



Secondary Substation Design: FAQ

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Introduction

This document provides the design principles and building construction standards for new secondary substations & HV switchrooms. It is not designed to cover every eventuality or variation for particular sites. UK Power Networks must approve in writing any variation to the guidelines provided in this document. The plant layout and specification within the substation/switchroom remain the responsibility of UK Power Networks.

UK Power Networks uses conventionally built structures and Glass Reinforced Plastic (GRP) housings capable of accommodating electrical plant. All new secondary substations are designed to withstand or safely relieve internal pressure due to a fault on the plant.

For the purpose of this document it is assumed that the GRP option has proved unsuitable to either UK Power Networks or the client and a conventionally built structure is required.

'Secondary Substations & HV Switchrooms' are generally referred to as 'substations' and this convention will be adopted for the remainder of this document.

Any specific reference to 'HV Switchrooms' applies up to 11kV only.

The document is in three sections:

Section 1 explains the basic information and the first steps to take;

Section 2 covers the basic building construction requirements when building secondary substations;

Section 3 provides detailed design information;

Section 1 - Basic Information

1.1. What is the likely duration of the programme of works?

This will depend on the nature of the substation and the associated alterations to the distribution network required to facilitate your connection.

Your UK Power Networks Project Designer will be able to give you an indication of time scales when you meet to discuss your project.

Full details of the connection process can be found here:

http://www.ukpowernetworks.co.uk/internet/en/help-and-advice/documents/the_connection_process.pdf

1.2. What lease conditions are required?

The client must have sufficient title and consent to provide a freehold transfer or to the grant of a long-term lease for the substation, usually 99 years, with associated rights including 24 hour unrestricted access to all our apparatus.

UK Power Networks will pay a nominal rent of 5p per annum if demanded for the lease term. Completion of Legal Agreements is often the cause of delay in the provision of supply. UK Power Networks will not commence supply of electricity to you until such time as formal legal agreements are completed. It is therefore recommended that you initiate the legal process as early as possible.

Payment for the legal process can be made in advance to aid this process, please contact your UK Power Networks Project Designer should you wish to take up this option.

In circumstances where an existing UKPN substation within the development is to be replaced; the new substation footprint must be equal to or greater than the footprint size of that to be removed.

The client will be expected to maintain the structure of the substation, all accesses to it and any associated equipment.

1.3. Who is responsible for the costs involved?

The client will pay the full cost of construction of the substation structure.

The client will be expected to pay all legal costs, including 'Easements' that may be required to connect the substation to the nearest supply.

1.4. What are the first steps in the process?

During the feasibility stage of the design process, the client should inform UK Power Networks of the proposed new connection requirements and submit a drawing of the proposed substation.

This should be based upon the information contained within this document and any relevant UK Power Networks 'standard' drawing that has been provided.

The drawing must be submitted in accordance with the UK Power Networks 'Substation Design - Drawings Information Requirements' form ([See Appendix 1](#)).

On receipt of these proposals, UK Power Networks will comment accordingly and – assuming that the proposals are acceptable in principle – will work with the client to develop the scheme further.

Section 2 - General Construction Requirements

Equipment will only be installed into purpose built enclosures that satisfy our requirement as described in 'Engineering Design Standard - EDS 07-0102' and have been inspected & accepted by UK Power Networks.

2.1. Are there essential features to consider?

- Adequate useable floor space and headroom clearance for the installation of equipment (including emergency generators), and the safety of personnel working within the substation;
- Security against unauthorised entry;
- Unrestricted 24-hour access for UK Power Networks staff, without recourse to third parties and controlled by a standard UK Power Networks operational lock;
- Sufficient natural ventilation to remove heat from the transformer and to prevent condensation;
- Where provided within the building the substation should be situated against an outer wall. Ideally locate the substation so that access can be provided directly from the public footpath;
- Suitable access for the safe installation and replacement of substation equipment;
- Access for high and low voltage cables;
- Substations will contain a maximum of two transformers, should the load requirements necessitate that three or more transformers are required then a combination of 'single' and 'double' substations will be used;

2.2. What location and physical issues need to be addressed?

The location of the majority of substations will be approved by UK Power Networks 'Connections' staff. The exception to this rule being substations located at basement level, where the approval of the 'Connections' Design Manager (or equivalent) and/or the Distribution Planning Manager are required.

Subject to the exceptions mentioned below; the substation will be freestanding and the location of all secondary substations shall:

- be at or near the electrical load centre of the network to be supplied;
- be at ground level;
- provide safe and adequate 24 hour access from the public highway for operational personnel and vehicles, including plant delivery vehicles;
- be such that obstruction is not caused with the doors open;
- wherever possible, access from road junctions and major roads shall be avoided;

New substations shall not be located on any level above ground floor level.

2.2.1 Integral Substation

A separate substation building is the preferred arrangement, but in some situations site constraints may require a location within a larger building. The substation shall be positioned such that at least one wall is an external wall (Section 3.13.1 refers) and be constructed by the developer to UK Power Networks specification.

2.2.2 Basement Substation

The normal location for a substation, whether in a separate building or integral to a customer owned building, is at ground level.

Substations at ground level provide optimum access and egress for maintenance, inspection and

at times of emergency. Susceptibility to flooding is also greatly reduced compared with a basement substation.

