

ENGINEERING DESIGN STANDARD**EDS 07-4000****GRID AND PRIMARY SUBSTATION CIVIL DESIGN****Network(s):** EPN, LPN, SPN**Summary:** This document provides guidelines and references for the planning and designing of construction works at grid and primary substations.**Author:** Uriel Arias**Date:** 26/06/2020**Approver:** Barry Hatton**Date:** 21/08/2020

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New civil design standard for grid and primary substations.			

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1 Introduction

The civil and construction standards for grid and primary substations are contained in the following suite of documents:

- EDS 07-4000 - Grid and Primary Substation Civil Design (this document)
- EDS 07-4030 - Grid and Primary Substation Fencing Arrangements
- EDS 07-4050 - Grid and Primary Substation Switch House Buildings
- EDS 07-4060 - Grid and Primary Substation Building Services
- EDS 07-4070 - Grid and Primary Transformer Bunds and Enclosures
- EDS 07-4080 - Switchroom Overpressure

When developing substation designs, designers/developers/customers are required to consider that wherever UK Power Networks operational personnel need access, the design guidelines presented in these document shall apply.

This suite of documents outlines the requirements for the design of 132/33/11kV grid and primary substations. In the electricity network context, the conceptualisation of civil/structural items follows after the electrical requirements are established.

The purpose of the substation civil design is to provide personnel safety, network security, asset durability and cost-efficiency while causing the least possible impact to the environment. UK Power Networks encourages sustainable designs that minimise waste. Where reasonably practicable, the reuse and recycling of materials and equipment is expected.

The guiding principles, given throughout the EDS 07-4000 suite of documents, are performance-based and therefore not associated with any particular type of plant, equipment or construction technique. The proposal for each design shall be based on the equipment selected for the corresponding project.

Whereas standardisation of construction aspects is preferable, each project is specific. It is essential therefore that the substation design, whilst incorporating the requirements of the present suite of documents, assesses each project on its merits.

The standard substation guidelines given, apply to civil works at greenfield sites. At brownfield sites, pre-existing conditions may constrain the civil works; therefore, the standard guidance applies as reasonably as practicable. Any diversion from the guidance, shall not compromise the environment, the safety or the security of the site and shall be agreed in principle by UK Power Networks.

Third party requirements may dictate some of the construction details; notwithstanding this, it is essential that the requirements outlined in the EDS 07-4000 document series are incorporated into the final design.

UK Power Networks shall approve all works designed for adoption by UK Power Networks, under the provisions of ENA EREC G81.

Guidance on new EHV and HV demand and generation connections is provided in UK Power Networks standard documents EDS 08-4100 and EDS 08-3100 respectively.

2 Scope

This standard (and the associated standards listed in Section 1) apply to design and construction of civil and structural elements of new and existing:

- Grid and primary substations at 132kV, 33kV and 11kV.
- Substations for customer connections at 132kV and 33kV.

3 Glossary and Abbreviations

Term	Definition
CCTV	Closed-circuit television
CDM	Construction (Design and Management) Regulations
ENA	Energy Networks Association
EPR	Environmental Permitting Regulations
ESQC	Electricity Safety, Quality and Continuity Regulations
ICP	Independent Connection Provider
LPCB	Lost Prevention Certification Board
LPS	Lightning Protection System
LVAC	Low Voltage Alternating Current
MEWP	Mobile Elevating Works Platform
UK Power Networks	<p>UK Power Networks (Operations) Ltd consists of three electricity distribution networks:</p> <ul style="list-style-type: none"> • Eastern Power Networks plc (EPN). • London Power Network plc (LPN). • South Eastern Power Networks plc (SPN).

4 Mandatory Requirements

4.1 General

This section outlines the requirements that apply at all times, when designing or planning a substation or elements of it.

4.2 Legislation

As a minimum, the substation design shall comply with the following:

- Construction (Design Management) regulations.
- Health, Safety and Environmental legislation.
- European and British standards.
- The 'Building Regulations', Part L2A.
- The 'Town and Country Planning Act'.
- Electricity Safety, Quality and Continuity Regulations.

The above list gives a reference of documents, other pieces of legislation or Standards may apply depending on site conditions or project scope.

4.3 Health and Safety

Prior to determining construction details, a site risk assessment shall be carried out to EDS 07-1109. The conclusion of this shall specify the security rating required for the substation.

In accordance with the CDM regulations, the design shall consider safe construction, access, maintenance, operation, installation and removal/replacement of plant and the eventual decommissioning and demolition of the substation.

For all these aspects, the design package shall make clients aware of their duties, give due regard to health and safety in the design work, provide adequate information about the residual health and safety risks associated with carrying out and completing the project as well as any operational risks e.g. confined spaces.

Site Specific Hazard Risk Assessments shall be completed for all elements of the design and shall be included in the CDM Health and Safety documentation to be retained on site. Generic and Site Specific Hazard Risk Assessments shall be completed for all design elements and included in the final Health and Safety documentation for the substation.

4.4 Environment

UK Power Networks is committed to protecting the natural and built environment, including wildlife, water and historic features.

