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Code of Practice 355

Issue 4 May 2024

Civil Designs Aspects of 132kV Substations

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 3 **September 2023**	New template applied only. Prepared by: Matthew Kayes Approved by: Policy Approval Panel and signed on its behalf by Paul Turner, PAP Chairperson
Issue 4 **May 2024**	Revision to Section 3.1.5: Reference to CP998 added. Revision to Section 3.2: Remove reference to detailed drawings. Revision of Section 3.1.3: New section for Embodied Carbon Revision to Section 4.1: Change title to Land Rights and Consents Revision to Section 4.3: Type of fence clarified. Revision to Section 5.1: Reference to EPD307 omitted. Revision to Section 5.2: Addition of pressure relief vents Revision to Section 5.8: Reference to ES366 Revision to Section 6.1: Oil Containment, risk-based approach. Revision to Section 7: Reference to ES400D5 Duct Seal Revision to Section 8: Fire Control. Revision to Section 8.3: Fire Extinguishers Revision to Section 8.4: Addition of Code of Practice Revision to Section 9.1: Addition of Code of Practice Revision to Section 9.4: Addition of Engineering Standard Revision to Section 9.5: Addition of Code of Practice Revision to Section 12: Reference to CP351 Revision to Section 13.2: Addition of Engineering Standard Revision to Section 13.2.4 Revision to shower room Revision to Section 14: Amended references. Revision to Appendix A. Updated civil drawing. Prepared by: Kelvin Smith Approved by: Policy Approval Panel and signed on its behalf by Paul Turner, PAP Chairperson

Contents

1 Scope

This Code of Practice 355 covers the civil design aspects of 132kV substations in Electricity North West Limited. The document takes account of the requirements of the Electricity Safety, Quality and Continuity Regulations 2002

This Code of Practice is intended to convey the principles of the civil design criteria for incorporation in: -

(a) 132kV Open Terminal Substations

(b) 132kV Gas Insulated Substations (GIS)

The civil design aspects of Primary substations are covered separately in CP351.

2 Introduction

This Code of Practice is intended to convey the principles of the civil design criteria for incorporation in all primary substations.

A general arrangement drawing of a generic substation is appended in Appendix A to provide guidance to the preferred design when site conditions and electrical requirements permit.

It is not intended that this Code of Practice shall be retrospective in action but lays down an acceptable standard which shall be considered during any future replacement and refurbishment work.

Each construction project is specific: sometimes the work involves construction upon an operational site containing live equipment, with all the difficulties the site-specific operational requirements impose upon the construction process and sequence of work activities.

The designer shall always have due regard to simple value for money design objectives, constructing a substation that meets all current safety legislation and legal requirements, which is functional and fit for purpose with maximum security. In addition, action shall be taken regarding the impact upon third parties both environmentally and aesthetically. The completed design shall result in a building that:

(a) Meets the operational programme, with the appropriate impact upon the (complex) electrical network.

(b) Is low maintenance and has optimum lifespan.

(c) Meets the requirements “of "buildability", i.e., is easy to construct.

3 Substation Design

3.1 Design Criteria

From the Standards and Codes of Practices enforced upon the designer, the following design criteria shall be adopted:

3.1.1 Function

The primary function of a substation is to provide electricity to the local community in a safe, cost effective and environmentally friendly manner.

3.1.2 Environment

The substation shall provide a safe, clean, secure, and user-friendly environment for operatives and equipment.

Frequently, the substation will be sited adjacent to residential areas and must therefore be designed to minimise the effect on the visual and auditory amenity of the area, giving due consideration to legislation laid down by the Local Planning Authority. (eg Sound insulation etc).

3.1.3 Embodied Carbon

Designers should consider reducing the Embodied Carbon footprint on all projects, whilst considering all other factors of a suitable design, as outlined in this document. A calculation will be undertaken to assess the Embodied Carbon levels for all designs, in accordance with industry best practise and the RICS Professional Statement. The embodied carbon total for each design, should be expressed in terms of total kgCO2e. This is intended to assist with whole life carbon assessments and enhance consistency in outputs, in accordance with the guidance and methodology stipulated by EN 15978.

3.1.4 Legality

The substation design shall take full account of current legislation, including Health and Safety, Electricity Safety, Quality and Continuity Regulations, British Standards, Building Regulations, and accepted Codes of Practice currently in force.

3.1.5 Security

Site security is also imperative, to safeguard the building and its equipment from danger, theft and vandalism, and also to safeguard against unauthorised access to high voltage equipment. For further guidance and security standards please refer to CP998 - Substation Security.

3.1.6 Site Restrictions

Where a substation is to be built within an existing operational site, due consideration shall be given to the potential hazards and risks associated with working on and around live operational equipment.

3.1.7 Life Span and Maintenance

A well-designed, good-quality value-for-money building, built in easily available, cost effective and environmentally sustainable safe materials will minimise the impact of COSHH requirements, help to minimise future maintenance requirements and ultimately optimise the life span of the building and its equipment (i.e., lifespan of building to match equipment - approximately 60 years).

3.1.8 Buildability & Programme

Where possible, the building design and materials used shall also take account of possible future expansion and upgrading of equipment. Considerable savings in the future will offset any additional costs associated with this forward planning.

