inadequate bolt and/or washer configuration has been detailed and installed. The selected system shall therefore specifically address this failure mode and where necessary demonstrate its suitability by means of design and/or testing.

- 5.2.14 Roof lights should not be provided in the Switch Hall building.
- 5.2.15 The designer shall specify the means of obtaining maintenance access to the roof. The preferred approach is to provide clear access for a mobile or fixed platform alongside the building, rather than providing fall arrest or permanent maintenance systems.

INFORMATIVE: For reasons of economics and health and safety the Switch Hall building design concept is generally one of low inspection and maintenance

The basis of the design therefore, is that there shall be no planned inspection or maintenance activities that require direct roof access during the buildings life. Consequently fall arrest or similar permanent maintenance systems are not required provided clear access for a mobile or fixed platform to facilitate the necessary visual inspections is established and maintained. Where specific logistics (for example at existing sites) dictate otherwise this requirement shall be reviewed and appropriate measures taken

5.3 Foundations and floor slab

- 5.3.1 The Switch Hall floor shall be 150mm above the external site level.
- 5.3.2 Portal frame columns shall be supported on concrete pads, strips or piled foundations dependent on the prevailing ground conditions.
- 5.3.3 Switchgear shall be installed on a suitably designed raft or piled concrete foundation. This shall be of the minimum width necessary to suit the plant configuration but shall extend longitudinally for this fixed width to the vehicular access door.
- 5.3.4 The remaining floor area (that is the area not providing structural support to the switchgear in its permanent position) may be either independent reinforced concrete ground bearing infill slabs or an extension of the switchgear foundation. The designer shall ensure that the floor area is suitable for all maintenance vehicles and other maintenance equipment in combination. As a minimum it shall be designed as Category E2 to BS EN 1991-1-1 (specified by the client) to support a uniformly distributed load of 4kN/m² together with a 50kN wheel load in whichever combination causes the worst effects.
- 5.3.5 Cable trenches or ducts for multicore cables and earthing shall link the switchgear to the LCC's. External cable trenches with suitable covers shall link the LCC's with the ancillary plant room buildings as necessary

5.4 Drainage

- 5.4.1 The building roof shall drain to a gutter system connected to full height, external down pipes. These shall outfall to a 'french drain' (stone land drain) system installed immediately adjacent to the building. Wherever possible this shall form, or be connected to, a soakaway rather than a 'positive' drainage system.

INFORMATIVE: On low permeability sites 'positive' main drainage systems may be necessary and shall be designed accordingly.

INFORMATIVE: The 'french drain' shall be positioned in accordance with the requirements of TS 2.10.01 Oil Containment specifically, "Where practical, no part of any oil filled equipment, oil storage area, or mobile tanker shall be sited within 5 metres of any drain through which oil could enter and discharge directly into controlled waters".

5.5 Doors

- 5.5.1 A manually operated, galvanised steel, roller shutter or sectional overhead door having minimum dimension of 5m wide x 5m high shall be installed at one end of the building to facilitate vehicular access. The bottom rail of the door shall incorporate a rubber weatherseal to accommodate minor floor irregularities and prevent water ingress. The threshold shall be formed with an external fall away from the opening to facilitate run-off and prevent ponding.

INFORMATIVE: The roller shutter or sectional door shall be primarily provided, and therefore sized, to facilitate the removal of operational (commissioned) equipment for maintenance and/or replacement purposes. The stated sizes are based on the dimensions of a typically laden flatbed truck and if necessary shall be increased to suit these requirements. However, an over sized door solely to suit a contractor's chosen method of installation shall not be provided.

- 5.5.2 Personnel fire escape doors shall be provided in accordance with the means of escape distances stated in the Building Regulations for buildings in the 'Industrial' purpose group having a 'normal' fire risk.
- 5.5.3 One personnel door shall be designated as the normal point of access and shall be lockable from outside and quick release from inside. All other personnel doors shall be fitted with quick release only operable from inside the building.
- 5.5.4 External personnel doors shall be painted steel, opening outwards and shall be fitted with door closers.

5.6 Building finishes

- 5.6.1 Internal wall finishes shall comprise the exposed steel frame, purlins and inside face of the cladding sheet. Unpainted cement particle board or 'Heavy' or 'Severe' duty wall board shall (where appropriate) be fixed to the sheeting rails to provide protection to cladding sheets from internal impact up to 1m above finished floor level.
- 5.6.2 The insides of cable trenches shall not be painted.
- 5.6.3 Trench covers shall be either galvanised steel chequer plate or coloured fibreglass with slip resistant finish suitable for all construction, inspection and maintenance loads.

INFORMATIVE: Consideration shall be given to the need to protect trench covers during construction and/or increase the load rating to suit construction vehicles.

5.7 Building services distribution

- 5.7.1 A dedicated building services low voltage combined power and lighting distribution board shall be provided within the Switch Hall building. This shall be supplied from the main LVAC switchboard.

5.8 Telephone points

- 5.8.1 A telephone point with wiring back to the remote telecoms room shall be provided at the main personnel access/egress door.

5.9 Small power

- 5.9.1 3 phase power sockets for the gas cart processing plant shall be provided at suitable positions (generally third points along both longitudinal walls but not greater than 30m centres) together with 240 Volt 63 amp sockets at the same locations for the connection of test equipment.
- 5.9.2 110 Volt 16 amp socket outlets shall be provided at suitable locations (nominally 15m centres) for maintenance and task lighting, with an appropriate supply system at the LVAC board. It shall be possible to easily isolate the 110 Volt system at point of supply to remove transformer losses when out of service.

5.10 Lighting

- 5.10.1 General lighting levels shall be 50 lux average illuminance and 20 lux minimum measured illuminance over all areas necessary to allow for the safe movement of people, machines and vehicle for access and to facilitate the routine operation of equipment. General lighting shall be provided by low level uplights around the perimeter of the building or bulk head lights fitted to equipment/walkways. These shall be configured such that they are maintainable from ground or platform level.

INFORMATIVE: All lighting shall be 'low level' to facilitate safer maintenance activities unless, and only then with the agreement of National Grid, it can be proven that high level lighting units are necessary to achieve the required lux levels. Where such systems are installed they shall be demonstrably maintainable from ground or platform level.

- 5.10.2 Permanent localised task lighting of 100 lux average illuminance and 50 lux minimum measured illuminance shall be provided where necessitated by routine (i.e. at least once a month) operations and also at all positions necessary to facilitate operational switching activities.

INFORMATIVE: Fixed task lighting is not a mandatory requirement and shall only be provided where the design incorporates activities that require routine (i.e. monthly) inspection and/or maintenance.

During specific maintenance activities fixed lighting shall be supplemented by portable systems as necessary supplied from the small power outlets. The design shall ensure sufficient power outlets are provided to facilitate this.

- 5.10.3 If the lighting design comprises lamps which are subject to arc re-strike times they shall be supplemented by fluorescent tube or bulkhead lighting around the periphery and along general access routes. This supplementary lighting system shall have 20 lux average illuminance and 5 lux minimum measured illuminance.
- 5.10.4 Emergency lighting shall comply with BS 9999:2008, 'Code of practice for fire safety in the design, management and use of buildings' and BS 5266-10:2008, 'Guide to the design and provision of emergency lighting to reduce the risks from hazards in the event of failure of the normal lighting supply'.

5.11 Heating and ventilation

- 5.11.1 High level fixed louvres with fly screens shall be provided at both ends of the building for the dissipation of any heat from the switchgear or due to solar gain unless the designer can show that they are not necessary.
- 5.11.2 Engineers shall consider natural ventilation as National Grid's preferred environmental control philosophy, however innovative solutions may also be considered where they demonstrate benefits to capital, operating cost and user comfort. This shall follow the technical deviation process of TP 188.

5.12 Plumbing

- 5.12.1 No plumbing is required in the switch hall building.

5.13 Fire detection, alarm system and extinguishers

- 5.13.1 A Category L1 automatic fire detection and fire alarm system as defined in BS 5839-1, 'Fire detection and fire alarm systems for buildings. Code of practice for system design, installation, commissioning and maintenance' shall be provided. This shall be a VESDA (Very Early Smoke Detection Apparatus) type aspirating system in accordance with BS EN 54-20, 'Fire detection and fire alarm systems - Part 20: Aspirating smoke detectors' and as certified by the Loss Prevention Certification Board. This shall not incorporate additional in-line filters.
- 5.13.2 The fire alarm panel shall be located in the Substation Control System/Permit Room.
- 5.13.3 Break glass call points linked to the fire alarm panel shall be provided at all personnel access doors.

INFORMATIVE: The GIS Switch Hall houses predominantly metal enclosures containing a non flammable inert gas (SF₆). The cables are LSF, the walls and building frame are metal and the floor is concrete. Consequently there is virtually no fire load and nothing that can support a long term fire. With adequate means of escape in accordance with the building regulations no other fire protection is necessary unless an external hazard or boundary dictated that an external wall or roof required an enhanced fire rating.

- 5.13.4 Suitable (Dry powder or CO₂) hand held fire extinguishers shall be provided.

5.14 Crane

- 5.14.1 See TS 3.10.12 Structural Steelwork and Aluminium, Section 12.21 Crane Gantry Girders, Rails and Fixings for the requirements on Crane Gantry Girders and Crane Rails.
- 5.14.2 An electrically operated overhead gantry crane shall be provided. This shall be of sufficient capacity and configuration to facilitate installation and removal of the heaviest and/or largest items of GIS plant. The designer shall establish actual plant and equipment loading and thus determine the capacity and self weight of the gantry crane. The overall gantry crane loading shall be used to design the gantry crane supports, the building frame and foundations.
- 5.14.3 The crane can be omitted if the GIS installer has alternative installation and maintenance lifting procedures agreed beforehand with National Grid. This shall follow the technical deviation process in TP 188.

INFORMATIVE: It is assumed that the crane will be used during the construction works for the installation, testing and commissioning of the plant and equipment and consequently will not be in 'new' condition on completion. This is deemed acceptable provided that the design life and functionality are demonstrably not compromised. Any necessary maintenance, testing and repairs shall be completed prior to handover.

INFORMATIVE: The design of the gantry crane shall consider and allow for all access (e.g. from scaffolds, MEWPs, etc.) that is necessary to inspect, maintain and certificate the system in accordance with the appropriate legislation. This includes access to the crane rails, connections and supports. Configurations that necessitate abseiling or industrial rope access inspection techniques are not preferred however these may be acceptable to National Grid if it can be proven by design risk assessment that they offer the most balanced solution.

- 5.14.4 The crane rails, connections and supports shall be coated with a suitable protective paint system.
- 5.14.5 Connections (including temporary connections during either fabrication or erection) shall not be made to tension flanges unless specifically designed. Workshop assemblers and site erectors shall be made aware of this prohibition by a prominent note on the Contractor's shop drawings.