UK Power Networks reserves the right to request proof of relevant approvals and consents from third parties, consenting substation works.

Consultations shall be sought with the Environment Agency, the Local Authority, landlords, third party asset owners potentially impacted and, where appropriate, local wildlife or environmental groups to ensure that the design is compatible with current legislation.

When installing new transformers, a noise survey and a model of the new noise condition shall be part of the planning of the substation. This will allow the establishment of a baseline noise level from which to measure any future noise increases; the assessment of noise impact prior to construction will help to establish whether noise suppression, in the form of transformer enclosures or screening, is required.

In order to ensure the design of suitable foundations, a ground investigation of the site shall be carried out; this will determine the underground strata, the ground bearing capacity to inform the design and any soil contaminants that will need to be dealt with as part of the substation construction.

Subject to the area where the project is to be undertaken, unexploded ordnance or pile probing surveys might be required. For construction works affecting third party assets, such as above and below ground structures (e.g. tunnels, bridges), services or live network equipment, an impact assessment shall be submitted to the asset owner for acceptance.

As part of the substation design process, consideration shall be given to Designated Landscapes and the impact to historic structures such as Scheduled Ancient Monuments. A Designated Landscape is an area that has a special status and needs to be protected for its natural and/or cultural importance. National acts, local councils, bylaws or international laws protect Designated Landscapes. Where a landscape has been designated there are restrictions on activities and developments within and adjacent to the area. The following areas are protected in England:

- National Parks.
- Areas of Outstanding Natural Beauty (AONB).
- Sites of Special Scientific Interest (SSSIs).
- Special Areas of Conservation (SACs).
- Special Protection Areas (SPAs).
- Ramsar wetlands.
- (Local) Nature Reserves.
- Sites in the process of becoming SACs or SPAs ('candidate SACs', 'possible SACs', 'potential SPAs' and sites of community importance (SCIs) or a Ramsar wetland ('proposed Ramsar site').
- Marine Conservation Zones.

4.5 Security

UK Power Networks Company Security shall be consulted to determine the security rating and risk classification pertinent to the area where a substation project is to be undertaken. For higher risk or critical substations additional physical security measures or systems (card access, intruder alarm, detection systems, CCTV, etc.) may be specified by UK Power Networks Company Security. Refer also to EDS 07-1109 for operational sites.

In line with ESQC regulations, site security is imperative to safeguard substation compounds and the equipment from damage, theft/vandalism and to safeguard against unauthorised access to high voltage equipment.

The substation shall be designed with main and secondary points of entry; all other doors and emergency exits shall open from the inside with panic bars and shall have no external locking mechanism.

For high-risk substations and Critical National Infrastructure (CNI) sites, additional security measures shall be as specified by UK Power Networks Company Security. Refer to EDS 07-1109 for security requirements for operational sites.

4.6 Flooding

The substation design shall incorporate protection against, or early warning of, flood events where appropriate. The National Planning Policy Framework (NPPF) and the 'Planning Practice Guidance – Flood Risk and Coastal Change' are the official references that regulate the assessment of flood risks and the appropriate mitigation planning process.

Flooding can be caused by the rise of watercourses, breaches of coastal defences, surface water run-off or water main failure. Guidelines for flood assessment and mitigation measures can be found in EDS 07-0106 and ENA ETR 138; these documents determine the return period to be used according to the number of unrecoverable connections at risk and the mechanism of flooding; both documents shall be referred to when setting substation equipment and plant levels.

The Environment Agency provides maps indicating areas and degree of flood risk.

If a site is likely to be affected by flooding issues, an alternative site should be considered in the first instance. In practice, the substation location is not easily changeable and therefore the implementation of flood mitigation measures need consideration.

Wherever practicable, electrical connections are to be made at high level in order to reduce the risk from interruption or damage by floodwater.

Where substations or individual items of plant are located below street level, additional risk of flooding by a burst water main or, to a lesser extent a sewer, shall be considered. In these cases, the local water and wastewater service provider should be contacted in order to establish the size, location and age of any water mains and sewers near the substation.

4.7 Fire Protection

Refer to EDS 07-0116 for specific policy details on separation, compartmentation, fire detection and alarm systems.

Substations shall be designed to prevent the propagation of fire, in particular from an electrical failure from internal switchgear, transformer or from power cable faults.

General fire mitigation measures to minimise fire fuel material shall be implemented e.g. install steel doors and avoid use of combustible materials where possible.

Cable routes and other penetrations through walls and floors shall be sealed after installation of all plant and cables with fire seals of equal rating to the walls penetrated.

4.8 Design Life and Future Maintenance

The substation design shall ensure that future maintenance is minimal, does not require bespoke equipment, and access restrictions and future risks to operational engineers are considered.

Design principles adopted and materials specified shall ensure that buildings and structures have a life expectancy equal to or greater than the electrical equipment housed.

The main fabric of structures and enclosures shall have a lifespan of no less than 40 years.