3.1.9 Design

Whilst the design aspect should be done in accordance with the National Building Specification a design brief shall be issued detailing material, local authority and any third-party requirements for each substation.

3.1.10 Flood Protection

Where a proposed substation site is situated in a flood plain, the policy requirements of EPD355 shall be applied.

3.2 Current Design

The drawings, within Appendix A, indicate typical layouts, elevations, and sections for a generic substation:

(a)	900190-00194	Typical 132kV Circuit
(b)	900190-00195	Typical 132kV Substation Alternative Arrangement
(c)	900190-00196	Typical 33kV Switch House Concrete G.A
(d)	900190-00197	Typical 33kV Switch House Architectural G.A
(e)	900190-00198	Typical Containerised Switch House Architectural G.A

In addition, a comprehensive specification is available) ES366 – Electrical Installations within Grid and Primary Substations.

Generally, the works comprise the combination of switch room and control room with a transformer bay(s) and security fencing. An access road, together with paved footpaths to pedestrian circulation areas and a general finish of limestone chippings externally. The design provides for small bore foul and surface water drainage, electrical and plumbing services.

The design in this example is not fixed but is an already proven low-cost standard solution. However, each project must be critically assessed to ensure the design is suitable and if necessary alternative construction techniques adopted (refer to Section 13).

The following sections provide an insight into the key elements of construction issues and parameters for consideration when designing a substation.

4 External Works of 132kV Substations (Open Terminal and GIS)

4.1 Site

A substation site shall satisfy the following requirements:

(a) Provide sufficient space for the ultimate envisaged number, size and layout of plant and buildings.

(b) Provide adequate access for the largest indivisible loads envisaged, and adequate and safe personnel access and exit.

(c) Provide adequate space for the maximum envisaged number and size of overhead line and underground cable entries. Easements shall be negotiated via the Land Rights and Consents section.

(d) Shall be capable of complying with the detailed planning requirements of the Local Authority, including amenity aspects. At the same time, it shall not be so large, beyond the substation requirements, as to require expensive treatment of the unused portion of the land.

(e) Consideration shall be given to the environmental impact of developing each particular site.

4.2 Roadways

Construction shall be made to allow access for:

(a) Delivery, offloading and maintenance of transformers and switchgear should be taken into account when designing the layout of a substation. Co-ordination with haulage companies delivering transformers is recommended.

(b) Parking and turn around areas to be included for site staff vehicles.

The turning requirements for articulated vehicles shall be allowed for within the design. Co-ordination with haulage companies delivering transformers is recommended.

4.3 Fencing

4.3.1 Application

Wherever possible the site shall be surrounded by fencing which presents a clear view of the enclosed space as a deterrent to unauthorised interference.

Where high voltage conductors are exposed in a substation, a security fence constructed to specification BS 1722, shall be installed.

Where a distribution substation is on the same site and is within the main security fence no additional security is required but fencing for demarcation purposes shall be installed.

Consideration shall be given to the use of removable panels in place of gates where access is only required for transit of fixed plant.

NOTE: Where a distribution substation is required, the first option will be to provide a separate entrance so that access to the 132/33kV parts of the site is not given.

4.3.2 Amenity Fencing

Fencing provided to meet covenants or planning authorities' requirements shall:

(a) Be the minimum standard to meet those requirements, having due regard to maintenance costs,

(b) Provide minimum screening effects to discourage unauthorised interference, combined with reasonable resistance to vandalism. (Graffiti proof surfaces are preferable.)

In view of the varying requirements of planning authorities and the desirability of avoiding a clash of appearance with the surrounds no standard is set.

4.3.3 Security Fencing

The minimum acceptable specification shall be based on risk assessments of the proposed site in conjunction with CP998. Usually two alternatives are considered:

(a) Palisade security fencing.

(b) Weldmesh single skin 358 mesh.

Each site shall receive its own risk assessment during design to ascertain appropriate security fencing. This risk assessment shall be carried out in accordance with Appendix A of EPD301.

4.3.4 Gates

Entrance gates shall match the fencing.

Consideration shall be given to the location of access and vision splays in accordance with Local Authority recommendations.

Gates to transformer compounds shall be positioned to provide convenient access for carrying out maintenance work, e.g. access for scaffolds, special tools, oil equipment etc.

4.3.5 Earthing

Fencing shall be earthed in accordance with the requirements of the documentation referred to in Section 12 of this Code of Practice.

4.4 Drainage

(See also Section 7 regarding oil containment.)

Each substation site shall be considered on its own merits.

The selected site shall be thoroughly investigated to ascertain presence or absence of drains.

Where drains already exist, every effort shall be made to utilise them.

A system of land drainage may be installed adjacent to the building at an invert level below cable entry level and connected into the existing surface water drainage system.

In the absence of any form of accessible mains drainage the following courses shall be adopted:

(a) Surface water shall be collected into its own system and directed into a soakaway as far removed from buildings and structures, as the site will allow.

(b) Foul drainage shall be direct into a septic tank.