6 ANCILLARY PLANT ROOM BUILDINGS

6.1 Building layout

6.1.1 Refer to Guide Drawings 3 & 4 contained in the Appendix.

6.1.2 The guide drawing dimensions are indicative only, and are based on road transportable, prefabricated modular steel units. The rooms shall be sized to suit their particular function (e.g. no of bays/panel etc.)

INFORMATIVE: The size of the rooms (particularly their width) will be a direct function of the panel configuration. Front access panels with cable entry and exit from the top will provide the minimum building footprint and consequently the multi disciplinary design team must work together to achieve the optimum solution.

6.1.3 Buildings provided on AIS substation sites shall typically have pitched roofs.

6.1.4 Should modular units be utilised they shall be configured such that there is a minimum 1200mm clear horizontal gap between the vertical faces of adjacent units. Otherwise the units shall be closely butted together with the exposed gap fully sealed with an appropriate joint filler. In this latter case the buildings shall be specifically designed to suit this configuration.

6.1.5 The buildings shall be designed and configured such that an unaccompanied individual will be able to undertake routine (i.e. at least once a week) operational, inspection and maintenance activities.

Battery room

6.1.6 Battery rooms shall comply with the requirements of BS EN 50272-1:2010 'Safety requirements for secondary batteries and battery installations. General safety information'. They shall be adequately ventilated to prevent the accumulation of gas from battery charging and shall use explosion proof fittings throughout. A "Belfast" style sink incorporating an overflow shall also be included in these rooms for washing purposes.

6.1.7 It shall not be necessary to drain the battery room to a blind tank. It shall be drained into the main site drainage.

INFORMATIVE: Battery systems tend to require a different operating environment to typical protection and control equipment. It is often difficult to balance the necessary ventilation requirements against the maintenance of a stable thermal environment where both are housed in the same room.

Utilisation of a dedicated battery room has a number of advantages:

- Where required, naturally vented cells can be used in dispersed relay room applications.
- Battery systems can be maintained in a well ventilated environment and the risk of overheating is minimised. Conversely the main relay room can be maintained at a more stable temperature thus reducing energy costs.

Based on a typical life cycle cost benefit analysis it can be shown that the additional building costs are mitigated by the reduction in forced ventilation and the associated maintenance.

Telecoms room

- 6.1.8 Space shall be provided in the Telecoms Room for two wall mounting boards (set 5m apart) to accommodate telecoms equipment and outgoing floor cable apertures.

LVAC/Supplies Distribution Room

- 6.1.9 The LVAC/Supplies Distribution Room shall be arranged to suit against the wall mounting with access for installation and maintenance from the front only. Cable entry shall be from below, with cables exiting from the top of the cubicle.

Dispersed Relay Rooms

- 6.1.10 The layout of a 'dispersed relay room', that is a building housing bay or bays specific relay panels and associated electrical equipment also referred to as a 'blockhouse' or 'portable relay room', shall, where practicable, incorporate a segregated room for the installation of the battery system. This room shall be separately accessed – see Guide Drawing 4 in the appendices.
- 6.1.11 The segregated battery room shall comply with the requirements of BS EN 50272-1:2010 'Safety requirements for secondary batteries and battery installations. General safety information' and be appropriate to the type of batteries that are installed. A suitable notice plus design information shall indicate the type of batteries the room is suitable for.
- 6.1.12 A 'Belfast' style sink is not required provided suitable washing facilities exist elsewhere on site.

INFORMATIVE: Where the facility is designed for (say) valve regulated cells it would generally not be suitable for the subsequent installation of vented cells.

6.2 Building frames and cladding

Equipment Panels

- 6.2.1 The building/room units shall be designed to support the equipment panels without undue deflection/distortion during transportation, off loading and installation. The floor shall be detailed to incorporate the fixing arrangement necessary for the panels.

INFORMATIVE: Panel weights will be project specific however the maximum floor loads may be assumed as Category E2 to BS EN 1991-1-1 (specified by the client) as follows:

Battery Room – 12kN/m²

All Other Rooms – 8kN/m²

Cable entries

- 6.2.2 Cables shall be supported on ladder rack systems as and where necessary
- 6.2.3 Cable apertures complete with gland plates shall be provided in the marshalling area for incoming cables.
- 6.2.4 Cable connections shall not reduce the IP rating of the building.
- 6.2.5 Cables and pipes passing through external walls shall have suitable seals to prevent the ingress of manufactured or natural gas. They shall have a fire resistance appropriate to the building
- 6.2.6 Cable apertures complete with gland plates shall be provided for the LVAC board in the LVAC Supplies/Distribution Room

- 6.2.7 In the Telecoms Room two floor apertures shall be provided to suit outgoing telecom cables (one for each wallboard)
- 6.2.8 All cable entries to the Battery Room shall be through walls.
- 6.2.9 Sufficient suitable cable tray/racking shall be included within each building/room unit to facilitate cabling between individual items of equipment. Cable tray/racking shall run at high level. Internal ducting for control auxiliary cables shall also be provided.

Earthing

- 6.2.10 Each building shall have earth connection points. All metalwork e.g. doors, structure, handrails, cable trays etc shall be earthed.
- 6.2.11 Doors shall be connected to the body of the building with an appropriately sized flexible braided earth strap.

6.3 Foundations and floor slabs

- 6.3.1 Each building shall be supported on strip or piled concrete foundations 50mm (nominal) above general substation level. All buildings shall sit directly onto the foundations except for the LVAC Supplies/Distribution Room(s) which shall be supported on a galvanised steel frame 50mm (nominal) above general substation level.

INFORMATIVE: The LVAC Supplies/Distribution Room shall be raised as necessary to allow for the bending radii of incoming power cables

- 6.3.2 600mm wide x 300mm deep cable trenches (nominal dimensions) shall be installed, between the various buildings as necessary and the GIS Switch Hall terminating at the marshalling area. The top of the trenches shall be level with the adjacent site level.

6.4 Drainage

- 6.4.1 Refer to clause 4.4 for general requirements for drainage design.

6.5 Doors

- 6.5.1 External doors shall be painted steel lockable from the outside and quick release from the inside.
- 6.5.2 All doors shall be of sufficient size to allow installation and removal of the panels contained within their associated rooms.
- 6.5.3 The external door(s) of each building/room unit shall be labelled to indicate the room type.
- 6.5.4 The doors shall be outward opening complete with a mechanism allowing them to be retained in the open position.

6.6 Building finishes

- 6.6.1 The walls and floor of the battery room shall have an acid resistant coating.
- 6.6.2 Unless specified otherwise finishes shall be as follows;
- | | | |
|-----|-------------------------|--------------------------|
| i | Internal walls and roof | Off white, semi gloss |
| ii | Underfloor | Black Underseal Compound |
| iii | Internal floor | Light Grey Vinyl |

6.7 Building services distribution

- 6.7.1 A dedicated Building Services LV combined Power and Lighting distribution board shall be provided within each building except for a discrete Battery room where an externally housed distribution board shall be provided.
- 6.7.2 Connections to socket outlets, lighting and other equipment shall be via conduit and trunking as necessary.

6.8 Small Power

- 6.8.1 A minimum of two 240 volt 13 amp socket outlets and two 110v (amperage) socket outlets shall be provided in each room (one of each at both ends) except for the Battery Room and the Substation Control System/Permit Room – see below.
- 6.8.2 The Substation Control System / Permit Room shall be provided with an internal marshalling cabinet to allow the alarm signals from oil containment and other systems to be relayed to the substation control system. 'Desk height' dado trunking with integral six 240 volt 13amp socket outlets shall be fitted to the walls.
- 6.8.3 An external 240 volt 13 amp power socket shall be provided close to the Battery Room door
- 6.8.4 No socket outlets shall be provided in the Battery Room because of the risk of explosion created by the possible presence of hydrogen gas from the batteries.

6.9 Lighting

- 6.9.1 General lighting levels shall be 200 lux average illuminance and 100 lux minimum measured 1m above floor level
- 6.9.2 Above each exit doors there shall be an exterior PIR controlled bulk-head light with cowl.
- 6.9.3 Light fittings within the Substation Control System/Permit Room shall be fitted with diffusers to avoid glare on computer screens.
- 6.9.4 Emergency lighting showing the route to the nearest exit shall be provided. This shall be of the self contained, self maintained type.
- 6.9.5 Explosion proof fittings shall be provided throughout the battery room.

6.10 Telephone points

- 6.10.1 One telephone point shall be provided by the doorway inside each room apart from the Battery Room.
- 6.10.2 A minimum of four additional telephone points shall be provided in the Substation Control System/Permit Room (two at each desk position)

6.11 Heating and ventilation

- 6.11.1 The ventilation, humidity and heating of rooms shall be controlled within the following limits. Calculations shall take account of heat gain from any contained equipment and/or plant.

(a) Telecoms and Substation Control System/Permit Rooms (individually or combined);

Min +18°C, Max +27°C for either of the ambient temperature ranges below.

Relative humidity shall be maintained within a range of 20% and 75%

INFORMATIVE: These values are extracted from TS 1, 'Ratings and General Requirements for Plant, Equipment and Apparatus for the National Grid System' current at the time of writing. Please refer to the latest version to ensure the building design compliments equipment requirements.

(b) All other rooms;

Min +5°C, Max +35°C for the daily average ambient temperature range below.

Min +5°C, Max +40°C with an average value not exceeding +35°C over a 24h period for the extreme ambient temperature range below

INFORMATIVE: The temperature limitations in these areas relate to human occupation and use rather than equipment operation which is typically assumed to tolerant of wider limits however this assumption must be confirmed on a design by design basis.

- 6.11.2 For design purposes UK ambient temperatures shall be assumed as follows;

Daily average ambient temperature range +30°C to -10°C

Extreme ambient temperature range +35°C to -25°C

INFORMATIVE: As the building/room units are not regularly occupied by personnel it is unlikely that the majority of operational and maintenance activities will coincide with an extreme ambient temperature condition. For this reason it is not considered economically viable to install control devices that can consistently maintain temperatures below 30°C (i.e. within the 'zone of thermal comfort' advised by HSE) and consequently the acceptable limits stated above are, at their high end, governed by ambient conditions. This does not mean the rooms will maintained at those levels merely that it is acceptable should they rise to them. In the event that work activities are programmed during periods of high ambient temperatures portable environmental control systems may be necessary.