5 Design Functionality

5.1 Operational and Working Clearances

Minimum design clearances around transformers, switchgear and protection/control panels, are as follows:

Table 5-1 – Minimum Design Clearances around Electrical Plant

	Switchgear and Auxiliary Equipment	Transformers
Front	The larger distance between: a.) The switchgear longest dimension plus 200mm or b.) 750mm plus a switch panel door length.	Minimum 1200x1200mm clear floor area to allow the lowering of the tap changer to the floor for maintenance purposes. Manufacturer to confirm actual requirements for selected transformer.
Top, rear and sides	750mm Note: certain types of auxiliary equipment require rear access for operational purposes; access requirements shall be discussed with the manufacturer.	750mm

It is important to note that the distances listed above are the absolute minimum and shall not be taken as an alternative to operational or manufacturer's requirements.

When planning structures that support live electrical equipment, consideration shall be given to the working and safety clearances stated in the UK Power Networks Distribution Safety Rules.

Provision for sufficient space for operational personnel, auxiliary and operational equipment (including temporary steps and MEWP) needs to be considered during the whole life cycle of the substation, dependant on frequency and use.

Equipment doors when open shall not impinge on an escape passage.

5.2 Access for Personnel and Equipment

UK Power Networks owned or adopted facilities shall only be accessible to personnel holding the corresponding and sufficient level of authorisation as established by the UK Power Networks Distribution Safety Rules.

Substation plant/equipment shall be accessible to UK Power Networks staff at all times (24/7) from a public road. Access gates and doors shall be fitted with approved UK Power Networks locks and identification. Where access to site is via a third-party gate in an external boundary, an approved proprietary dual locking system shall be installed. Access via recourse to third party security, fob or coded access is not permitted.

Personnel gates should be as near to the main access gates as reasonably practicable. Additional personnel gates shall be provided where applicable for escape purposes, see Table 5-2. Personnel gates shall allow easy access and egress to/from the substation compound. Personnel gates shall be equal to the substation's security rating.

Equipment gates security rating shall be equal to the substation's security rating. See Section 5.6 for information on delivery and movement of heavy loads in substations.

5.3 Escape Routes

In accordance with the Building Regulations Approved Document B, areas/rooms with oil-filled transformers and switchgear are designated 'Places of Special Fire Hazard'.

To simplify the interpretation of the Building Regulations in terms of fire escape distances, UK Power Networks assumes that all areas in a substation are 'Places of Special Fire Hazard', with no exception. Based on this, the limitations on travel distances are summarised in Table 5-2. Refer to EDS 07-0116 for further detail.

Table 5-2 – Limitations of Travel Distance in Substations

Substation Area	Maximum travel distance where travel is possible in ⁽¹⁾ :	
	One direction only (m)	More than one direction (m)
Rooms with oil-filled or compressed gas equipment <i>e.g. transformer or switch rooms</i>	9	18
Escape route not in open air and non- operational rooms ⁽²⁾ <i>e.g. internal corridors</i>	18	45
Escape route in open air ⁽²⁾ <i>e.g. areas leading out of a transformer bay at outdoor substations</i>	60	100

Notes:

1. If the internal layout of partitions, fittings, etc. is not known, direct distances, rather than travel distances, should be assessed. The direct distance should be assumed to be two-thirds of the actual travel distance.
2. Maximum part of travel distance within the room/area.

Means of escape shall be provided where site-specific risk assessment dictates so or where otherwise deemed as necessary by UK Power Networks for the safe operation of the substation.

Escape routes shall give access to safe external areas or to a protected internal zone giving access to a safe external area.

Escape route passages shall have a minimum width of 750mm at pinch points and doors, and a minimum headroom corridor height of 2100mm.

Pedestrian safety barriers may be necessary when the escape route leads to a vehicular traffic route. These barriers may need consideration for temporary removal to facilitate access to site for maintenance teams or for the delivery of equipment.

5.4 Cable Entries and Routes

The design shall consider:

- Duct sealing technique dependant on environment.
- Cable entries from outside circuits.
- Power and control cable routes.
- Existing services.
- Provision for future requirements.
- Cable support frequency.

Unless the outer sheath is low smoke, all exposed EHV, HV, LV, Control and Building Services cables within the substation shall be treated with intumescent paint in accordance with ECS 02-0031. Documents EDS 02-0032, EDS 02-0033 and EDS 02-0034 specify cable-bending radii. For UK Power Networks approved cables refer to EAS 02-0000.

Duct banks are to be limited to a maximum of nine ducts and should enter/exit the substation by the maximum number of distinct routes possible.

A review of the services present in the surrounding footpaths and roads shall be carried out to determine the capacity for cable installation prior to the final decision regarding cable routes.

5.5 Existing Sites

When carrying out alterations and modification works within existing substation buildings, where some or all existing plant and cables remain live, careful consideration shall be given to the following:

- Creating a safe working area (temporary partitions).
- Protection of plant and cables against damage.
- Preventing the existing environment in the 'operational' portion of sites from deteriorating.
- Preservation of operational areas.
- Vibration damage (mal-operation of relays, etc.).
- Continuous safe and easy operational access to UK Power Networks and other authorised staff.
- Maintaining the fire protection rating.
- Maintaining security.