Where a site has a history of, or the potential for flooding, steps shall be taken to provide a system of land drainage. This drainage shall be gathered into a series of catch pits located within a French drain constructed on the perimeter of the site. The outfall from this drain shall be connected to either an existing surface water drainage system or a soakaway/convenient drainage ditch.

4.5 Transformer

The net transport weight of transformers can typically be up to 60t. To cater for this load haulage vehicles of the articulated type up to 17.7m long are used, and access roads shall be constructed accordingly. Co-ordination with the haulage companies is recommended. For each specific site, a check should be made on the likely weight of transformer to be installed both initially and on any foreseeable future occasion.

Care shall be taken to ensure that the position of any overhead equipment near or over the access road does not impede the passage of the loaded haulage vehicle and that safety clearances are maintained.

Consideration shall be made within the design to ensure plant and equipment can be installed in a safe and satisfactory manner. The designer is advised to seek advice from the plant manufacturer and installation company.

Transformer plinths shall preferably be sited alongside a road or temporary hardstanding. Where this is not possible the use of a crane shall be considered. If this is not practical it may be necessary to provide permanent concrete skidways of sufficient bearing ability to carry the transformer in transit from the road to its plinth.

4.6 Cable Trenches, Ducts, etc.

All cable trenches, ducts etc required for power and auxiliary cabling shall be provided. Cables shall generally be laid in concrete cable trenches or agreed GRP mouldings, although cables may be laid direct in some parts of the site. The trenches shall be sized to accommodate the cables required by the contract, with an allowance for those anticipated for future works.

Where required, the cable trenches shall have covers capable of withstanding a 2.0t wheel load and incorporating hand holds or lifting eyes every five covers. Where cable trenches cross roads, heavy duty covers capable of withstanding an 11.5t wheel load shall be used. The trenches shall be drained to the surface water drainage system.

Ducts and drawpits for telecommunication cables shall be provided. Termination pits shall be provided adjacent to the buildings as necessary.

Ducts shall be provided wherever directly buried cable would pass underneath hard surfaces. Wherever a duct is required an additional duct of the same specification shall be provided for future use. The positions of ducts shall be accurately recorded and marked on site.

4.7 Switchgear

Delivery of switchgear may require off-loading, pulling and landing platforms at the building entrance. Co-ordination with the electrical engineer to ascertain actual requirements is recommended.

4.8 Combined Services

Due to the extent of services located within a site, e.g. drainage, cables, earthmat, building services, multicores etc, it is imperative that the setting out of all underground services is co-ordinated and recorded as installed.

Where possible, services shall be routed away from areas that may be used for heavy equipment during the construction phase. If this is not possible suitable protection shall be provided.

4.9 Fixed Access Ladders and Facilities for Working at Height

Although fixed access ladders have been provided in 132kV substations in the past, any future open terminal sites shall not be provided with this feature. The need to work at height should be eliminated at the design stage, where this is possible.

Existing open terminal sites with fixed access ladders shall have them removed at the earliest opportunity, as they are operationally difficult to inspect and maintain and many are in poor condition.

Future access to equipment, where required, will be by scaffold, GRP platforms or mechanical platforms as appropriate, taking due cognisance of safe working procedures.

5 Aluminium and Steel Support Structures

5.1 Design

The structures shall be delivered to site complete with all pre-drilled holes for fixing of earth tapes, cables and all other relevant attachments. In addition, where required, they shall be supplied with suitable drain holes. Site drilling after erection shall not be permitted.

Structures shall be suitable for bonding of electrical equipment to an earth mat and evidence shall be provided which demonstrates that the structure is capable of withstanding the rated short time current. Where practicable, bolted structures shall be avoided.

5.2 Serviceability

When considering the serviceability of the supporting structures, it shall be ascertained that deflections are appropriate for the proper function of the structure and for the plant and equipment supported by the structure.

5.3 Finishes

The finishes applied to structural steelwork elements shall have a uniform appearance and shall be appropriate for the level of corrosion protection for the required 40-year design life of the substation. Enhanced coatings may be required for sites in coastal locations.

The holes drilled in the structure to accommodate the galvanising process shall be fitted with suitable plugs.

6 Equipment Containing Oil

6.1 Oil Containment

6.1.1 Scope

The Control of Pollution (Oil Storage) England Regulations 2001 states that: “It is an offence to cause or knowingly permit the discharge of poisonous, noxious or polluting matter into relevant waters or into any underground strata.”

Energy Networks Association Engineering Recommendation S39 states that all primary and supply point transformers shall be bunded.

Bearing in mind the statutory requirements, this section lays down the practical steps which shall be taken.

6.2 Principles of Oil Containment

An assessment of oil containment shall be made of all oil filled equipment, including the decommissioning of existing and delivery of new, particularly if there is the risk of oil leakage into the ground or added protection is needed for local water courses.

The principle is that all plant containing oil with a volume in excess of 250 litres be contained within a completely bunded area where practically possible.