- 6.11.3 Ventilation ductwork shall comply with BS 5720, 'Code of practice for mechanical ventilation and air conditioning in buildings' where not in contrast with relevant European standards, and shall be terminated in louvres which are self-closing in the event of fire. Wall penetrations shall be adequately sealed to ensure that the fire resistance of compartment walls are maintained.
- 6.11.4 Re-circulating ventilation systems shall be designed to shut off the re-circulation in the event of a fire and maintain the extract function of the ventilation system.
- 6.11.5 Rooms shall incorporate measures to avoid deterioration due to the working environment and these shall include the use of anti-condensation heating, ventilation etc where appropriate.
- 6.11.6 Arrangements shall be included to prevent ingress of insects and small rodents.

- 6.11.7 The ventilation requirements of battery rooms shall be calculated in accordance with Section 8 of BS EN 50272-2 'Safety requirements for secondary batteries and battery installations. Part 2: Stationary batteries', or Section 6 of BS EN 50272-3 'Safety requirements for secondary batteries and battery installations. Part 3: Traction batteries'.

6.12 Plumbing

- 6.12.1 New control rooms shall be provided with a permanent shower/drying room conforming to the following minimum standard;
- i Room plan dimensions: 1400mm x 2500mm
 - ii Thermostatic mixer shower unit
 - iii 1400mm x 900mm stone resin shower tray with side panels to suit
 - iv Shower area to be tiled or to have pre-finished surfaces
 - v One locker unit plus one bench seat to suit
 - vi Slip resistant vinyl floor covering

INFORMATIVE: Dedicated SF6 washing facilities shall not be required on outdoor or indoor substation sites provided the control building, or other agreed space, includes a permanent shower/drying room.

6.13 Fire detection, alarms and extinguishers

- 6.13.1 In addition to the requirements of TS 2.10.06, Fire Detection and alarm systems shall be in accordance with the recommendation of BS 5839-1, 'Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises'. Detector and alarm sounders shall be located such that they can be assessed for the test, maintenance or repair with out infringement of safety distances to HV equipment specified in NGTS 2.1.
- 6.13.2 Suitable fire detectors shall be installed in each room together with push buttons and test station. They shall be wired back to an alarm marshalling kiosk located in the Substation Control System/Permit Room.
- 6.13.3 Audible alarms shall be located such that they cover all areas which personnel will access. Alarms shall be transmitted to the substation remote control points by means of National Grid's data acquisition system
- 6.13.4 Adequate hand held fire extinguishers shall be provided suitable for the equipment in the room. A minimum of two extinguishers shall be provided in each room. The fire fighting equipment shall be identified with signs complying with the Health and Safety (Safety Signs and Signals) Regulations 1996. Exact requirements shall be determined via a fire risk assessment.

7 AMENITIES BLOCK

7.1 Building layout

- 7.1.1 Refer to Guide Drawings 5, 6 & 7 contained in the Appendix.
- 7.1.2 The Amenities Block building shall comprise modular, pre-fabricated, road transportable steel unit or units with, wherever possible, off site fitted interiors and finishes (including partition walls and services). Indicative layouts of three Amenities Block variants are shown in Guide drawings 5, 6 & 7. These are based on manufacturer's advice and are made up respectively of 2, 3 and 4 'standard' road transportable units which shall be assembled on site.
- 7.1.3 The modular building system as a whole (as opposed to individual components) shall be BBA (British Board of Agreement) approved.
- 7.1.4 National Grid shall define whether a site shall have 2, 3 or 4 unit arrangements.
- 7.1.5 Individual room dimensions may be varied between -5% and +5% and overall room areas between 0% and +10%.
- 7.1.6 With the exception of access to and use of the archive room, shower and changing/locker room provision shall be made throughout for wheelchair users in accordance the appropriate sections of the Building Regulations
- 7.1.7 A cantilever rain canopy (i.e. no supporting legs) shall be fitted above the entrance door.
- 7.1.8 The Amenities Block building shall be a single unit containing individual rooms, as necessary, specified and equipped as follows;
- (a) Entrance Lobby
- Wall mounted 'T' card holder (supplied by National Grid).
 - 1 no 1200mm x 900mm notice board
- (b) General Office
- 4 no four drawer filing cabinets*
 - 6 no 1600mm x 800mm desks*
 - 6 no below desk drawer units*
 - 6 no desk chairs*
 - no 1800mm x 1200mm white boards
 - 1 no 1200mm x 900mm notice board
 - 6 no waste paper bins
 - no 900mm x 450mm x 1800mm steel storage cabinets*
 - no coat stands
 - 6 no 4 socket extension leads @ 3m long
 - 2 no desk screens*
- (c) Mess Room
- Stainless steel single drainer sink
 - no 500mm base units with worktop
 - 1 no double wall unit
 - Space under work top for fridge and dishwasher (with plumbing and waste to suit)
 - 1 no 800mm x 300mm x 1800mm cleaners cupboard*
 - no 1800mm x 900mm table*
 - 12 no stackable chairs*
 - 1 no 1800mm x 1200mm white board

- 1 no 1200mm x 900mm notice board
- 1 no large waste bin
- 1 no kettle
- 1 no toaster
- 1 no microwave oven
- 1 no under worktop fridge
- 20 no mugs
- 12 no large dinner plates
- 12 no small dinner plates
- 12 no bowls
- 12 no cutlery sets (knife, fork, spoon & teaspoon)
- 8 no coat hooks

(d) Shower

- Electric power shower
- 1400mm x 900mm stone resin shower tray with side panels and fixed screen to suit
- Shower area to be tiled or to have pre-finished surfaces
- 1 no 300mm x 300mm x 1900mm double door locker*
- 1 no 300mm x 900mm bench*
- 2 no towel hooks
- 1 no 450mm x 450mm mirror
- Shower mat

(e) WC

- 1 no electric hand dryer
- 1 no WC
- 1 no hand wash basin
- 1 no 450mm x 450mm mirror (above basin)

(f) Meeting Room

- 4 no four drawer filing cabinets*
- 1 no 900mm x 2200mm meeting table*
- 8 no chairs*
- 1 no 2400mm x 1200mm white board
- 1 no waste paper bin
- 1 no coat stand

(g) Disabled WC

- 1 no electric hand dryer
- 1 no WC
- 1 no hand wash basin
- 1 no 450mm x 450mm mirror (above basin)

(h) Changing/Locker Room

- 1 no electric hand dryer
- 2 no hand wash basins
- 2 no 450mm x 450mm mirrors (above each basin)
- 2 no 300mm x 900mm bench*
- 7 no 300mm x 300mm x 1800mm double door lockers*
- 1 waste bin

(i) Archive Room

- 3 no rows of 500mm deep heavy duty shelves to suit lever arch files on three walls (see plan).

7.2 Building frame and cladding

- 7.2.1 The minimum floor strength of each room shall Category B2 imposed loadings in accordance with NA to BS EN 1991-1-1, i.e. $q_k=3\text{kN/m}^2$ (UDL) and $Q_k=2.7\text{KN}$ (concentrated load).
- 7.2.2 The floor to finished ceiling height of each room shall be a minimum of 2.5m. The ceiling shall be part of the system building with suspended ceilings only be provided where required by the system
- 7.2.3 30mm x 30mm x 1.5mm heavy duty grade 304 stainless steel corner guards shall be fitted to all internal wall corners having a change in direction greater than 45° . These shall extend 1200mm above the top of the floor coving.
- 7.2.4 All rooms shall have low maintenance, double glazed, opening windows with Upvc frames fitted with vertical blinds. These shall be 'frosted' (obscure) or high level in both toilets and the changing/locker room. All glass shall be 'Stopsol' or similar reflective solar-control glazing.
- 7.2.5 All service connections shall be through the external walls:

INFORMATIVE: In order to maximise the benefits of utilising modular, factory fabricated building units the associated insitu site infrastructure shall be simplified wherever possible. For example service connections through the building walls rather than the floor will facilitate the construction of a less complicated concrete foundation system.

- 7.2.6 Earthing points shall be provided at each corner of the building(s). These shall comprise 10mm thick galvanised steel plate with 2 no 14mm diameter holes at 50mm centres (vertically).

7.3 Foundations and floor slabs

- 7.3.1 The building(s) shall be detailed to suit installation on concrete foundation pads whose upper surface is 50mm (nominal) above finished substation level.

7.4 Drainage

- 7.4.1 Refer to section 4.4 for general requirements for drainage.

7.5 Doors

- 7.5.1 External doors shall be rated 'Medium Security' certified to LPS 1175 level 2. All internal doors shall be softwood with name plates indicating the rooms function. All WC, Changing/Locker Room and Shower Room doors shall be lockable from the inside with an external override.

7.6 Building finishes

- 7.6.1 Floor finishes shall comprise heavy-duty, slip resistant sheet vinyl flooring with welded seams and coved skirting.
- 7.6.2 All internal walls shall be finished/lined.

7.7 Building services distribution

- 7.7.1 Refer to section 4.7 for general requirements for building services distribution.

7.8 Small Power

- 7.8.1 240 volt 13 amp power sockets shall be provided as follows;

- Entrance Lobby – One double wall socket
- Meeting Room – Three double sockets within dado trunking plus one double floor socket (under table)
- General Office – Two double wall sockets per desk (12 total) plus four additional double sockets all within dado trunking
- Mess Room – Three double wall sockets above work top plus two double wall sockets all within dado trunking. Two fused spurs to suit fridge and dishwasher locations.
- Archive Room – One double wall socket

7.8.2 Triple Compartment Dado trunking (i.e. desk level) for power and communication cables shall be fitted in the General Office, Meeting Room and Mess Room – see indicative layout.

7.9 Lighting

7.9.1 T5 Lighting shall be provided via ceiling surface mounted units and conduit. Lighting levels shall be 300 lux average, 200 lux minimum. Emergency lighting shall be provided in accordance with the Building Regulations.

7.10 Telephone points

7.10.1 Six Telecoms and six Ethernet sockets shall be provided in the General Office & Meeting Room.

7.11 Heating and ventilation

7.11.1 Thermal insulation shall comply with the Part L of the Building Regulations.

7.11.2 All rooms shall be fitted with devices to maintain the temperature between +18°C and +22°C assuming an outside temperature of between -10° and +30°

7.11.3 Mechanical ventilation systems shall be provided to the Shower Room, Changing/Locker Room, WC's, and Mess room in accordance with the relevant section of the Building Regulations, specifically Part F as appropriate.

7.12 Plumbing

7.12.1 Splash back tiling (white) shall be provided to sinks and wash basins.

7.12.2 The building shall have a domestic water services supply.

7.12.3 All WCs shall be dual flush type.

7.12.4 The Disabled WC shall be fully compliant with Part M of the Building Regulations.

7.13 Fire detection, alarm systems and extinguishers

7.13.1 A fire alarm system shall be fitted having detectors in the General Office, Meeting Room, Archive Room and Mess Room.