Only when all potential locations at ground level have been fully explored and it is proven beyond doubt that a ground level substation cannot be achieved due to the site constraints or planning requirements will UK Power Networks consider the option of a new basement substation. In all cases any proposed basement location must still satisfy the key requirements in terms of access, ventilation, plant replacement etc.

Any access arrangement for a basement substation shall ensure 24 hour direct access from public highway land for operational staff.

Special access keys or access via a security office is not acceptable.

Approval from the Connections Design Manager (or equivalent) must be obtained prior to any agreement for a basement substation location.

A document including supporting arguments for each individual project is to be submitted for consideration.

2.2.3 Equipment

The substation enclosure shall be solely for the use of UK Power Networks equipment with no access for the customer or interconnecting doors to the customer's switchroom.

2.3. Who is responsible for obtaining planning/building regulation approval?

The client is expected to obtain these and any other consent, which may be required.

It is important to note; that contact should be made with UK Power Networks regarding the design and location of the substation, prior to securing planning permission.

2.4. What access is required for UK Power Networks' personnel?

Electricity distribution is a 24-hour business. Because of this UK Power Networks will need unrestricted access to substations, and their equipment at all times. Access to the substation provided by contacting security staff or by arrangement is not acceptable. This causes delay in securing and restoring of supplies following breakdowns.

A ground floor location with direct access from the public highway into the substation is the simplest way of meeting this requirement. Access into substations will be by UK Power Networks master key locking via the substation doors from the public footpath.

If the substation is located behind additional locked gates or doors then these are also required to be locked in the standard UK Power Networks master locking suite.

Lock cases shall be supplied by the client and be capable of accepting standard UK Power Networks cylinders ([See Appendix 2 – Photo 1](#)).

Hasp & staple arrangements shall be capable of receiving a heavy duty padlock (padlocks/cylinders by UK Power Networks).

Where access to substation doors are likely to be compromised by parking vehicles then preventive measures should be installed, ideally in the form of fixed or removable bollards. Alternatively protection could be afforded by the creation of a locally raised kerb (220mm high) in front of the doors.

2.5. What access is required for items of heavy plant?

Substation plant is very reliable but when breakdowns do occasionally occur, it will be necessary to be able to replace equipment safely, quickly and with minimal disruption to the main premises.

The large items of plant housed in the substation are delivered via a low loader with a 'HIAB' or similar hydraulic lorry mounted crane. The weight of a fully loaded vehicle can be up to 32 tonnes (individual items of plant have a maximum weight of 4000kg).

The roadway giving access to the substation must be capable of sustaining the axle weight of the lorry in transit and whilst undertaking unloading activities. Therefore the roadway should be level with sufficient room to deploy outriggers e.g. an area approximately 11.0m long x 8.0m wide ([See Appendix 2 - Photo 2](#)).

The plant access route should not be via a 'traffic sensitive' area (i.e. the main entrance/exit from a development; that is likely to cause difficulties if substation plant needs to be replaced).

Plant must be offloaded as close to substation doors as possible to minimise the need for manual handling ([See Appendix 2 - Photo 3](#)).

The minimum clear headroom from ground level to the top of the crane arm for offloading and manoeuvring is 6.5m, if lifting plant over fences etc. then an allowance for the additional height of the obstruction must also be taken into account.

Plant drop zones remote from the substation location should not be more than 10m from the substation doors. The route between the drop zone and the substation must be as direct as possible ([See Appendix 2 - Photo 4](#)) and should be flat and level or laid to nominal falls only ~ in all cases the gradient must not be steeper than 1:10.

Corridors on the plant access route must be a minimum of 2000mm wide generally with pinch points not less than 1500mm and provide a minimum clear height of 2500mm.

In all cases the developer's structural engineer shall confirm in writing to UK Power Networks, that the entire plant access route is capable of sustaining these loads.

It is important to note that the minimum clear dimensions for the moving of plant shall be maintained throughout the life of the substation and must not be compromised by the future installation of pipework, traywork etc.

Any deviations to be discussed/agreed with UK Power Networks at the design stage.

2.6. What are the requirements if a plant access hatch is necessary?

If plant access is required via an opening within the ground floor slab then a horizontal plant access hatch is to be provided.

Plant access hatches must be located external to substations (ideally adjacent to the substation doors) in common areas. Hatches sited in tenanted areas or areas usually occupied by persons can only be permitted where unobstructed access can be maintained and legal covenants permitting this access are in place.

The standard UK Power Networks approved plant access hatch is the 'Elkington Gatic 2000' which provides a minimum clear opening of 2000mm x 1500mm with the hatch covers removed.

The covers are designed to be installed flush with the finished floor finish so that when the covers are replaced no additional reinstatement is necessary. A lightweight (B125) cover is to be specified for internal use and a heavier duty (C250) external type is to be specified in areas subject to vehicular movement.

A minimum of 1000mm clear working space should be allowed around all sides of the hatch at both ground and basement levels. An adjacent on-site space is to be provided for the temporary storage of the hatch covers.

It is preferable for the hatch to be located in an area clear of any overhead buildings or structures with a minimum headroom of 6500mm above the hatch so that delivery via lorry mounted crane is possible. The area surrounding the access hatch shall be designed to allow for the heavy duty delivery vehicle which weighs 32 tonnes when fully loaded with plant.

Access to the plant access hatch is required at all times; no permanent or demountable structures shall be positioned over the hatch or within the surrounding zone designated as working space.