6.3 Measures for Containment of Oil

A continuous bund wall shall surround the majority of oil filled equipment, even where this is not required for the prevention of spread of fire. The area within the bund wall shall be sealed by means of an impervious base set at such a depth as to provide a free volume - allowing for any chippings - equal to the capacity of the largest tank – including any oil coolers – envisaged at this position minus 15% absorption into the limestone chippings. The limestone chippings to be used shall be 10/20mm grading. Entries shall be ducted from a point outside the bunded area to a point inside it; the ducts shall be cast into the walls of the bunded area, and all ducts shall be sealed (see ES400 D5 - "Duct Seal"). Where a transformer is in a noise enclosure and the turrets and bushings pierce the enclosure roof, the roof drainage shall discharge inside the bunded area. **Oil bunds adjacent to environmentally sensitive areas such as Sites of Special Scientific Interests, and watercourses shall be individually assessed.**

6.4 Drainage

Bunded areas shall drain to a sump provided within the bunded area. The sump shall be provided with automatic pumping with a control that differentiates between oil and water.

7 Prevention of Gas Accumulation

All sites shall be assessed prior to construction for gases. All cable ducts shall be sealed in accordance with ES400D5. Ducts entering buildings below ground must be made discontinuous immediately outside and large openings may be reduced to a more convenient size with properly mortared brickwork and then sealed with the approved sealing kit.

In special high-risk situations where the site is adjacent to a landfill site or ground where methane gas is present, additional guidance shall be obtained.

Where a risk is known to exist and ventilation is restricted, a gas detection system shall be considered.

Where underground chambers allow entry of personnel, consideration shall be given to the installation of a permanent gas alarm.

7.1 Equipment containing Potentially Harmful Gas

When equipment is installed containing potentially harmful gases (eg Fluorinated Gases), consideration shall be given to the installation of leakage monitoring and alarm systems.

8 Fire Control

This section details some of the design points to be considered to control the effects of fire. Each site, however, is to receive its own fire risk assessment in accordance with CP357 during design to ascertain appropriate measures, bearing in mind that the new substation may be located within a third-party site.

8.1 Segregation of Plant

8.1.1 Transformers

ENA Engineering Recommendation S39 gives guidance on separation distances and barriers. Where the distance defined in this document between the transformer and other essential equipment or buildings cannot be achieved, a fire separation barrier shall be constructed.

Each site shall be assessed to determine the extent of works required regarding fire separation.

The height of a fire separation wall shall be at least equal to the height of the transformer tank.

Where a transformer is in a noise enclosure, the enclosure walls and roof shall have a minimum fire resistance of 1 hour.

Firewall construction can vary depending on specific requirements from:

(a) Brick.

(b) Cladding.

(c) Concrete.

8.1.2 Switchgear

Indoor switchgear does not contain oil or compound filled cable boxes. Segregation by walls are not required. Outdoor switchgear shall comply with 8.1.1 above regarding clearance from transformers.

It may be advantageous to allow for the installation of temporary barriers to provide protection between sections when an Operational Instruction is imposed. This could be in the form of brackets, hooks, etc. set into walls and roofs to allow for the easy and quick installation of a temporary screen.

8.2 Escape from Fire; Provision of Doors

8.2.1 Door Types

Switch room and control room doors shall be of three-hour fire resistance and open outwards to assist escape.

Doors opening to a public footway should be avoided but where essential the approval of the local authority must be obtained.

On the inside of the buildings the panic door shall be painted green
BS 4800: 1989 colour ref 14.E.53 to contrast with the walls and be fitted with panic exit furniture, PUSH labels and overhead door stays.

It shall be possible to open these doors from outside the hazard chamber for rescue purposes.

8.2.2 Provision of Doors

8.2.2.1 Combined Switch Room and Control Room

A minimum of 2 doors to open air shall be provided at opposite ends of the building to allow emergency egress. For switchrooms over 20m in length there shall be 3No doors.

8.2.2.2 Access to Outdoor Compounds

Access to compounds shall be by independent gates through compound fencing.

8.2.2.3 Toilets

These should preferably have an external door not requiring transit of the substation.

8.2.2.4 Transformer Housings (enclosed spaces)

(a) These shall be treated as hazard chambers with a minimum of two exits required at diagonally opposite corners.

(b) On the inside of the housings the panic door shall be painted green BS 4800:1989 colour ref 14.E.53 to contrast with the walls and be fitted with panic exit furniture, PUSH labels and overhead door stays.

8.3 Fire Extinguishers

8.3.1 Portable Extinguishers

Portable extinguishers will not be provided in substations.

Fixed fire suppression systems shall only be installed at the request of a third party. In order to ascertain the correct gas to be used, reference shall be made to current legislation and to the Head of Policy & Standards

8.4 Hazard from Confined Spaces

Hazards due to confined spaces within cable tunnels, shafts, basements, or trenches shall be assessed. If such hazards may occur then guidance shall be sought and, where there is doubt, treated as confined spaces and reference made to CP905 for access and emergency procedures etc.

8.5 Fire Hydrants

When considering the risk of fire, the local fire officer shall be consulted for advice on the availability of local fire hydrants.

9 Security

9.1 General

This section details some of the design points to be considered to prevent unauthorised access. However, each site shall receive its own specific security risk assessment during the design stage to ascertain appropriate security. Reference shall be made to EPD301 and CP998 when assessing the security classification.

9.2 Fences

All 132kV sites are to have perimeter fencing and entrance gates of Electrified Palisade with single skin weldmesh 358, minimum of 2.4m high.