Alterations to existing structures and buildings shall match existing finishes and details unless utilising alternative or improved construction techniques and materials that can achieve a significant improvement.

When carrying out works at existing sites, an assessment of the condition of the buildings and supporting structures - also referred to as dilapidations survey, shall be made to assess the feasibility of re-utilising these structures during the expected lifespan of the new equipment to be installed.

Sub-standard elements found at an existing substation, but outside the scope of a specific project, should be raised to the current standards as is reasonably practicable. The efficiencies of a project running in parallel with out-of-scope works should be considered and incorporated within a planned scheme, as is reasonably practicable. The additional work should be make the substation compound compliant with UK Power Networks Health, Safety and Environment policies. Works over and above specific project requirements shall be summarised within the ESQCR risk assessment. Asset Manager to authorise the additional work in the scope of works for the project.

5.6 Delivery of Heavy Loads to Site

5.6.1 Transformers

Net transport weight of transformers can be up to 40 tonnes for 33/11kV transformers and 90 tonnes for 132/33kV or 132/11kV transformers.

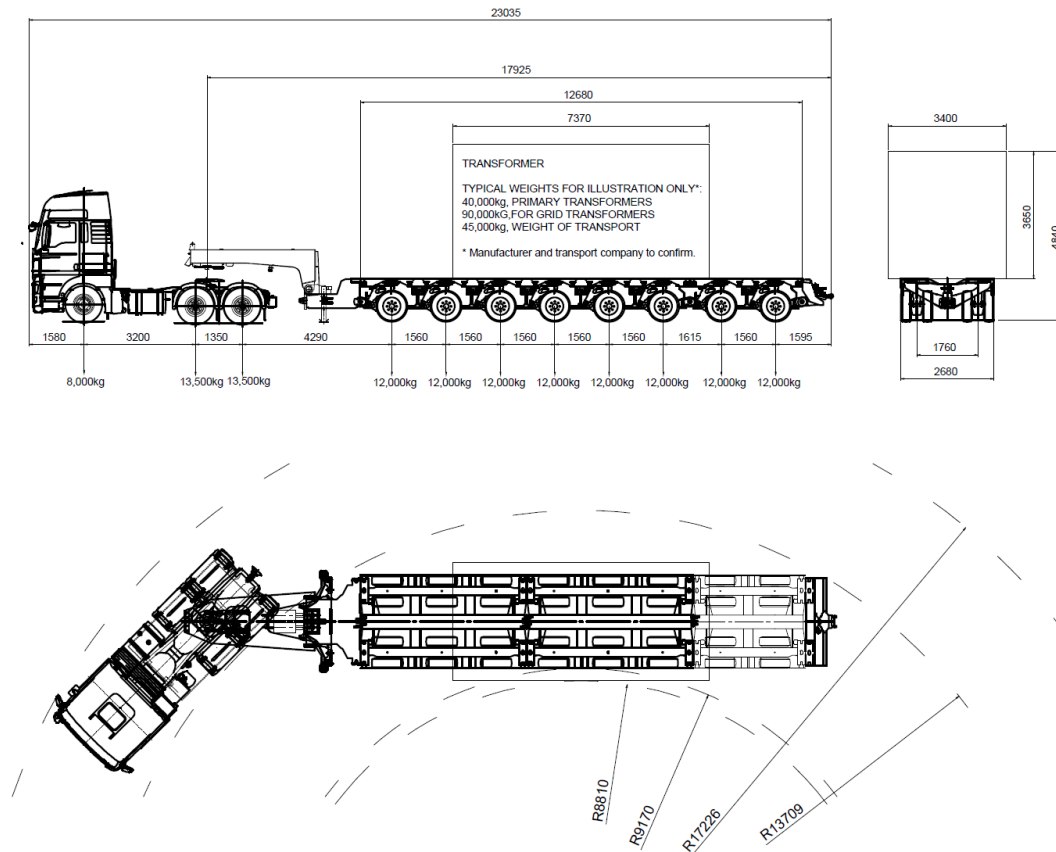


Figure 5-1 – Indicative Transformer Transport Arrangement

To transport these heavy loads articulated haulage vehicles are used.