Services, sprinkler pipes, conduit, etc. are not permitted to pass under the plant access hatch position; the clear opening size must be maintained at all times.

Hatches should always be located on a flat area with the surrounding area laid to falls to prevent possible 'ponding' local to the hatch position. Hatches can be installed within ramps providing that the fall of the ramp is not steeper than 1:10.

If a decorative floor finish is desired; the location of the hatch must be clearly identified by four brass studs or strips within the final finish.

In all cases, the proposed plant access hatch type & location must be approved by UK Power Networks.

2.7. What is required if a lifting beam is necessary?

Where substations are located within basements or below ground level, provision must be made for the safe movement of plant. Wherever possible plant movement shall be made by lorry mounted crane (HIAB or similar) parked adjacent to an appropriate sized plant access hatch or open lightwell opening.

Where access for a lorry-mounted crane is not possible, a lifting beam is required to lower the plant to the basement below: the beam must be of the running beam type fitted with a travelling trolley.

The beam shall be a permanent fixture and extend over the whole of the hatch and in addition must extend past the plant access hatch by a minimum of 2000mm to enable plant to be attached to the lifting tackle whilst on a permanent surface.

During the plant installation process the plant is lifted clear of the ground and then moved into position over the open plant access hatch opening where it is slowly lowered by a hand operated chain hoist to below.

Running beams shall be fitted with a travelling trolley permanently attached to the beam and retained by welded stop ends at both ends of the beam. The beam and the trolley are both required to be tested to a SWL of 5000kg and certification shall be provided to UK Power Networks prior to first use.

Beams shall be permanently marked with the SWL rating and shall be checked, tested and, where appropriate, re-certified prior to use by the operator in accordance with LOLER 98 (Lifting Operations and Lifting Equipment Regulations 1998).

The running beam position shall be aligned with the centre of the plant access hatch and parallel with the longest side. The minimum distance from the suspension point of the trolley to the top of the plant access hatch is 3250mm. Beams should not be installed more than 4500mm above plant access hatches as this can introduce additional risk in terms of access to the suspension point.

Services, ductwork, conduit etc. must be kept clear of the running beam; the travelling trolley must be able to travel freely from one end of the beam to the other at all times.

2.8. What is needed if a plant winching eye is deemed necessary?

Some plant access routes may require a winching eye to aid plant installation.

Where this proves necessary, UK Power Networks will request that the developer provide a suitable anchor point with a pulling ring (int. dia. 80mm) where indicated.

[\(See Appendix 2 – Photos 5 & 6\).](#)

The eye will normally be installed 500mm above the finished floor level. The pulling ring must be capable of sustaining a horizontally applied SWL of 2000kg and a test certificate must be provided to UK Power Networks before usage.

2.9. What access is required for UK Power Networks cables?

This usually involves the provision of cable ducts from the substation to the back edge of the public footpath.

Plastic ducts shall be laid in a straight line wherever possible and laid level.

Steel ducts must always be laid in a straight line and level.

If sites are working to reduced levels or cover during the construction phase then the ducts shall be suitably protected to prevent crushing from site traffic.

Proposed duct routes should take into account nearby tree roots, structures, existing services, cable pits, drainage routes etc. The cable duct must be fully accessible from both ends of the run.

Cables must only be installed in the appropriately approved ducts. Where required, in the case of bundled foundations or basement substations, the cable entries shall be sealed internally against water and gas ingress into the substation at the completion of the building construction.

The sealing arrangement must be removable to enable the cables to be installed and the cables entries resealed.

All proposals regarding potential cable routes and number of ducts required should be discussed with UK Power Networks at an early stage of the scheme design. UK Power Networks will confirm what is required to be provided as the scheme progresses.

Upon completion of all works as-built record drawings detailing the size/depth and position of ducts/cables/pits shall be provided to UK Power Networks.

Section 3 - Detailed Construction notes

The following notes indicate the minimum construction standards approved by UK Power Networks. They do not purport to be definitive, nor is any warrant given or implied that regulations under statute or otherwise would be satisfied by their adoption.

3.1 What is the specification of the floor slab?

The substation floor and all access routes must be capable of sustaining the weight of the substation equipment in any position. The maximum weight of the transformer is 4000kg. The transformers are typically supported on two 50mm wide x 1250mm long integral channels in contact with the floor at approx 500mm centres.

The standard floor slab must be a minimum of 225mm thick reinforced concrete with two layers of A393 fabric mesh reinforcement, laid top and bottom; client / developer proposed alternative arrangements will be acceptable providing the floor slab reinforcement is designed by a competent structural engineer to suit site conditions. Substation floors should be 150mm higher than adjacent ground level.

The slab reinforcement mesh must be bonded to the substation earth, see Earthing Section for details.

The top of the slab is to be finished with a surface hardener or a suitable wearing screed so as to provide impact and abrasion resistance. The maximum weight of a single item of plant could be as much as 4000kg and will be manhandled into position using pinch bars and steel rollers, the finished floor must be sufficiently hard to prevent chipping or crumbling, a minimum compressive strength of 40N/mm² after 28 days (RC 40/50 in accordance with BS 8500-1:2006) is recommended.

All concrete works to be finished smooth and level with a steel float to within ± 2 mm over 2000mm, it should be noted that a high standard of workmanship is required.

Kerb angles for floor trenches, where specified shall be cast into the slab (or bolted to slab if using a screed) and finish flush with the finished floor level; there must not be any trip hazards.