All bolts shall be secured to prevent unauthorised removal.

Gaps at bottom of fences, between sections, between fences and gates, or between fences and buildings shall not exceed 75mm.

If burrowing under fences is possible, additional measures shall be applied as specified in Section 6 of BS1722-12.

Stays, braces, locks, bolts, notices, or any other fittings shall not provide a foothold. If necessary, an extra pale shall be fitted.

Hinges shall be of a type that does not allow gates to be lifted off.

Gate bolts shall shoot through a post (or mating leaf of a double gate) for padlocking without relying on a drop bolt.

Where possible there shall be a clear space outside the fence of 2m, i.e. no trees, bushes, mounds, or any other aid to surmounting the fence. Allowance shall be made for growth of trees. Rising ground outside the fence shall be cut back 1.5m and then sloped. No lower fences or walls shall be allowed to directly meet the security fence without a graduated height section paled both sides.

No plant shall be positioned within 3.0m of a fence or boundary wall.

9.3 Buildings

Outward opening doors with hasp, staple and padlock give greater security and shall be specified.

- Emergency doors with locks operating on top and bottom shoot bolts give greater security (by not relying on accurate mating of the two leaves which may be affected by shrinkage).
- For security, all doors to have three-hour fire resistance.

It may be necessary to reinforce the inside of doors near locks to prevent forcing by a jemmy.

Downpipes shall be covered or provided with anti-climbing guards, especially so if live conductors are above or near the roof, or the building is in the run of security fence. Downpipes shall not be positioned near the point where a security fence meets a building.

Ventilators, if fitted, shall be robust and shall be baffled internally.

Dehumidifier ducts should preferably terminate inside the security fence. If not, they shall be securely cowled, and mesh screened.

Projecting courses of brickwork must not be provided.

Windows must not be provided.

Roof lights must not be provided.

9.4 Locks on Access

Reference shall be made to CP606 Procedure S.16 regarding padlocking of switchgear and transformers. Substation doors and gates shall be locked in accordance with EPD603 & ES309 Locks for Substations.

(a) Profile cylinder type external to panic bolts or

(b) Shouldered cylinder type padlocks

The normal access door shall be provided with means of securing from the inside to ensure security while work is in progress out of sight of the door. Such restraint shall not impede the emergency exit if the door forms part of an escape route.

9.5 Security Alarm

Security alarms shall be fitted to all property entry points including perimeter gates.

Traffic light system to be installed where visible from entry gate to ensure electric fence de activation prior to entry. Keypads to be located adjacent to main entry gate and main entry door of substation.

The security alarm shall be designed and installed to prevailing British and Industry Standards. (The building entrances only shall be protected.) The security alarm shall be installed by a member of NACOSS or SAIB (Security Alarms Inspection Board) and shall be registered on the list of the local police force. This is to ensure that the police will respond to the alarm.

Security alarms must be connected to telecontrol.

9.6 Notices and Nameplates

The following table (Table 2) gives details on the type and position of notices and nameplates that are required at 132kV substations.

Table 2 – Notices and Nameplates

Security Classification (see EPD301)	Site with Security Fencing and Exposed Conductors		Site with Security Fencing but no Exposed Conductors	
	Statutory	Other	Statutory	Other
1	A1 and B	A2 and C*	A1 and B	A2
2	A1 and B	A2 and C*	A1 and B	A2

3	A1 and B	A2	A1 and B	A2
4	A1 and B	A2	A1 and B	A2

A1 Property plate adjacent to principal access (ES356 - Table 2, Item 1)

A2 Property plate adjacent to other access points and/or points of approach (ES356 - Table 2, Item 1)

B Safety sign "Danger of Death - Keep Out" to be placed so that notice is clearly visible from any position outside the perimeter fence (ES356 - Table 2, Item 2)

C Safety sign "Danger of Death - Keep Off" to be placed on equipment (ES356 - Table 2, Item 15)

* It may be more appropriate to use adhesive notices on equipment.

The signs when fitted shall not act as an aid to climbing.

10 Noise

10.1 Introduction

All transformers generate noise, the principal component being a continuous tone of 100Hz. Other sources of noise are forced cooling fans. Where these fans are designed to run only on the loss of one transformer it is accepted that there may be some nuisance during emergency conditions.

The more irritating rattles due to loose nameplates, loose valve locking pins, tap changes, etc should be easily eliminated.

Noise can only be airborne, but it must be remembered that ground-borne vibrations may be re-radiated as noise by some other structure.

It is current practice to design substations without noise reducing housings for electrical plant.

Each site shall be designed using equipment to Electricity North West Limited specifications. Where required, assessment of noise levels to be expected at the site boundary shall be calculated. Where required by Local Authority planning assessment at other positions shall also be calculated. If further noise control is required, as specified by the Local Authority, provision shall be made for a noise reducing housing for the transformer.

Each site shall be assessed for noise pollution, and it shall be agreed with the Project Engineer and, where applicable, the Local Authority as to whether provision for a transformer housing is required.

10.2 Vibration

It is a standard requirement to fit anti-vibration pads to new transformers.