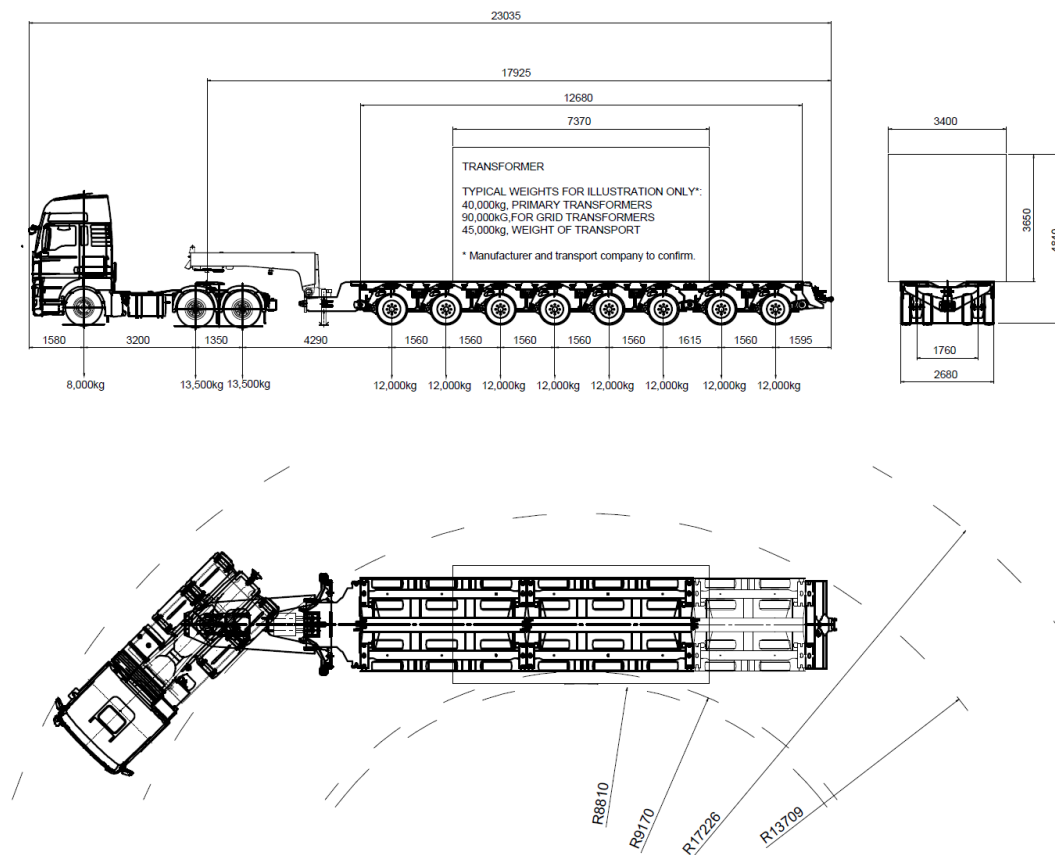


Figure 5-1 presents indicative details for illustration. The transformer manufacturer and the transport company shall confirm the definitive weights to be transported, the trailer load per axle, the load per wheel, the ground bearing pressure (e.g. 135kg/m²) and the tyre contact patch.

Co-ordination with the haulage company delivering the transformer is essential in case the road leading to the substation needs strengthening.

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.

Transformer plinths should be located adjacent to the substation access road or hardstanding. Where this is not possible, the use of a crane will be necessary. Alternatively, skidways of sufficient bearing capacity to carry the transformer from the access road to the corresponding plinths shall be provided.

5.6.2 Switchgear and auxiliary equipment

The switchgear drop zone shall be in front of the switchgear room double doors where reasonably practicable. Where this is not achievable, the maximum distance permitted to manually handle equipment shall not be greater than 10m on a nominally flat surface.

Allowance shall be made for sufficient space for large goods vehicles with mounted crane to manoeuvre inside the substation compound, to accomplish the off-loading operation safely.

6 Layout and Configuration

The most common substation configurations are a 33/11kV substation, a 132/33kV substation, a direct transformation 132/11kV site and a separate 33kV switch house where control equipment can be or already is within other buildings on the site.

The drawings listed in Appendix A show examples of substation configurations for greenfield sites. In practice, most projects occur at existing sites where the guidelines from this document are applicable, as reasonably as practical.

The individual elements of the substation defined in the standard drawings should be engineered as appropriate and arranged to make the most efficient use of the space.

A typical substation project may accommodate one or a combination of the following:

- Transformers and associated coolers.
- 132kV/33kV/11kV switchgear room.
- Transformer bushings, sealing ends, tap-changer, auxiliary transformer and neutral earthing reactors, fans, pumps and ventilation equipment.
- Auxiliary room including space for battery chargers and battery air conditioning units.
- LVAC room.
- Toilet with hand wash.
- Store room.
- Cable basement.
- Access road with turning area for operational vehicles.

The combination of buildings and structures will be project specific and vary depending on the electrical requirements for the site. In addition, the area and property layout may dictate the site layout and building configuration.

The substation shall accommodate all plant as dictated by the electrical design and output requirements.

Where necessary, a tunnel shaft from the basement will also be part of the civil design.

Future electrical requirements are to be considered and allowance shall be made for additional electrical equipment within the design, i.e. space for future switchgear or transformers.

For new substations, allowance shall be made for addition and/or alteration to the equipment including plant from other suppliers.

Foundations shall be designed to suit ground conditions and substation load together or any anomaly. Consideration for the earthing layout shall be given when designing and constructing the substation foundations.

The walls and roof shall be designed to prevent falling debris, following catastrophic failure of a transformer, from entering a publicly accessible area.

The details of roof construction shall be designed by a structural engineer and may be subject to approval by the local planning authority and/or building control. Following the site security risk assessment, the selection of building type and fabric should reflect site conditions, electrical requirements, durability and building efficiency.