Steps within substation floors are not permitted.

3.2 Are floor gratings required?

Cable trenches, where specified, are required to be grated and must not pose a trip hazard.

Floor gratings shall consist of 38 x 38 deep moulded fibreglass gratings by Captrad, open type with gritted surface, and are coloured green. Gratings shall be seated within rebates formed from 45 x 45 x 6mm mild steel angle kerb supports with welded tangs or bolted lugs for casting into concrete ([See Appendix 2 - Photo 7](#)).

Gratings must be seated true and level with no rocking and negligible sideways movement (e.g. no more than 10mm in any direction). All gratings shall be in place for plant delivery.

The gratings (as specified) span in two directions, so it is possible to create 'cable cut-outs' local to the incoming cable entry positions. It is important to maintain sufficient bearing at all times ([See Appendix 2 – Photo 8](#)).

3.3 What is the specification of the walls?

Walls shall be constructed of 215mm fully bonded brickwork to BS EN 771-1 laid English bond, common bricks to be 'frogged' and laid with 'frogs'¹ facing upward.

Brickwork shall have a minimum compressive strength of 20N/mm² (Durability MN), with water absorbency less than 23%, neat struck joints and walls to provide a flush finish internally.

Engineering bricks are not permitted above DPC level.

As an alternative; 180mm (min.) RC can be utilised, but must have sufficient concrete cover to the reinforcement to achieve a 4 hour fire rating.

Blockwork walls are not permitted.

The following alternative may be applied to Freestanding substations:

Walls can be constructed of two skins of brickwork laid in 'stretcher bond' with expanded metal lathing (EML) and a horizontal bed joint reinforcement every third course with no cavity.

The inner skin shall be of common Flettons laid frog up, external facing brick to harmonise with adjacent brickwork.

Brickwork walls may be rendered or clad externally if specifically required by the Planning Department.

Brickwork shall not be projecting nor of a design that provides footholds to act as a climbing aid.

Brickwork shall incorporate a proprietary DPC membrane, 'Hyload' or similar at 150mm above the external finished ground level.

3.4 How is the roof to be constructed?

All brick built substations shall have a concrete roof slab constructed using cast in situ concrete. The standard design shall comprise two layers of A393 reinforcement mesh fabric, one for the top and one for the bottom with sufficient minimum concrete cover to the reinforcement so as to provide a four hour fire rating.

All reinforcement in the structural slab shall have a minimum cover of 55mm in order to achieve the fire resistance value. Ribbed bar reinforcement shall be to BS4449 – Strength grade: B500B. Fabric reinforcement shall be to BS4483.

Hollow pot beams, pre-cast concrete planks and lightweight concrete placed on metal profiled decking are not permitted for this application.

Freestanding substations also require the following:

- Roof slab to project 150mm beyond supporting brickwork and incorporate a drip detail to the eaves.
- Roof shall be fully weatherproofed; the standard detail specifies a 20mm mastic asphalt finish in two coats to underlay of felt on a minimum 1:80 fall to the rainwater outlet. Edge of slab provided with a GRP roof edge trim.

¹ 'Frog' is the prism shaped recess in the brick.

'Frogged' is the laying of bricks with the recess at the top of the brick ensuring a stronger build.

- The top of the asphalt shall receive two coats of RIW 'Solaflect' solar reflective paint or similar approved.
- Roofs with parapet walls to all 4 sides are to be avoided if adjacent to trees.
- The introduction of insulation or preformed void fillers which provide the falls on the slab, are not acceptable for substation roof applications.

Where desired or to comply with Local Planning requirements, a traditional pitched roof is permitted but it shall be in addition to the standard concrete slab roof detail.

[\(See Appendix 2 – Photo 9 &10\).](#)

The slab must still be laid to falls and provided with two coats of waterproofing treatment or built up propriety roofing. Roof trusses or joists shall be suitably secured to the concrete slab and all roof voids appropriately ventilated. All tiles shall be double nailed to battens.

The use of lead-free flashings should always be considered.

Fascias and soffit boards should be of low maintenance UPVC or similar approved and not timber unless expressly required by the Local Planning Authority.

Guttering and rainwater associated kit should be low maintenance UPVC or similar.

Rainwater downpipes should terminate below ground level into back inlet gullies or similar drainage, discharging to local surface water sewer with permission from the local water services company or a dedicated soakaway.

3.5 What headroom is required within the substation?

A minimum clear headroom of 2475mm is required within substations at ground level equipped with plant that has bottom entry cable boxes.

A minimum clear headroom of 2800mm is required within substations at basement level equipped with plant that has top entry cable boxes.

For basement locations; where the ceiling slab design incorporates downstand beams, the 2800mm dimension is to be taken from the underside of the lowest beam.

3.6 What are UK Power Networks' cable entry requirements?

Generally UK Power Networks requires the provision of cable ducts from the substation to the back edge of the public footpath. The ducts shall be laid in a straight line wherever possible and laid level.

Cable entries into substations should be direct into cable trenches wherever possible. The developer is to ensure that all UK Power Networks cable ducts are accessible when excavating from the public footpath above and clear of any existing utility service pits etc. (i.e. gas, water, telecoms).

When designing a substation with high level cable entry a minimum of 1500 x 1500mm clear floor area shall be provided to create a clear space locally where a scaffold tower can be safely erected to facilitate pulling and cleating cables at height.