10.3 Noise Reduced Housings

Transformers are purchased with low noise signatures and only in exceptional situations should it be necessary to provide a noise reducing housing.

If a noise reducing housing is required, consideration shall be made to its construction. Typical construction method is either traditional built brickwork or a proprietary prefabricated acoustic enclosure.

Consideration shall be given for the possibility of a future transformer housing within the design if deemed necessary.

11 Earthing

For the design, installation, testing and maintenance of earthing systems in 132kV substations, reference shall be made to the following documents:

- EPD333 - Supply System Earthing
- CP335 - Earthing Design for 11kV, 33kV and 132kV Grid and Primary Substations and Equipment

12 33kV Switch House and Associated Buildings within 132kV Site

12.1 General

It is imperative that, before the plant and building layout is finally approved as a basis for detailed design work, agreement has been reached between the Electrical Design Section on plant layouts, cable routes and overhead line supports inside the substation, and the Civil Design Section on access roads, foundations, and structures. See CP351, Civil design aspects of Primary Substations.

Where the switchgear requires a substantial cable basement, consideration shall be given to a two-storey structure to minimise the problems of sealing underground chambers against the ingress of moisture and gas.

The building volume shall be large enough to satisfy the requirements for internal arc relief. The designer is advised to seek advice from the plant manufacturer for the specific type of switchgear to be installed.

12.2 Walls

The general structures are normally brick/block cavity walls with Approved rigid cavity insulation built in during construction, but other approved construction techniques can be considered. The design shall provide a robust barrier to withstand a disruptive failure from operational equipment, additional through wall vents will be required for flat roofed substations.

All internal walls must be suitable of supporting equipment up to a maximum weight of 100kg.

12.3 Roofs

The roof shall be of lightweight construction laid to a single cross fall with overhanging eaves to shed rainwater clear of the building. Gutters and drainpipes shall be provided and protected with an anti-climb guard.

A duo pitched roof may be used where the transformer compounds are not immediately adjacent to the combined switch room and control room.

In addition, flat roof construction can be used, although not preferred due to increased maintenance costs, unless used to house the transformers due to height restrictions. Pressure relief to be provided by through wall vents.

The soffit of the roof shall be protected with an approved fire-resistant material to provide a half-hour fire resistance. Access hatches must be incorporated to allow access to the roof void and to provide unrestricted pressure relief to the building in the event of a switchgear failure.

12.4 Doors

12.4.1 External Doors

The preferred construction shall be assessed to ensure that, as a minimum, all items within clause below are considered. Reference shall be made to ES326 for details on door construction.

External substation doors shall be constructed to provide a three-hour rating.

Reference shall be made to the following criteria:

(a) Escape from fire; provision of doors.

(b) Planning considerations (if applicable).

(c) Security of buildings.

(d) Emergency exit.

(e) Equipment installation

12.5 Floors

Full raised access floors shall be installed to all Control and battery rooms to facilitate bottom entry installation of all cabling.

All control panels and battery chargers must be supported on individual steel supports and must not bear onto the raised floor panels.

12.6 Thermal Insulation

Thermal insulation shall be incorporated to ensure minimum "U" values to satisfy current Building Regulation Approved Document Part L,

12.7 Toilets/Welfare

Toilet amenities are to comply with the current Health and Safety Welfare regulations.

Toilets are to be built into all new substations where this is practical, to be accessed from outside the building. Mess rooms shall not be provided.

12.8 Environmental Control

The air within a substation shall be maintained at a combination of temperature and humidity that will ensure that equipment is maintained with a suitable operating range of temperature without risk of condensation, with the minimum overall capital and running cost combination. It is also necessary to avoid a build-up of flammable gas.

(a) Preferred minimum temperature, combined switch room and control room: 15°C.

(b) Operating relative humidity: 50%.

These conditions may be obtained by a combination of heating and dehumidification.

Refer to ES366 – Heating, Lighting and Small Power Installations in Grid & Primary Substations for details.

12.8.1 Transformer and Cooler within Confined Space

(a) When it is necessary to install both the transformer and cooler within a confined space, then the following calculations shall be completed and presented to the client for approval:

- Anticipated peak summer space temperature based on one transformer only operating under emergency conditions (i.e., 65 °C rise (maximum) above ambient).
- Anticipated peak winter space temperature based on one transformer only operating under emergency conditions (i.e., 65 °C rise (maximum) above ambient).

(b) Should the anticipated space temperature exceed the maximum design ambient temperature of the transformer, then supplementary ventilation shall be provided.

12.9 Water and Sewerage Supplies

For firefighting water supplies see Section 8.

Unless the cost is unacceptable a mains sewer connection shall be provided for domestic use (toilet and washing facilities).

If a new water supply is needed, contact the Accommodation Team/Energy Team for the correct new connections form. Details of the meter location and number need to be passed back to the Accommodation/Energy Team post installation for recording in internal databases.

New water meter points will Ideally be located outside the substation compound, however in the event of design constraints the meter may be located inside the substation compound when the installation of outside cannot be achieved.

12.10 Lighting – Internal

The internal lighting system shall be designed to provide illuminance levels appropriate to the tasks to be performed. Luminaires shall be located to take into account the operational and maintenance needs of the switchgear and other equipment. ES366 is the standard specification for heating and lighting installations.