7 External Works

7.1 General

A substation site shall satisfy the following requirements:

- Provide a safe access way leading to the substation gate. For requirements of unmade/unbound private roads leading to substation compounds, refer to EDS 07-0021.
- Provide sufficient space for the manoeuvrability of the ultimate envisaged number, size and layout of plant and buildings.
- Provide adequate access for the largest indivisible loads.
- Provide adequate and safe personnel access and exit. This includes assessing service roads and highways not controlled by UK Power Networks providing an access route to the site boundary gate.
- Provide adequate space for the maximum number and size of overhead line and/or underground cable entries.
- Provide adequate and safe access for inspection and maintenance works to all parts of the substation compound. This includes access for maintenance vehicles not impinging safety clearances specified by the UK Power Networks Distribution Safety Rules.
- Provide internal physical segregation according to the level of technical competency required to access each different voltage compounds.
- Comply with the planning requirements of the Local Authority, including amenity aspects.
- Not be larger beyond the substation requirements, as to require expensive maintenance of the unused portion of the land.

7.2 Roadways/Pedestrian Access

A suitable access roadway for plant delivery and for general access into the site is required to reach the different substation areas. The access road shall allow for the following:

- Delivery / removal of transformers.
- Delivery / removal of switchgear.
- The passing of an 11 tonnes axle weight with an adequate turning bay if access is possible from one direction only.
- Access to replace faulty equipment.
- Access for maintenance and operational activities.
- A nominal width of 4500mm.
- Provision of a 3500mm wide for turning section of the road, orthogonal to the main axis of the road.
- A 1200mm wide pedestrian paved footpath laid from roadway to main doors of the switchroom.
- Turning areas for vehicles.

7.3 Route of Services

Due to the extent of services located within a site, such as drainage, cables, earth mat, building services and multicores, it is imperative that the setting out of all underground services is 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.

Cable routes shall be located to avoid the undermining of the sub-base to the site roads when excavated (e.g. by the installation of duct blocks in concrete surround).

7.4 Drainage

External ground/access road levels shall be designed such that there is no detrimental build-up of surface water in the proximity of the switch house.

The site shall be thoroughly investigated to corroborate the presence of drains or otherwise. Where drains exist, every effort shall be made to utilise the existing drainage system. Each substation site shall be considered on its own merits regarding drainage design.

Where the substation has toilet facilities, the foul water system shall be designed in accordance with the general binding rules for small sewage discharges (e.g. sewage treatment plant with drainage field) set in the Environmental Permitting Regulations.

At sites with shallow foundations, where it is possible to discharge directly to the ground, rainwater from roofs and the access roads may be directed into a soakaway as far removed (no less than 5m) from the buildings and supporting structures on site, providing that the ground infiltration rate allows for it. Alternatively, direct connection into nearby ditch watercourse or shallow swale can be considered.

The outfall from the substation may be subject to permissions and discharge consent conditions from the local water utility company.

Advice from the Environment Agency should be sought to confirm that the proposed type of discharge is acceptable.

The discharge of the proprietary oil interceptors installed inside the bunds is of a quality that allows the use of standard available means on site without further treatment. For substations where vans are parked with relatively high-frequency, for instance at depots of manned substations, an oil interceptor should be introduced to treat the rainwater falling over the access road.

Where a system of land drainage needs to be installed adjacent to a substation building, this shall be at an invert level below cable entry level and connected into the existing drainage system.

Size, level and gradient of the substation pipework shall be designed for flow rates such that the pipes run un-surcharged at self-cleaning non-scouring velocities.

The surface drainage systems shall be designed for storm conditions, to a return period of 100 years minimum, unless greater period is dictated by the site conditions.

7.5 External Ground Finishes

All ground surfaces within the substation, except the bunded areas and access road, shall be finished with a 100mm depth layer of 40mm nominal clean washed, cubicle or angular to well-rounded natural stone G_c85/20 to BS EN 12620.

Apply a proprietary systemic weedkiller to all areas prior to laying the porous geo-textile membrane.

8 Outdoor Supporting Structures

8.1 Structure Design

Supporting structures shall be delivered to site complete with all pre-drilled holes for fixing of earth tapes, cables and all other relevant attachments including grouting points.

Where required, they shall be supplied with suitable drain holes.

Site drilling after erection shall be avoided.

Structures shall be used 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.

BS EN 1090 makes compulsory to supply fabricated structural steelwork or aluminium to site that to conform to the standard and carry the CE mark. Only firms that are CE marked with a specific 'Execution Class', as defined in BS EN 1090-1 shall be used. For substation projects, the execution class is 'buildings in general'.

8.2 Serviceability

When considering the serviceability of the supporting structures, the contractor shall ensure that deflections are appropriate for the proper function of the structure and for the plant and equipment supported by the structure but in any case, shall not be greater than that recommended in the appropriate British and European Standards.

8.3 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 to BS EN ISO 1461.

For substations located near coastal areas, or where the environment condition can be corrosive, refer to the Galvanizers Association Corrosion Map for confirmation of the galvanizing thickness.