3.6.1 Cable Ducts – Plastic

Unless UK Power Networks drawings stipulate otherwise, all cable ducts will be 125mm internal diameter twin wall HDPE ducting to ENATS 12-24, colour black, marked with the legend 'Electric Cable Duct' on two diametrically opposed sides, e.g. Ridgiduct by Polypipe Civils Ltd. or similar approved.

3.6.2 Cable Tubes – Steel

Where cables pass through or under a building it shall be a requirement that steel tubes are provided in lieu of the standard plastic ducting. Steel tubes shall also be specified for entry into basement substations.

Where requested, steel tubes are to comply with EN 10255 and be 125mm nominal internal diameter welded steel tube with no protruding seam internally or seamless. Any internal weld must be smooth to the touch throughout. All joints to be screwed and socketed with ends of tubes bevelled internally and then de-burred so that they are also finished smooth to the touch. When joining tubes together the tubes should butt up tight against each other with the joint located central to the socket. Tubes to be Medium duty in red oxide or self colour finish.

All steel tubes to be laid in a straight line and level.

For excessively long runs or for particular applications, tubes with an internal diameter of 150mm may be specified.

Steel tubes shall be puddle flanged where they pass through retaining walls straight into a substation. Steel tubes shall be fitted with internal expanding pipe bungs.

Galvanised tubes are not acceptable as the galvanising process can leave the ducts with an abrasive finish internally.

3.6.3 Cable Supports

Where specified shall consist of a Unistrut P1000T (41 x 41) slotted channel surface mounted to walls/ceiling at 600mm centres. If drop rods are used then Unistrut P1001T (83 x 41) slotted channel shall be specified to enable cables to be cleated either above or below the Unistrut ([See Appendix 2 – Photo 11](#)).

The weight of mains cables varies depending upon type, size and materials used but when designing for cable supports allow for the maximum weight which is 11.5 kg/m per cable.

If Unistrut cable supports are required to be fitted to the underside of Promat Durasteel SMT blast ceilings then the Unistrut cable supports shall be provided and installed by the approved Promat installer at the time of the initial install. Unistrut must not be retrospectively fitted to the Durasteel SMT blast ceiling by non-approved Promat installers as the additional weight of the cables and Unistrut could compromise the ceilings performance in a fire. In these circumstances the Unistrut should be fixed wall to wall independent of the ceiling above.

3.6.4 Cable Trenches

Ground level substations should be designed to incorporate cable trenches containing the UK Power Networks mains cables in all cases. Cable trenches should be a minimum of 1000mm deep so as to accommodate cable bending radii and enabling the connection onto switchgear with bottom entry cable boxes.

The standard width of a cable trench is 600mm. All cable trenches should be grated over with open mesh GRP gratings for safety at all times.

Ducts terminating into the ends of trenches should be finished flush with the internal face of the substation and the ducts built into the opening with a small application of mixed concrete infilled locally ([See Appendix 2 – Photo 12](#)).

3.6.5 Cable Winching Eyes

Long cable runs may require a cable winching eye and where specified UK Power Networks will request the developer provides a suitable anchor point with a pulling ring (with an internal diameter of 80mm) opposite the incoming cable position ([See Appendix 2 – Photo 13](#)). This will normally be within the cable trench.

The pulling ring must be capable of sustaining a horizontally applied SWL of 1500kg, test certification to be provided to UK Power Networks before usage.

In all cases the developer's structural engineer shall submit a proposal with supporting calculations to UK Power Networks for comment/acceptance prior to installation.

3.7 What is required for the client's service cable entry?

Service cable slots are sized to suit the number and size of cables required. Openings shall be kept as small as possible so as not to create 'weak spots' within the substation fabric.

All service cable slots shall be fire stopped to a 4 hour standard where the cables leave the substation, so as to maintain fire separation at all times. Promat 'Promaseal' Fire Compound or similar approved to be utilised.

3.8 Is small power & lighting required within HV Switchrooms?

Yes, as detailed below; with all works carried out by a contractor who is registered with the NICEIC and/or ECA to carry out the whole of the works as described in this section. The electrical installation shall be installed and tested to BS 7671 IEE Wiring Regulations - a 'Dead Test' certificate will be required.

3.8.1 Internal Lighting

- Internal lighting shall provide a minimum illuminance of 500 lux;
- General purpose luminaires shall be of a fluorescent type complying with BS 4533;
- 1500mm long with twin 58W tubes and have a minimum degree of protection of IP65 in accordance with BS EN 60529, to be installed at 1800mm AFFL;
- A 1 gang, 1 way light switch with surface back box (1200mm AFFL) or surface mounted pull cord shall be positioned immediately adjacent to the access into the switchroom building. If the switchroom has more than one door then multiway switching is to be provided by each door;

3.8.2 Power Circuit Fittings

- Fittings shall be corrosion resistant metal clad surface units. As a minimum 1 x 13A IP56 switched twin socket shall be provided (500mm AFFL). Each socket shall include a RCD with a tripping sensitivity of 30mA and an operating time of 30ms;

3.8.3 Consumer Unit

- An consumer unit conforming to BS EN 60439-3 and BS 5486-12 and providing, as a minimum, 63A double pole dis-connector, a 32A MCB for the power circuit and a 6A MCB for the lighting circuit shall be provided;
- The consumer unit is to be fitted adjacent to a 100A fused cut-out receiving the live, neutral and earth feeds;

3.8.4 Tubular Heaters

- A minimum of 4 x 135W (typically 915mm long) tubular heaters double stacked and installed at 450mm above FFL controlled by thermostats mounted at 1500mm above FFL.