8 STORAGE & WORKSHOP UNITS

8.1 Building layout

8.1.1 Refer to Guide Drawing 8 contained in the Appendix.

8.1.2 Each unit shall be equipped as follows:

(a) Storage Unit

- Steel cage with 1m wide padlockable door for storage of portable earths;
- 'A' frame for Portable Primary Earths;
- Hooks for 'CAUTION' notices.

(b) Workshop Unit

- Work Bench with vice;
- Tool Cupboard (steel);
- COSHH cabinet (steel);
- 500mm deep shelving.

8.2 Building frame and cladding

8.2.1 Each unit shall comprise a modified 20' ISO standard steel shipping container – metric dimensions 6096mm x 2438mm x 2591mm. See appendices for details.

8.2.2 The units shall have a life to first maintenance of 20 years. All exposed external surfaces (i.e. the sides and roof) shall be finished with a high build paint system with the underside sealed (under cloaked) against corrosion. Unit colour to be determined on a site by site basis.

8.3 Foundations and floor

8.3.1 The containers shall be supported at each corner on discrete concrete supports a minimum of 150mm above finished substation level to allow ventilation beneath. A damp proof membrane shall be provided at each support point

8.4 Drainage

8.4.1 Refer to section 4.4 for general requirements for drainage.

8.5 Doors

8.5.1 Double leaf doors with minimum width of 2m shall be provided as shown.

8.5.2 A full width concrete ramp with brush finish shall be provided to all doors

8.6 Building finishes

8.6.1 The units shall be lined with 18mm plywood.

8.6.2 Floors shall be sealed and finished with a non-slip epoxy paint.

8.6.3 All internal surfaces shall be finished with a suitable paint – colour light grey (RAL 7035).

8.7 Building services distribution

8.7.1 All (internal) services shall be in surface mounted galvanised steel conduit.

8.8 Small Power

8.8.1 240 volt 13 amp double power sockets shall be supplied as follows;

- Storage Unit – 1 no adjacent to double doors
- Workshop Unit - 2 no above workbench

8.9 Lighting

8.9.1 Lighting shall be 300 lux Standard Service Illuminance with a Limiting Glare Index of 22.

INFORMATIVE: Lighting requirements are based on recommendations in CIBSE Lighting Guide LG1, The Industrial Environment

8.10 Telephone Points

8.10.1 No telephone points shall be provided in storage and workshop buildings.

8.11 Heating and Ventilation

8.11.1 High level vermin and insect proof ventilation grills shall be provided.

8.12 Plumbing

8.12.1 No plumbing is required in storage and workshop buildings.

8.13 Fire detection, alarm systems and extinguishers

8.13.1 Refer to the general requirements in Section 4.13 and TS 2.10.06.

9 EXTERNAL SITE FEATURES

9.1 Paths

- 9.1.1 Refer to TS 2.10.08 Roadworks and surfacing for general footpath and trolley access requirements.

9.2 Vehicle access and parking

- 9.2.1 Refer to TS 2.10.08 Roadworks and surfacing for general roadworks requirements. All vehicle accesses and hardstandings shall be designed for the relevant vehicle loadings.
- 9.2.2 At the switch hall, a 6m wide by 5m long external concrete hard standing for equipment off loading and handling shall be provided adjacent to the vehicular access door. There shall be a concrete ramp (nominal gradient 1 in 12) between the vehicular access door and concrete equipment off loading area. Bollards shall be installed adjacent to and either side of the ramp to protect the building from vehicular damage.
- 9.2.3 An access road shall be provided from the site main gate to the hard standing area adjacent to the vehicular access door, together with a suitably located parking area for 6 cars. These shall be surfaced in either bound bitumen macadam or concrete and designed to suit the worst case axle loads, spacing and frequencies noting that vehicles other than those directly associated with the switch hall building may use them (e.g. transformer transporters)

INFORMATIVE: It is assumed that during construction larger vehicles delivering equipment etc will use the adjacent unbound substation surfacing for turning and standing as necessary. Such areas shall be designed accordingly and clearly identified on site for this purpose.

9.3 SF6 Washdown Area

- 9.3.1 An outdoor SF6 washdown area is required where a permanent shower/drying room is not provided in the control building (refer to section 6) and shall comply with the following requirements.
- 9.3.2 The washdown area shall as a minimum, comprise a rectangular reinforced concrete slab having dimensions of 6m x 4m projecting 50mm above the surrounding finished substation level. The slab shall be laid to minimum falls for drainage purposes with surface water running off to the surrounding areas (unless the site topography and geology dictate a positive drainage system is necessary).
- 9.3.3 The washdown area shall be provided with electricity connections (in accordance with BS EN 60309-2:1999 – 'Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories') and water supplies as follows:
- 1 No 3 phase 32 A integrated isolator/socket including a neutral connection (IP 67 rating)
 - 1 No single phase 16A integrated isolator/socket (IP 67 rating)
 - 1 No insulated potable water supply with an outdoor tap.
- 9.3.4 A manhole chamber (minimum 'medium duty' in accordance with TS 2.10.05) shall be provided adjacent to the slab to accept waste water discharges from the mobile facility. This shall connect to a foul water sewerage system via a 100mm (minimum) outlet pipe incorporating a trap. Where the site is not connected to mains drainage a cesspool or similar storage unit may be used provided this is not specifically for the purpose of collecting SF6 waste (to be resolved).

PART 2 – REFERENCES, DEFINITIONS AND DOCUMENT HISTORY

10 REFERENCES

This specification makes reference to, or should be read in conjunction with, the following documents:

10.1 Her Majesty's Stationary Office

CDM 2015 Construction (Design and Management) Regulations 2015

CPR The Construction Products Regulation (EU) 305/2011

Building Regulations

Equality Act 2010

Health and Safety (Safety Signs and Signals) Regulations 1996

Town and Country Planning (General Permitted Development) Order

The Control of Substances Hazardous to Health (COSHH) Regulations

10.2 British Standards Institution

Note: The date of issue of the standards listed below is purposely omitted. This is to allow designers to use the version of the document which is current at the commencement of the project.

BS 476	Fire Tests on Building Materials and Structures
BS 5266-10:2008	Guide to the design and provision of emergency lighting to reduce the risks from hazards in the event of failure of the normal lighting supply
BS 5720	Code of practice for mechanical ventilation and air conditioning in buildings
BS 5839-1	Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises
BS 9999:2008	Code of practice for fire safety in the design, management and use of buildings
BS EN 54-20	Fire detection and fire alarm systems - Part 20: Aspirating smoke detectors
BS EN 1886	Ventilation for buildings. Air handling units. Mechanical performance.
BS EN 1990	Eurocode – basis of structural design (and UK National Annex)
BS EN 1991	Actions on structures (and UK National Annexes)
BS EN 1992	Design of concrete structures (and UK National Annexes)
BS EN 1993	Design of steel structures (and UK National Annexes)
BS EN 1994	Design of composite steel and concrete structures (and UK National Annexes)

BS EN 1995	Design of timber structures (and UK National Annexes)
BS EN 1996	Design of masonry structures (and UK National Annexes)
BS EN 1997	Geotechnical design (and UK National Annexes)
BS EN 1999	Design of aluminium structures (and UK National Annexes)
BS EN 50272	Safety requirements for secondary batteries and battery installations
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories

10.3 National Grid

TS 1	Ratings and General Requirements for Plant, Equipment, Apparatus and Services for the National Grid System and Connection Points to it
TS 2.01	Substations
TS 2.10	Generic Electricity Substation Design Manual for Civil, Structural and Building Engineering
TS 3.10	Generic Technical Specification for Civil, Structural and Building Engineering
TS 3.01.02	Earthing

10.4 Others

CP 3	Code of basic data for the design of buildings. Loading. Wind loads
HSG194	Thermal comfort in the workplace, Guidance for employers
LG1	CIBSE Lighting Guide LG1, The Industrial Environment

11 DEFINITIONS

Major Maintenance – Any work involving the wholesale or significant inspection, replacement, reapplication or repair of any of the component systems or parts necessary to maintain the function, integrity and design life of the asset in question. It is permissible for Major Maintenance activities to require electrical outages however these shall be minimised and shall be consistent, in duration and interval, with those required for the associated HV plant and equipment.

12 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
1	September 2014	Consolidation of information from DH18 into suite of TS 2.10.xx documents	Gibson Bhunu/Nick Tobin/Rob Everitt	Jon Fen
2	April 2017	Updates to TS 2.10.XX to comply with Eurocodes and General updates	Gibson Bhunu	EEPIG

13 IMPLEMENTATION

13.1 Audience Awareness

Audience	Purpose Compliance (C) / Awareness (A)	Notification Method Memo / letter / fax / email / team brief / other (specify)
Electricity Transmission Owner	A	e-mail
UK Construction	A	e-mail/Eurocodes Launch
Construction Delivery Units	C	Eurocodes Launch

13.2 Training Requirements

Training Needs N/A / Informal / Workshop / Formal Course	Training Target Date	Implementation Manager
Eurocodes Launch	25 May 2017	Phil Clements

13.3 Compliance

This document is essentially a reproduction of existing information previously available in DH18 400kV and 275kV Gas Insulated Switchgear (GIS) and Air Insulated Switchgear (AIS) Substation Buildings – Design Handbook. Consequently compliance is generally regarded as ongoing and retrospective application unnecessary in the main. Minor exceptions to this principle shall be incorporated into the works wherever possible and where not National Grid shall be advised via the appropriate project design management routes.