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

8.4 Foundation Design

The foundations shall provide adequate strength, stability and durability for the anticipated service life of the substation and for the site conditions. Foundations to transfer moments, horizontal and vertical forces generated by the structures into the ground at formation level. The structure manufacturer shall provide forces and moments at the base level for foundation design.

The foundations shall be sufficiently large in plan and depth to accommodate the structure holding down bolts, and shall ensure that the overall and differential settlement of the ground below the structure foundation lies within the tolerances specified by the structure manufacturer and/or the electrical equipment manufacturer.

9 Switch House Buildings

The primary function of any building within an electrical substation is to house electrical equipment. The substation design shall meet the technical and safety requirements for the equipment and cables required for the project.

The specification of the electrical apparatus dictates the size and parameters of the building's design.

UK Power Networks procures electrical equipment from various manufacturers, each with their own supporting requirements. Details of the supporting particulars of the specific switchgear type need reviewing at early design stage.

The switch house building design shall be provided in accordance with EDS 07-4050.

10 Fences

The substation security and amenity fences shall be provided in accordance with EDS 07-4030.

11 Building and Electrical Services

The substation building services shall be provided in accordance with EDS 07-4060.

The substation electrical services shall be provided in accordance with EDS 07-1119.

12 Bunds and Enclosures for Transformers

When considering the location of transformers it is essential to contemplate the ecological impact and the sustainability of the design, minimising the risk of oil leakages going into ground and surface water systems.

Based on the understanding of the duty of care on importers, producers, carriers, keepers, treaters or disposers of controlled waste to prevent unauthorized or harmful activities (Environmental Protection Act, 2008), the corresponding measures shall be introduced when handling or storing oil. The Water Resources Act 1991 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.

This is applicable regardless of the size of the container or the purpose of the polluting substance and the fines and possible custodial sentences are set in the Environmental Protection Act and The Environment Act.

Where noise or vibration can affect the public, suitable measures to avoid complaints shall be provided. Noise surveys are recommended to be carried out before and after installation of transformer.

The transformer bunds and acoustic enclosures shall be provided in accordance with EDS 07-4070.

13 Overpressure in Substations

The substation overpressure design shall be provided in accordance with EDS 07-4080.

14 Earthing

The substation earthing system shall be designed and constructed in accordance with EDS 06-0013 and ECS 06-0022.

The earthing system should be installed at the same time as the construction of the substation.

Where any part of the substation is above ground level and is considered to be at risk from a lightning strike the a suitable lightning protection system (LPS) shall be designed and installed accordingly. The LPS shall be linked to the main substation earth in order to prevent arcing during lightning strike conditions. Refer to EDS 07-4060 for further guidance on LPS.

15 Signs and Labels

The substation signs and labels shall be provided in accordance with EDS 09-0019.

16 Handover and Post Construction Phase

16.1 General

When a project is completed, the Substation Health and Safety folder shall be handed over with all risks updated.

The handover process of the project shall include representatives from UK Power Networks - Network Operations and include details of maintenance and operational requirements.

16.2 Fire Plan

Prior to the handover of civil assets to standard operational use, a fire risk assessment shall be undertaken.

The fire plan shall be specific to the premises and shall detail the pre-planned procedures in place for use in the event of a fire. It is recommended that the fire plan is developed with input from the local Fire Brigade.

An emergency plan shall be prepared where a license under an enactment is in force or when an Alterations Notice under the Fire Safety Order requires it. Where appropriate, the emergency plan shall, include the following:

- Actions on discovering a fire.
- Warning if there is a fire.
- Calling the fire brigade.
- Evacuation of the premises including those particularly at risk.
- Power/process isolation.
- Firefighting equipment.
- Places of assembly and roll call.
- Liaison with emergency services.
- Identification of key escape routes.
- Specific responsibilities in the event of a fire.
- Training required.
- Provision of information to relevant persons.

16.3 Mechanical and Electrical Equipment Testing and Maintenance

Following installation and commissioning, all mechanical and electrical equipment shall be manually tested in operation to current regulations and standards.

All mechanical and electrical equipment shall be supplied with a three-year manufacturer or supplier backed warranty, providing routine and reactive maintenance and repair agreements.

All LV electrical installations shall comply with BS 7671 and a compliance certificate shall be obtained. The compliance certificate shall be retained on file, recorded on the Asset Management database and, where possible, a copy displayed on site.

16.4 Health and Safety and As-Built Records

Full 'as-built' records shall be produced and shall be available at the time of handover. The Principal Contractor shall compile the information necessary to complete the Health & Safety file in accordance with CDM Regulations. The records shall include:

- Fully marked up 'as-built' drawings detailing all structural and dimensional details.
- Cables and circuits within the substation recorded and marked on the plans.
- Feeds relevant but external to the substation.
- Maintenance periods, procedures, and equipment supplier information are to be provided for all equipment and plant.
- Residual risks not mitigated by design.

A hard copy of the Health & Safety file shall be made available on site.

The 'as-built' drawings shall be uploaded onto the UK Power Networks document management system prior to equipment being made live. The building drawings shall be uploaded in CAD format.