12.11 Lighting – External

Where appropriate floodlighting shall be installed to external switchgear compounds. Fittings shall be positioned to enable ease of lamp replacement and to give a general illuminance to the compound to enable safe access and egress.

Selected luminaires shall have an appropriate degree of vandal resistance, taking account of the particular environment.

Care shall be taken when designing external lighting to minimise overspill to adjacent properties.

12.12 Electrical Installation – General

The incoming LV supply for auxiliary and essential services shall have an MPAN and fitted with an appropriate and fully accessible cut-out and meter board. Contact the Accommodation Team/Energy Team during late planning stages so they can arrange for our Meter Operator (MoP) to fit a settlement meter during the construction phase.

The installation shall be in accordance with ES366. 13 Amp socket outlets shall be positioned clear of all furniture or other fixed obstructions and shall be sufficient in number to suit the requirements of the particular site.

12.13 Furniture

Sufficient space must be allocated for operational engineer's workstation to include:

1 x desk
1 x chair
1 x 2 drawer filing cabinet.

13 132kV Gas Insulated Substation (GIS) Buildings

13.1 Buildings and Building Services

The physical size of a proposed 132kV GIS building shall be such that it is capable of accommodating all the plant and facilities associated with the operational requirements of the building and any future requirements specified.

In addition, restrictions imposed by the Local Authority shall be adhered to.

Each area is to be provided with all associated building services required to perform the normal activities which would be carried out. These shall include lighting, heating, power, fire alarms, telecommunications, hot and cold water, ventilation, and air temperature control.

13.2 Functional Facilities of GIS Building

13.2.1Switch house

This is the main building to contain the 132kV GIS switchgear. The switch house shall be adequate to install the required number of switch bays and include adequate lay-down areas at each end of the switch house for assembly and manoeuvring of the GIS switchgear.

The building shall be of adequate size to permit all operations, maintenance and testing to be undertaken, with adequate access and clearance for maintenance and test equipment etc.

The entrance and ventilation system for the switch house shall be appropriate to maintain the internal environment at sufficient clean room levels necessary for the installation, erection, connecting-up, testing, and future maintenance and overhaul of the GIS switchgear.

Windows shall not be permitted in any elevation of the building. Any apertures, ducting etc, shall not be permitted to any building elevation that forms part of the substation boundary.

An overhead crane, with an appropriate Safe Working Load, shall be provided. This shall be capable of lifting and having adequate clearance to the GIS switchgear to permit the heaviest item of plant to be installed, including test equipment. The crane shall run the full length of the building.

13.2.2Control Room

This shall be a separate area for accommodating the associated relaying and equipment requirements for the fully extended substation. Relay suites shall be in a logical order and meet the manufacturer's minimum clearance requirements.

An area shall be allocated within the control room to facilitate the common central control alarm and indicating equipment as required. This area shall be adequate to accommodate any additional equipment that would be required as a consequence of any likely future extension of the GIS installation. It shall also be sufficient in size to house all the panels and equipment as scheduled within the electrical design specifications.

An area within the Control Room shall be provided for the storage of key safes, drawings, manuals, test reports etc and the storage of test equipment. The area shall also be suitable for the preparation, issue recording etc, of switching instructions and safety documents as well as the preparation and review of testing procedures, and test results. The office area shall be adequate to accommodate a desk and chairs plus one 3-drawer filing cabinets.

13.2.3Battery Area within the Control Room

A separate room shall be provided within the control room area to accommodate the batteries and associated equipment necessary for the operation of the substation. Cable trenches shall be provided for cabling to the equipment. The room shall be vented to allow the natural dispersal of gases in the event of malfunction of the batteries.

If non-sealed batteries are used, all electrical equipment within the room shall be sealed and an emergency eyewash provided. Finishes shall be suitable for a wet environment.

13.2.4Shower Room

A Normal Shower room shall be provided near the W/C Room. The need for an emergency shower by the GIS shall be reviewed on a project specific basis considering the switchgear type used. If an emergency shower is required an alternative using a hardstanding for Emergency Shower Container maybe considered by ENWL."

13.2.5Toilet/Washroom

A unisex WC/washroom shall be provided that complies with The Workplace (Health, Safety and Welfare) Regulations 1992.

13.3 Lighting

The internal lighting system shall be designed to provide illumination levels appropriate to the tasks to be performed. Luminaires shall be located to take into account the operational and maintenance needs of the switchgear and other equipment.

13.4 Electrical Installation – General

The installation shall be to industrial standards to suit the environment, i.e. galvanised steel trunkings and conduits. 13A socket outlets shall be positioned to be clear of furniture or other fixed obstructions and shall be sufficient in number to suit the requirements of the particular site. The specification for heating and lighting is set out in ES397 "Specification for Mechanical and Electrical Engineering Works".

13.5 Security Alarm

The security alarm shall be designed and installed to the requirements of BS EN 50131. The building entrances only shall be protected.

The security alarm should be installed by a member of NSI (National Security Inspectorate) or SAIB (Security Alarms Inspection Board) and should be registered on the list of the local police force. This is to ensure that the police will respond to the alarm. (See Section 9.5)

13.6 Telecommunications

A connection to the internal telephone network shall be installed to the Control Room.