13.4 Procedure Review Date

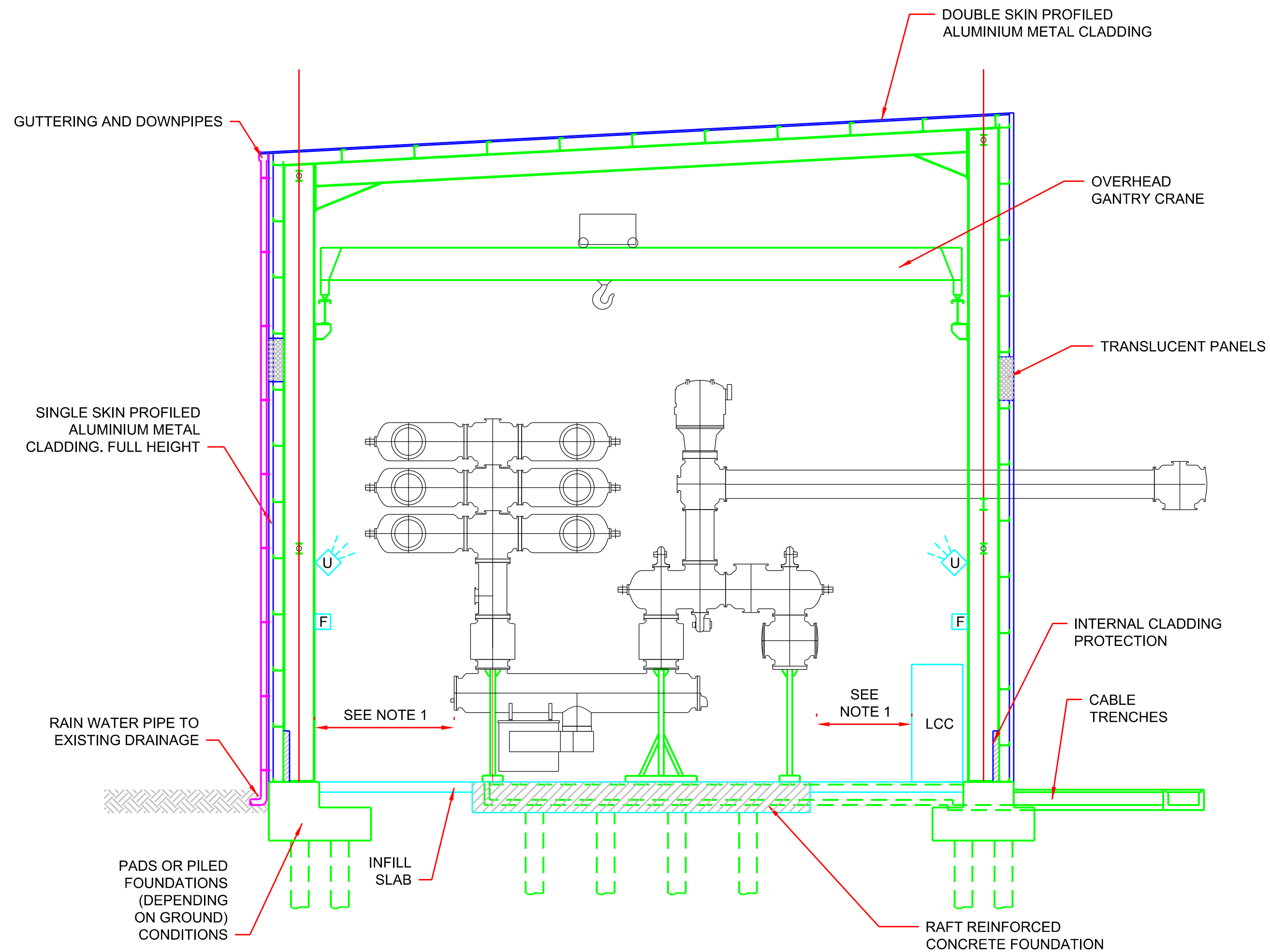
5 years from publication date.

PART 3 – GUIDANCE NOTE AND APPENDICES

TS 2.10.10 D1	Guide Drawing 1	Switch Hall Building Plan
TS 2.10.10 D2	Guide Drawing 2	Switch Hall Building Sections
TS 2.10.10 D3	Guide Drawing 3	Ancillary Plant Room Indicative Layouts
TS 2.10.10 D4	Guide Drawing 4	Ancillary Plant Room Indicative Layouts
TS 2.10.10 D5	Guide Drawing 5	Amenities Building (3 Unit)
TS 2.10.10 D6	Guide Drawing 6	Amenities Building (4 Unit)
TS 2.10.10 D7	Guide Drawing 7	Amenities Building (2 Unit)
TS 2.10.10 D8	Guide Drawing 8	Workshop and Storage Unit



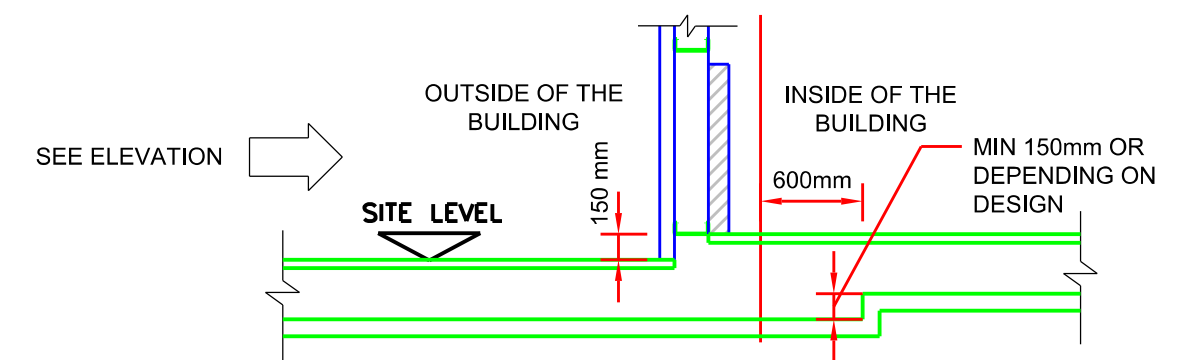
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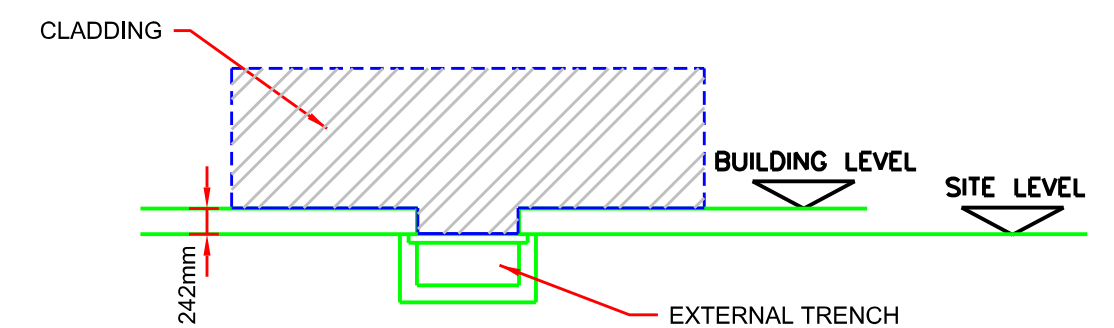
SWITCH HALL BUILDING : SECTION 1 – 1

SYMBOLS

-  UPLIGHT
-  FLUORESCENT LIGHT



TRENCHES : SECTION
2 – 2
(SEE NOTE 2)



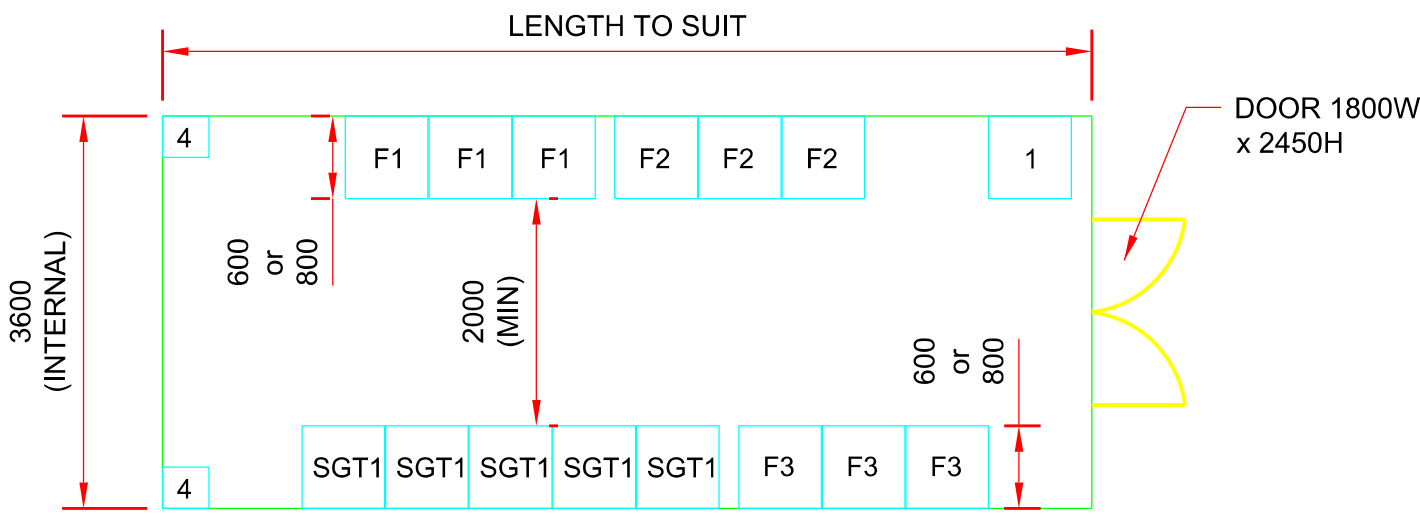
ELEVATION

NOTES

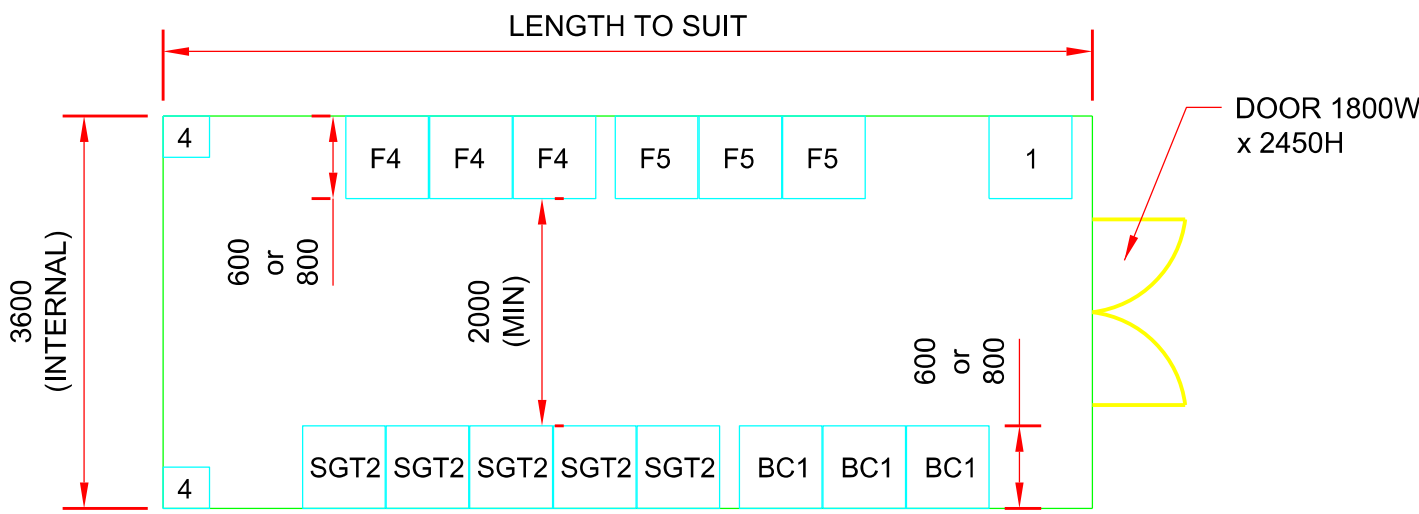
1. GAS CART ROUTE MINIMUM 1.60M WIDE (REFER TO TEXT).
2. BOTTOM OF THE CABLE TRENCHES INSIDE OF THE BUILDING TO BE ABOVE THE PERCHED WATER TABLE.