17 References

17.1 UK Power Networks Standards

EAS 02-0000	Materials List – Cables and Joints
ECS 02-0031	Installation of Power Cables and Joints in Air
EDS 02-0032	11kV and 33kV XLPE Transformer Tail Cable Ratings
EDS 02-0033	LV Waveform Mains Cable Ratings
EDS 02-0034	33kV Single Core XLPE Cables
EDS 06-0013	Grid and Primary Substation Earthing Design
ECS 06-0022	Grid and Primary Earthing Construction
EDS 07-0009	Specification for Signs and Labels for Operational Sites
EDS 07-0021	Unmade Unbound Access Roads to Substation Compounds
EDS 07-0106	Substation Flood Protection
EDS 07-0116	Fire Protection Standard for UKPN Property and Operational Sites
EDS 07-1109	Security Requirements for Operational Sites
EDS 07-1119	Substation Electrical Services
EDS 07-4030	Grid and Primary Substation Fencing Requirements
EDS 07-4050	Grid and Primary Switch House Buildings
EDS 07-4060	Grid and Primary Substation Building Services
EDS 07-4070	Grid and Primary Transformer Bunds and Enclosures
EDS 07-4080	Switchroom Overpressure
EDS 08-3100	HV Customer Demand and Generation Supplies
EDS 08-4100	EHV Customer Demand and Generation Supplies
EDS 09-0019	Safety Sign and Identification Labelling of Equipment

17.2 National and International Standards

Building Regulations

Water Resources Act 1991

Environmental Protection Act 2008

BR 187	External fire spread: building separation and boundary distances
BS 5395-1	Stairs, ladders and walkways – Design Code of Practice
BS 7671	Requirements for Electrical Installations (IET Wiring Regulations)
CDM	Construction (Design and Management) Regulations
BS EN 1090-1	Execution of steel structures and aluminium structures
BS EN 12620	Aggregates for concrete
BS EN 50522	Earthing of power installations exceeding 1kV a.c.
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS EN 1125	Building hardware. Panic exit devices operated by a horizontal bar, for use on escape routes. Requirements and test methods
ENA ETR 138	Resilience to Flooding of Grid and Primary Substations
ESQCR	The Electricity Safety, Quality and Continuity Regulations
EPR	Environmental Permitting (England and Wales) (Amendment) (England) Regulations
LOLER	Lifting Operations and Lifting Equipment Regulations.
LPS 1175	Loss Prevention Certification Board
NPPF	National Planning Policy Framework
SI 2007 No. 923	Smoke-free (Signs) Regulations

17.3 Dependent Documents

The documents below are dependent on the content of this document and may be affected by any changes.

EDS 06-0012	Earthing Design Criteria, Data and Calculations
ECS 06-0022	Grid and Primary Earthing Construction
EDS 07-4030	Grid and Primary Substations Fencing Requirements
EDS 07-4050	Grid and Primary Substations Switch Houses Buildings
EDS 07-4060	Grid and Primary Substations Building Services
EDS 07-4070	Grid and Primary Substations Bunds and Enclosures
EDS 07-4080	Overpressure in Substations

Appendix A – List of Drawings

Drawing	Title	Revision
EDS 07-4000.01	132/11kV Enclosed Substation	
	Sheet 1: Basement Plan	A
	Sheet 2: Plan at Level 0.000m	A
	Sheet 3: Sections	A
	Sheet 4: Transformer Module	A
	Sheet 5: 11kV Switch Room Module	A
	Sheet 6: Typical Supporting Details for Switch Panels	A
	Sheet 7: 132kV Circuit Breaker Module	A
	Sheet 8: Auxiliary, LVAC, Fire Suppression, Office, Store, WC modules	A
	Sheet 9: Cooler Bay, Mess Room, Unit Substation, Parking Bay	A
	Sheet 10: Escape Route Plan	A
	Sheet 11: Delivery Route Plan	A
	Sheet 12: Volumetric Requirements per Room	A
EDS 07-4000.02	132/33kV Substation Compound with Underground Incoming Circuit	
	Sheet 1: Elevations	A
	Sheet 2: Site Layout	A
	Sheet 3: External Works	A
	Sheet 4: Earthing Layout	A
	Sheet 5: Lighting Layout	A
EDS 07-4000.03	132/33kV Substation Compound with Overhead Incoming Circuit	
	Sheet 1: Elevations	A
	Sheet 2: Site Layout	A
EDS 07-4000.04	33/11kV Substation Compound	
	Sheet 1: Site Elevations	A
	Sheet 2: Site Layout	A
	Sheet 3: External Works	A
	Sheet 4: Earthing Layout	A
	Sheet 5: Lighting Layout	A
EDS 07-4000.10	Builders Details	
	Sheet 1: Access Road and Drainage 1	A
	Sheet 2: Access Road and Drainage 2	A
	Sheet 3: Lamp Post Base, Cable Ducts	A
EDS 07-4000.11	Sealing End Support	
	Sheet 1: Structural Details	A
	Sheet 2: Setting out	A