13.7 Fire Detection

The fire detection system and associated equipment shall meet the requirements of BS 5839 (Fire detection and alarm systems for buildings) and BS EN 54 (Fire detection and fire alarm systems). Cabling shall be contained, e.g. in trunking, or securely clipped as appropriate.

13.8 Heating/Air Conditioning

The air within a substation shall be maintained at a combination of temperature and humidity so as to ensure that the equipment is kept within a suitable operating range of temperature without risk of condensation, with the minimum overall capital and running cost. It is also necessary to avoid a build-up of flammable gas.

In combined Control Room and Switch house situations, Dehumidifiers with humidistats shall be considered together with wall mounted convector heater(s) on a dual thermostat installation with override timer.

In toilet/washrooms, direct acting heaters with thermostats shall be provided, to prevent freezing.

Further information on temperature and humidity settings is provided in Section 12.8.

13.9 Earthing

The Main Contractor shall make provision for an earthing system around the GIS building. The earthing system shall be in accordance with the documents stated in Section 11.

13.10 Platforms, Stairways, Ladders and Railing

Allowance shall be made for all platforms, galleries, stairways and ladders necessary to give access to the various sections of the plant being supplied under the contract. They shall provide adequate means of access for all operation, inspection and overhaul purposes and shall be of sufficient strength to support workmen, tools and portions of plant which may be placed on them during overhaul and inspection periods. The design shall review and justify the need for this access.

All galleries, platforms, stairways and ladders shall be galvanised carbon steel, unless otherwise specified.

Galleries and platforms around plant will generally be designed and provided by the plant supplier.

Ladders shall only be permissible where stairways are both impractical and access is required for maintenance purposes or for emergency purposes.

All aspects of platforms, stairways, ladders and other access ways shall comply with the requirements of the relevant British Standards, e.g. BS 5395-3 (Stairs, ladders and walkways. Code of Practice for the design of industrial type stairs, permanent ladders and walkways).

As far as practical, the flooring, stair treads and hand-rails shall conform to a uniform pattern throughout the whole of the GIS Building.

13.11 External Arrangement of the GIS Compound

The external arrangement of the compound shall be subject to the detailed requirements of the switchgear manufacturer for off-loading. Hard-standing areas shall be kerbed and have a suitable finish. The remainder of the compound shall be finished with limestone on an approved sub-base. Lighting to the compound shall be provided by floodlights mounted on the side of the building.

13.12 Cable Trenches

Allowance shall be made within the design for new external cable trenches if deemed necessary.

13.13 Protection of Services

All external services shall be adequately marked and protected at the required depths.

14 Documents Referenced

DOCUMENTS REFERENCED	
Health and Safety at Work Etc Act 1974	
Environmental Protection Act 1990	
Water Resources Act 1991	
Control of Pollution (Oil Storage) (England) Regulations 2001	
Control of Substances Hazardous to Health (COSHH) Regulations 2002	
The Management of Health and Safety at Work Regulations 1999	
Construction (Design and Management) Regulations 1994	
The Workplace (Health, Safety and Welfare) Regulations 1992	
Electricity Safety, Quality and Continuity Regulations 2002	
Engineering Recommendation S39. Limitation of Fire Risk in Substations at 132kV and below	
National Building Specification	
BS 1722	Fences
BS4800:1989	Schedule of Paint Colours for Building Purposes
BS 5839	Fire Detection and Alarm Systems for Buildings
BS EN54	Fire Detection and Fire Alarm Systems
BS 5395-3	Stairs, Ladders and Walkways. Code of Practice for the Design of Industrial Type Stairs, Permanent Ladders and Walkways
BS 8100	Lattice Towers and Masts
BS EN 50131	Alarm Systems. Intruder Systems
EPD301	Inspection & Maintenance of Electrical Plant and Substation Security
EPD307	Plant Approved for Use in Electricity North West Limited
EPD333	Supply System Earthing
EPD603	Substation Locking

CP335	Earthing Design for 11kV, 33kV and 132kV Grid and Primary Substations and Equipment
ES301	Distribution Substation Housings, Replacement Roofs and Doors
CP351	Civil Design Aspects of Primary Substations
CP998	Security of Substations
ES309	Locks for Substations and Associated Plant
ES356	Notices and Nameplates
ES398	Specification for Mechanical and Electrical Engineering Works
ES400 D5	Duct Seal

15 Keywords

Design; Environment; Housing; Noise; Plant; Substation; Switchgear; Transformer.

Appendix A – Typical Substation Drawings

The following typical general arrangement drawings are included in this Appendix:

(a)	900190-00194	Typical 132kV Circuit
(b)	900190-00195	Typical 132kV Substation Alternative Arrangement
(c)	900190-00196	Typical 33kV Switch House Concrete G.A
(d)	900190-00197	Typical 33kV Switch House Architectural G.A
(e)	900190-00198	Typical Containerised Switch House Architectural G.

These drawings show examples of a GIS Building and 132kV Site and Structures.

The design principles indicated on the drawings are for guidance only and indicate possible construction methods and materials.