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					FIRST ISSUE				

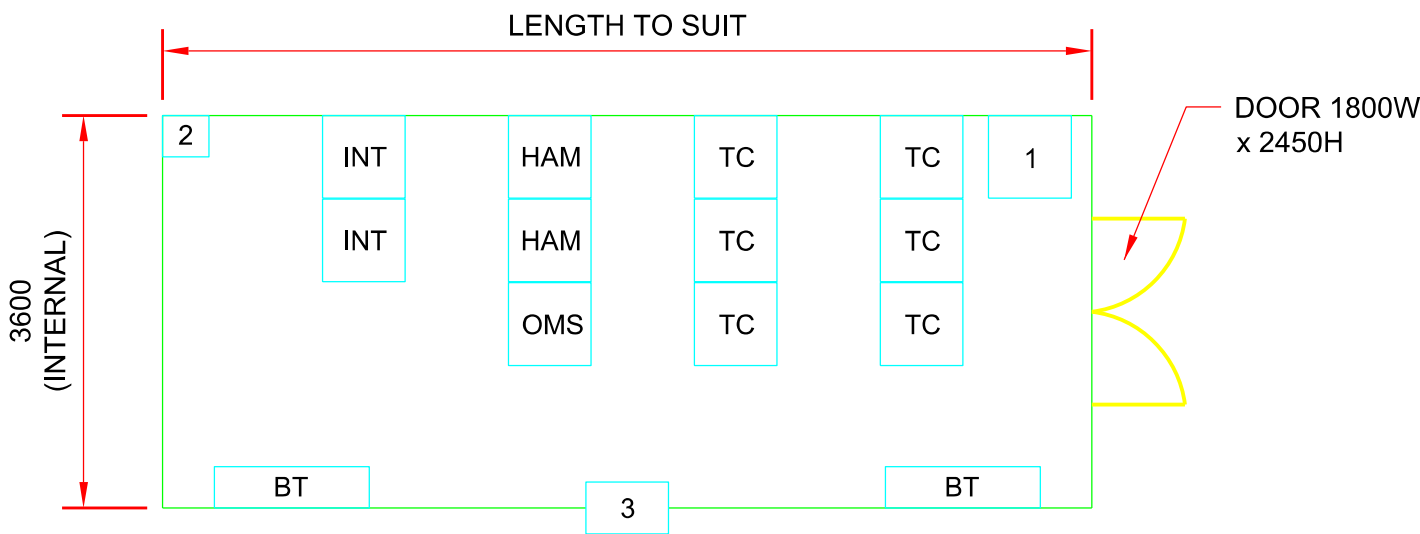
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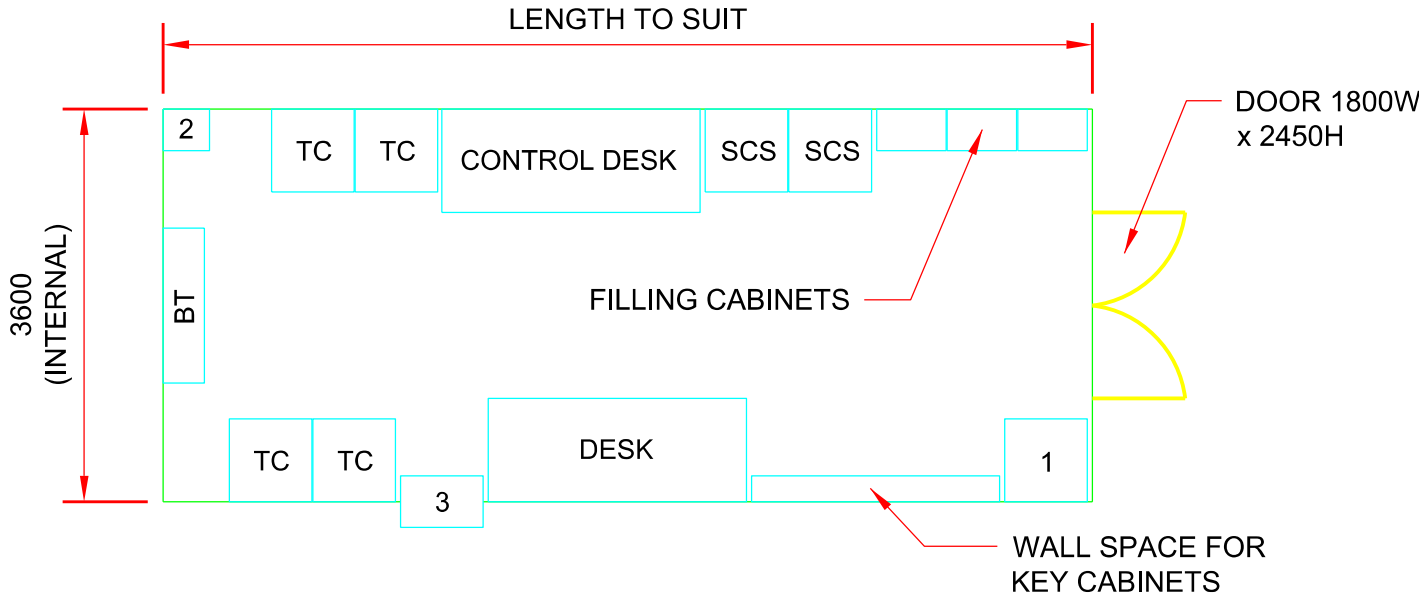
PROTECTION ROOM 1



PROTECTION ROOM 2



TELECOMMS ROOM



ALTERNATIVE OPTION FOR
COMBINED TELECOMM /
CONTROL / PERMIT ROOM

SYMBOLS (TYPICAL POSITIONS ONLY)

- 1 BUILDING SERVICES LV BOARD
- 2 FLOOR LEVEL CABLE ENTRY
- 3 AIR CONDITIONER MAYBE REQUIRED IN BUILDING
- 4 HIGH LEVEL CABLE ENTRY

ABBREVIATIONS

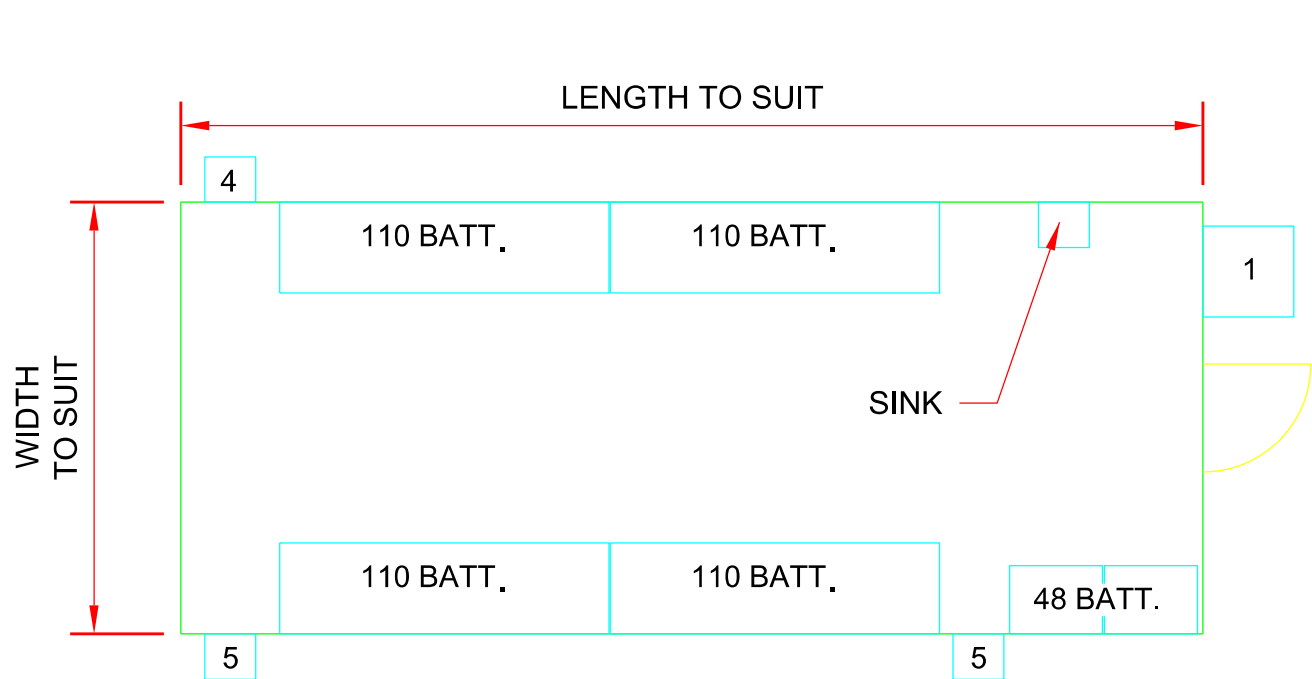
- BC BUS COUPLER
- BT BRITISH TELECOM POINT
- F FEEDER
- HAM HIGH ACCURACY METERING
- INT INTERTRIP PANEL
- OMS OPERATIONAL METERING SUMMATOR
- SCS SUBSTATION CONTROL SYSTEM
- SGT SUPER GRID TRANSFORMER
- TC TELECOMMS