3.8.5 Cabling

All cables shall have stranded copper conductors with a minimum dimension of:

- Cut out to Consumer Unit = Ø4mm;
- Lighting = Ø1.5mm;
- Small Power = Ø2.5mm.

3.8.6 Trunking and Conduits

- All cables shall be installed in trunking or conduit, normally at high level with drops to fittings;
- Trunking and accessories shall comply BS 4678 and shall be rigid PVC suitable for indoor use, self extinguishing and shall not propagate flames;
- Trunking shall be supported at intervals of no more than 2m horizontally and 2.5m vertically and shall be adequately sized for the number of cables installed;
- Conduit shall be round, high impact, non flame propagating, self extinguishing, heavy duty PVC to BS EN 50086;

3.9 What standard of waterproofing is required?

Substations are to be designed so that they are inherently dry internally.

A proprietary bitumen based waterproof concrete sealer shall be applied to all below ground external concrete surfaces prior to backfilling.

Watertight sealing of all ducts with or without cable shall be carried out prior to commissioning using purpose made stop ends or bungs.

As a minimum specification; basement substations must meet the functional environmental requirements of 'Grade 2 (better utility)', in accordance with CIRIA Report R139 & BS 8102.

Cable entries shall be puddle flanged to stop the ingress of water tracking around the duct entry position.

Proprietary hygroscopic treatments may also be specified depending upon the circumstances. Where this is the case; the appropriate chemical fixings are to be supplied to the UKPN Field Engineer fitting out the substation by the Developer and at their cost.

Retaining walls on basement substations provided with cavity drainage (Delta or similar) are required to be protected with the standard UK Power Networks specification brickwork.

An alternative approach is to set the substation wall slightly back from the retaining wall so that any ingress or water is arrested before it enters the substation.

3.10 Do structural steelworks within the substation require fire rating?

The standard freestanding substation construction should not contain any structural steelwork.

Where substations are of the integral or basement type then structural steelwork may be required and is to be encased in concrete with sufficient depth of cover so as to provide a four hour period of fire resistance.

Steelwork must not be clad with plasterboard or similar fire resisting boarding. If the steelwork cannot be encased in concrete then it should be protected with four hour fire resisting Promat 'Durasteel SMT' cladding.

It is important that the 'Durasteel SMT' is installed by a Promat approved licensee only, a letter of conformity from Promat is required for each and every installation.

It should be noted that alternative types of fire rated cladding or the use of intumescent paint or fire sprays are not permitted.

3.11 What earthing arrangements are required?

Earthing to be installed in accordance with the UK Power Networks Earthing Standard Manual; design and testing by a specialist consultant may be required. It will be necessary – as part of the design – for the developer to produce a soil resistivity survey report.

The earthing system will require one or more of the following features to be installed with the substation building works:

1. Copper tape connection to steel sheet piles and/or steel reinforcement in foundation piles supporting the substation building.
2. A mat of earth tapes in the earth under the basement slab or around the substation.
3. A number of earth rods connected by earth tapes.
4. Earth tape terminations in the substation basement which are connected to external earthing systems described in (1) to (3) above.

Standard earthing drawings are available for the suite of standard substation arrangements.

The earthing system is to be installed at the same time as the excavation and foundations construction works by a specialist sub-contractor. The tape and rods shall be protected from damage during the remainder of the construction works and the plant installation and commissioning works.

Earthing test certificates shall be submitted to UK Power Networks for comment & acceptance.

Any queries relating to earthing should be directed to the UK Power Networks Project Designer designated to your project.

3.12 What type of doors can be used?

The standard UK Power Networks approved steel Sunray louvred doors shall be used as these are specifically designed for UK Power Networks substation applications.

Doorset openings shall be sized to provide a clear opening suitable to accommodate the largest section of plant expected to pass through that door. Door leaves are designed to swing back 180° to give good access when installing plant.

Doors giving direct access to substations must always open outwards for emergency escape purposes.

Access doors shall be fitted with emergency escape ironmongery; two-point locking and panic bar fitted with Sunray 6000 hasp and staple with internal override. This arrangement permits escape from within the substation even if the hasp and staple is secured externally with a padlock.

Steel frames to be fixed into brickwork openings with M10 sleeve type anchor bolt or chemical resin fixings.

All steel doors shall be connected to the substation earthing system via the earthing lug on the door frame.

3.12.1 Escape Doors

The maximum distance from the point of switching to the nearest escape door must not exceed 5000mm, if this figure is exceeded or the layout of the room prevents clear and direct access to the door then an additional escape door will be required.

Additional escape doors may also be specified at the Building Officer/Engineer's discretion if the substation is of an unusual shape.

Escape doors into uncontrolled areas shall exit into a lobbied area. It is essential to ensure that these are clear and useable at all times, it is imperative that operatives can escape from a hazardous area into an area of safety. Panic escape furniture is detailed in the Sunray door specification.

3.12.2 Fire Rated Doors

Substation doors that open into a building or where fire resistance is expressly requested by the fire officer shall be the UK Power Networks approved steel Sunray 'Firelock' 240 fire doors. These doors have been specifically designed for UK Power Networks substation applications. They have been fire tested in accordance with BS 476 Part 22 (1987) for four hours when mounted in accordance with the manufacturer's instructions. Doors to be supplied with standard three-point locking and panic bar furniture.

Steel frames to be fixed into brickwork openings with M12 sleeve type anchor bolt or chemical resin fixings, 75mm of which should be located within the supporting structure. Threshold fixings shall be recessed so as not to constitute a trip hazard.

Fire rated doorsets are mounted on a 150mm high cast-in situ concrete threshold, the threshold supports the angle door frame surround which overlaps the brickwork and also acts as a bund to contain potential oil spills.

Doorsets to receive a four hour intumescent mastic infill (Lorient Poly products or similar equivalent) where the frame meets the supporting structure, mastic to be applied both internally and externally in accordance with manufacturers' installation instructions.

Fire rated doorsets require concrete lintels of one piece construction, either precast (King Stone Super Fire Range – Type 29 or similar approved) or cast insitu. The steel reinforcement within the lintel shall have sufficient concrete cover so as to provide a four hour fire rating.

Steel lintels or dual concrete lintels mounted side by side must not be used for these types of doors.

3.13 What method/amount of ventilation is required?

3.13.1 General

Adequate ventilation must be provided to dissipate the heat generated by the transformer. UK Power Networks substations shall be designed to achieve this by using natural ventilation only, generating a cross flow of air over the transformer(s).

The most common ventilation arrangement is via low level 'inlet' louvres within the doors with high level 'outlet' louvres behind or adjacent to the transformer position on the opposing side of the substation. It is important that the 'outlet' louvres are located as high as possible.

For an Integral location ventilation is best achieved by siting the substation on the corner of the building and venting on both external faces to generate good 'cross flow' ventilation. In situations where this cannot be achieved, ventilation ducting may be required within the substation to achieve the cross flow of air required.

For a substation containing a single transformer up to 1000kVA rating, a ventilation requirement of 3m² total louvre area is required, this is split approximately 50:50 between 'inlet' and 'outlet' ventilation. Louvres are assumed as being approximately 50% efficient.

3.13.2 Louvres

Louvres fitted to brick built structures shall be of steel construction within a steel frame and secured internally by suitable anchor fixings into the brickwork with no external fixings.

Louvre blades shall be of a profile so as to prevent the ingress of driving rain and also prevent foreign objects etc. being inserted through the louvres.

The steel blades shall be individually welded into the frame for security and to also prevent the blades becoming dislodged in the event of an overpressure within the substation. Louvres shall be powder coated and always installed horizontally and not raked or installed vertically.

Louvres must not be located in areas where heat or smoke dissipation could compromise adjoining escape routes.

Louvres are not permitted to vent into car parks, bin stores or loading bay areas.

Aluminium, timber or proprietary louvre blade systems that 'snap in' are not permitted.

All ventilation proposals are subject to approval by UK Power Networks.

3.13.3 Basement Substations

Good ventilation and a supply of breathable air are essential within basement substations. Basement substations shall be ventilated by using passive 'stack' ventilation principles. The system is driven by the difference in air pressure between the cold air 'inlet' and the hot air 'outlet'.

For this to work efficiently a dedicated inlet and outlet ventilation duct is required – ideally on opposite sides of the transformer. The cold air 'inlet' is trunked to low level; 500mm above substation floor level and the hot air 'outlet' is via a slot at high level. This is the preferred method of venting because it requires virtually no subsequent maintenance.

Ventilation shafts are considered to be an extension of the substation and as such shall be constructed to the same structural criteria. Ventilation shafts shall be constructed from the

standard 215mm fully bonded brickwork or cast in situ reinforced concrete to the Clients structural engineers design with sufficient cover to steelwork as required in order to achieve the four hour fire rating.

Ventilation ductwork, if required, should not exceed a total length of 10m and must contain no more than two changes in direction. Ductwork in excess of 10m may be considered but only if the duct arrangement is predominantly vertical and has an increased cross-sectional area of 1m².

All ductwork associated with basement substations must be of four hour fire resisting Promat 'Durasteel SMT' construction. It is important that the 'Durasteel' ductwork is installed by a Promat approved licensee only, a letter of conformity from Promat is required for each and every installation, as part of the UKPN acceptance process.

It should be noted that alternative types of fire rated ductwork are not permitted.

3.13.4 Mechanical Ventilation

Ventilating substations via mechanical means is a non-standard arrangement and will not be considered for new build applications.

3.13.5 Ventilation for HV Switchrooms:

Nominal background ventilation is required to prevent problems associated with condensation. Typically air bricks positioned at high and low level achieves this. Where fire separation is required intumescent grills/louvres may be added to the outside of the air bricks.

3.14 What standard of finish is required to the substation?

3.14.1 External:

Ground level freestanding substations are generally left in a natural brick finish; this can be rendered if desired to harmonise with adjacent properties.

Decorative cladding treatments are permitted if required by the Local Planning Authority; but should be avoided if possible, as they create a greater maintenance liability.

Steel doors and louvres should be powder coated, standard colour Moss Green 14-C-39, other colours to BS 4800 can be specified if required to harmonise with adjacent colour schemes.

Door and louvre frames surrounds shall receive a mastic pointing.

3.14.2 Internal:

Walls and ceilings shall receive two coats of white emulsion paint for dust sealing. Floors shall receive two coats of red or grey concrete floor paint.