NOTES

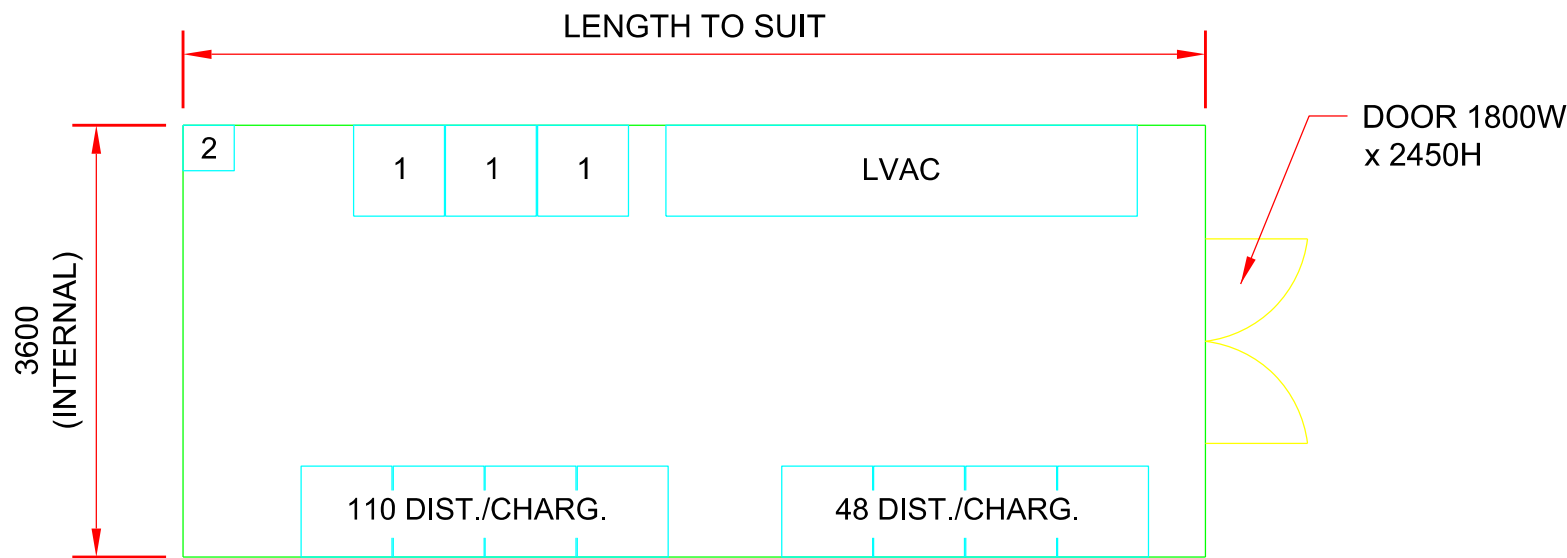
- ALL DIMENSIONS IN MILLIMETRES.
- DIMENSIONS ARE INDICATIVE ONLY AND ARE BASED ON GENERIC ASSUMPTIONS. REFERENCE SHALL BE MADE TO THE PROJECT SPECIFIC REQUIREMENTS TO INFORM FINAL BUILDING LAYOUTS AND SIZES.
- PROTECTION ROOMS 1 & 2 – 3.3m HIGH (INTERNAL). OTHER ROOMS – 3m HEIGHT (INTERNAL).

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BATTERY ROOM



LVAC / SUPPLIES
DISTRIBUTION ROOM

SYMBOLS (TYPICAL POSITIONS ONLY)

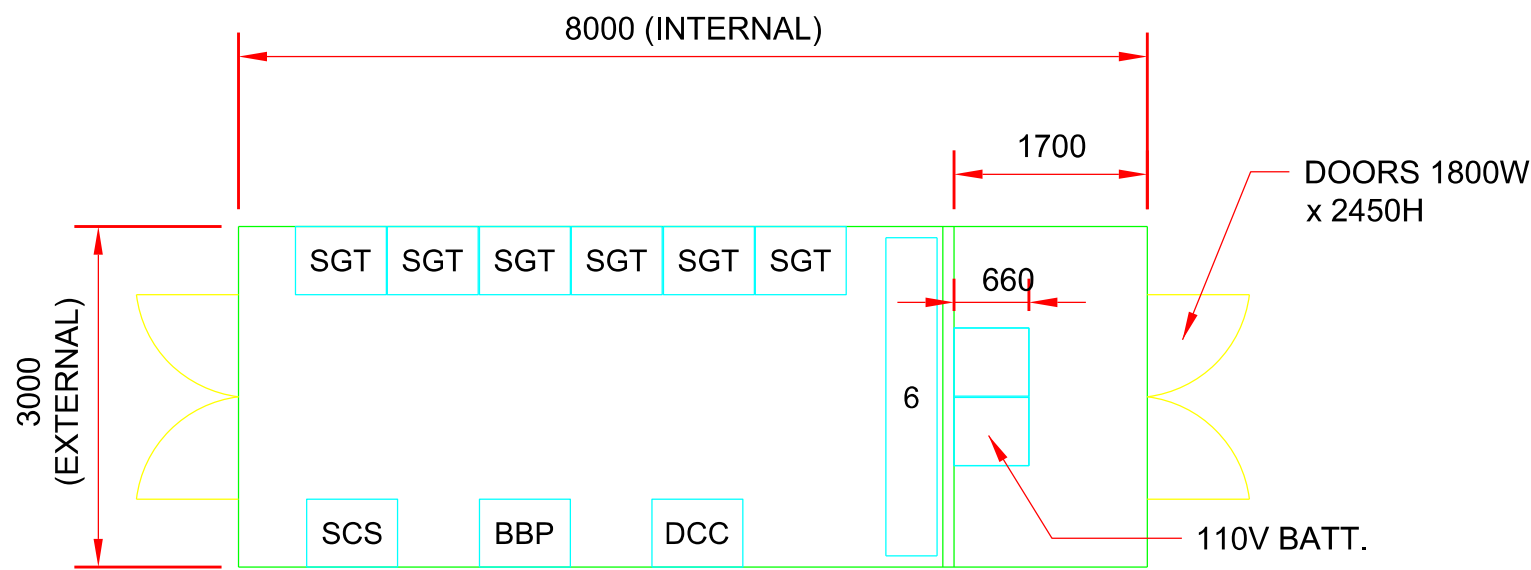
- 1 BUILDING SERVICES LV BOARD
- 2 FLOOR LEVEL CABLE ENTRY
- 3 AIR CONDITIONER MAYBE REQUIRED IN BUILDING
- 4 HIGH LEVEL CABLE ENTRY
- 5 FUSE BOX
- 6 CABLE GLANDING AREA

ABBREVIATIONS

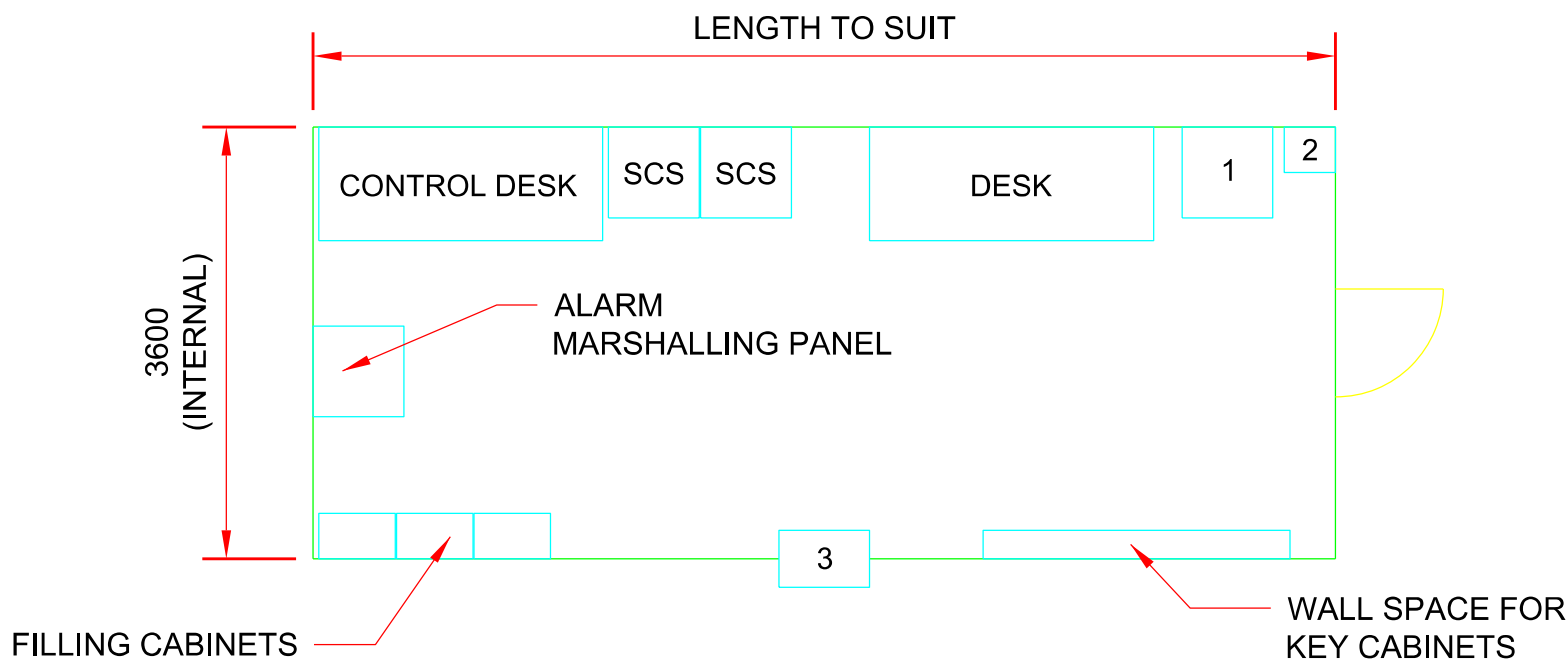
- BATT BATTERY
- BBP BUSBAR PROTECTION
- CHARG CHARGER
- DCC DIRECT CURRENT CHANGEOVER
- DIST DISTRIBUTION
- LVAC LOW VOLTAGE ALTERNATING CURRENT SWITCHBOARD
- SCS SUBSTATION CONTROL SYSTEM
- SGT SUPER GRID TRANSFORMER
- TC TELECOMMS

NOTES

- ALL DIMENSIONS IN MILLIMETRES.
- DIMENSIONS ARE INDICATIVE ONLY AND ARE BASED ON GENERIC ASSUMPTIONS. REFERENCE SHALL BE MADE TO THE PROJECT SPECIFIC REQUIREMENTS TO INFORM FINAL BUILDING LAYOUTS AND SIZES.
- ROOMS – 3m HEIGHT (INTERNAL).



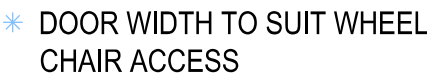
PORTABLE RELAY ROOM



CONTROL / PERMIT ROOM

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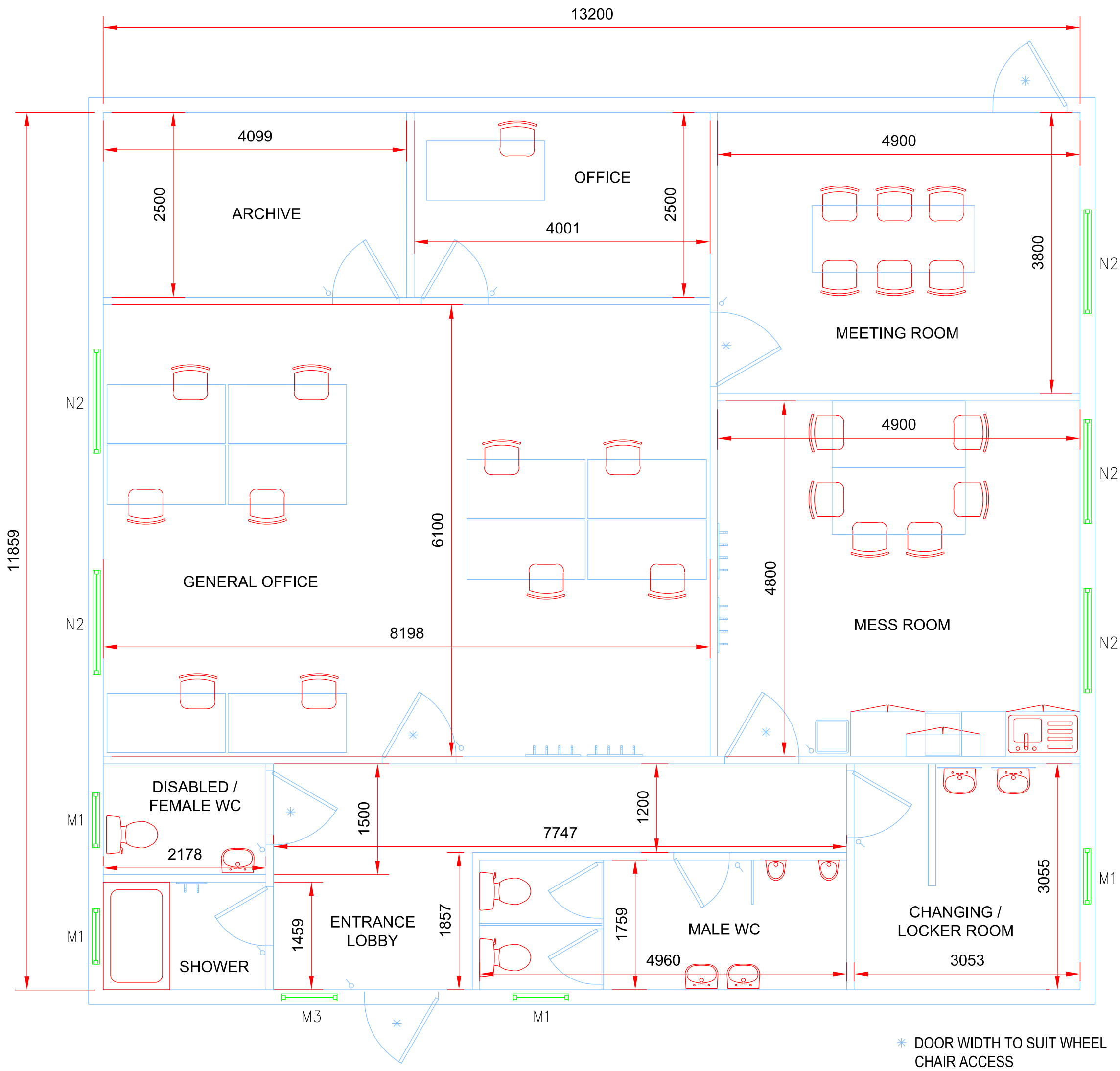
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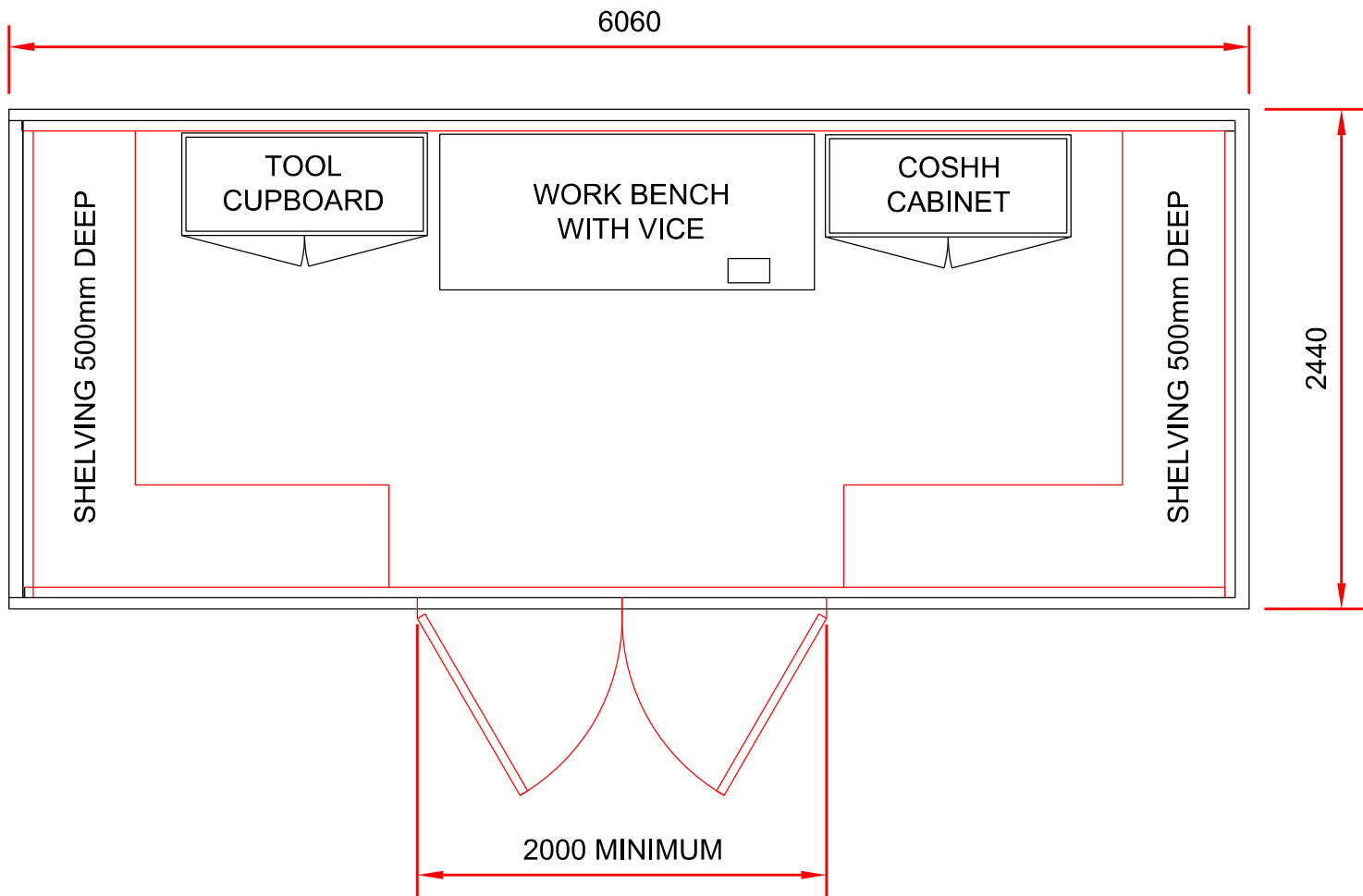
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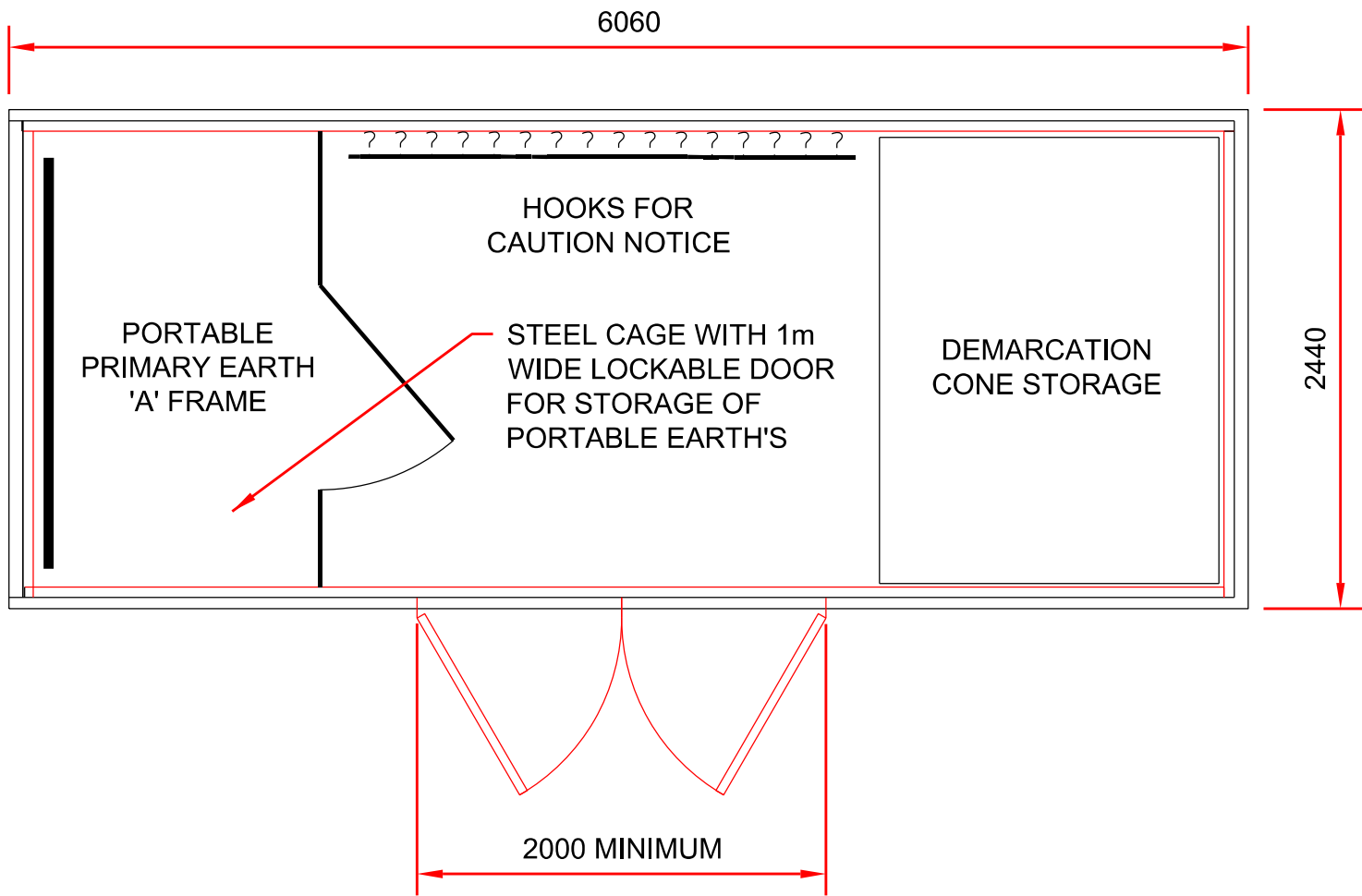


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WORKSHOP UNIT
N.T.S.



STORAGE UNIT
N.T.S.

NOTES

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