3.15 How does the acceptance process work?

On completion of the building works for the substation, the developer is to contact UK Power Networks to request an inspection.

A standard 'snagging' list will be sent to site to ensure that all requirements for the substation have been met. On completion of this form, a site visit will be arranged with a view to formally approving the substation.

All building works will be checked against the drawings agreed by UK Power Networks.

Any deviations of the building works to that shown on the agreed drawing, unless previously

agreed in writing, may result in the delay of plant installation, while remedial works are undertaken.

UK Power Networks will not install any equipment until all building works are completed and accepted by UK Power Networks.

3.16 Are there any other requirements I need to be aware of?

- Drawings provided by UK Power Networks are not to scale, use figured dimensions only. No variations to the stated dimensions or materials specified will be permitted without prior written consent from UK Power Networks.
- The running of sprinkler systems, smoke detection devices, heating, gas, water and other service pipes or cables through, in or under the substation will not be permitted.
- All measurements to be checked on site by contractor before work commences and any discrepancies reported to UK Power Networks.

Substation Design - Drawing Information Requirements

Substation checklist

During the feasibility stage of the design process, you, or any developers or consultants working on your behalf, should inform UK Power Networks of your proposed new connection requirements.

To deliver your requirements effectively and provide constructive feedback on your proposals we need relevant, accurate, and timely drawings. Where your site requires a new substation or HV switchroom the specific information below is mandatory.

Please use the checklists below to ensure you have included all required information in the correct format.

Your submissions must be:

- on a **single composite drawing**
- sent via email in an **AutoCAD 2010 (.dwg)** compatible file format (maximum file size – 12MB)
- compliant** with the minimum requirements illustrated by our standard drawings together with the notes set out in the policy document 'EDS 07-0102 ~ Secondary Substation Civil Design Standards'

Your submissions must contain:

- site location plan** showing the location of the site overlaid on the Ordnance Survey map
- block plan** showing the position of the substation or HV Switchroom on the site
- general arrangement floor plans** at ground and basement levels
- section detail** through the proposed area under consideration, a minimum of two is required, one in each plane; complex arrangements will require additional relevant sections.
These details to be fully annotated to show **finished floor** and **structural slab** levels/key dimensions/constructional details together with beams if present; please note that a flat soffit is to be provided wherever possible.
- elevation detail** showing proposed door and louvre positions

Your submission should clearly indicate:

- ventilation proposals:** using the 'stack effect' i.e. natural ventilation
- plant access:** method by which the plant is to be installed, indicate all access routes
- cable entry points:** showing position and depth of proposed incoming cables & service cables
- staff access:** clearly showing proposed 24-hour access route for UK Power Networks employees

Please note: access via recourse to a third party is not acceptable.

If the information is incomplete, inaccurate or submitted in an inappropriate format, there may be significant delays to the delivery of your project.



Photo 1: Example of Dual-locking Mortice Lock;



Photo 2: Example of plant delivery with 'out-riggers';



Photo 3: Minimise manual-handling;

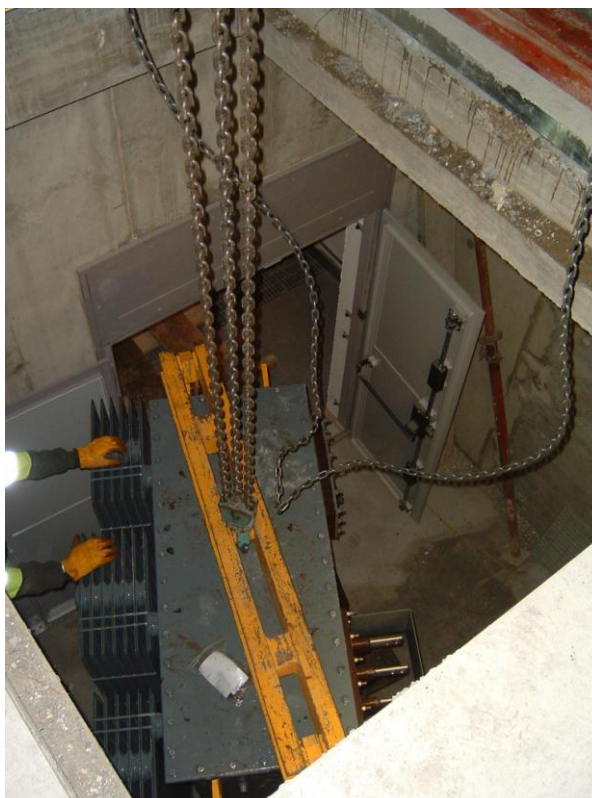


Photo 4: Plant 'drop-zone' should be as direct as possible, ideally adjacent substation doors – as above;



Photo 5: 'Winching eye' for plant installation ~ Example 1;



Photo 6: 'Winching eye' for plant installation ~ Example 2;



Photo 7: Example of 'Captrad' GRP floor gratings;



Photo 8: Example of 'cable cut-outs' in GRP grating;



Photo 9: Substation with 'pitched' roof ~ Example 1;



Photo 10: Substation with 'pitched' roof ~ Example 2.



Photo 11: Example of Unistrut 'P1001T' cable supports, allowing cables to be cleated above & below;



Photo 12: Example of ducts finished flush with the internal face of the substation;



Photo 13: Example of 'Winching eye' for cable installation.