ENGINEERING DESIGN STANDARD

EDS 07-3101

PRE-DESIGN REQUIREMENTS FOR SECONDARY SUBSTATIONS

Network(s): EPN, LPN, SPN

Summary: This standard outlines the requirements for the planning of secondary distribution substations and customer substations metered at HV or LV, including selection and agreement of locations for substation sites.

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Approver: Paul Williams

Date: 26/10/2018

Date: 23/11/2018

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Revision Record

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Reason for the update: Substation land size, fire risk and noise clarifications needed.

What has changed:
- Section 4.2: 4m Fire Damage Zone extend defined.
- Section 4.4: Requirement for anti-vibration pad made for 500kVA transformers and above.
- Section 4.6: Secondary oil containment requirements updated.
- Section 4.7: Occupational exposure limit revised to 6000μT.
- Section 5.1: References to EDS 06-0014 and EDS 08-2100 introduced.
- Section 6.1: Preferred enclosure type updated to freestanding brick-built enclosure.
- Section 6.2.1: GRP substation permitted locations due to fire safety specified.
- Section 7.4: Plot size guidelines presented for land acquisition and negotiation.
- Appendix C: Decision flowchart updated in line with changes in Section 6.1.

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Reason for the update: Feedback from the Standards Review Forum

What has changed: Clarification of the distance between the substation and other buildings to prevent noise nuisance, fire risk and the effects of EMF (Section 5.1).

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New standard to cover the planning and pre-design requirements for secondary substations. The relevant contents from EDS 08-0142 and EDS 07-0102 have been incorporated to this new document.
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1 Introduction
This standard details the requirements for the planning and pre-design of secondary distribution substations and customer substations metered at HV or LV and includes:

- Initial risk assessment.
- Substation location requirements.
- Substation selection.
- Land rights and planning permission.

This standard shall be read before going into the detail design of the scheme specified in EDS 07-3102. EDS 07-3101A (Appendix A) is a checklist to assist with the application of this standard and should be completed by designer1.

2 Scope
This standard applies to the selection and agreement of locations for secondary substations in EPN, LPN and SPN network areas. It is intended for the use of both UK Power Networks and customers.

3 Abbreviations and Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>AONB</td>
<td>Area of Outstanding Natural Beauty</td>
</tr>
<tr>
<td>CDM</td>
<td>Construction (Design Management) Regulations</td>
</tr>
<tr>
<td>Customer Substation</td>
<td>A secondary substation supplied at 20kV, 11kV or 6.6kV that supplies one customer at HV or LV</td>
</tr>
<tr>
<td>EMF</td>
<td>Electric and Magnetic Fields</td>
</tr>
<tr>
<td>ENA</td>
<td>Energy Networks Association</td>
</tr>
<tr>
<td>ESQC</td>
<td>Electricity Safety Quality and Continuity Regulations</td>
</tr>
<tr>
<td>FDZ</td>
<td>Fire Damage Zone</td>
</tr>
<tr>
<td>GRP</td>
<td>Glass Reinforced Plastic</td>
</tr>
<tr>
<td>HV</td>
<td>AC voltages above 1000V generally used to describe 6.6kV, 11kV or 20kV distribution systems</td>
</tr>
<tr>
<td>IDNO</td>
<td>Independent Distribution Network Operator</td>
</tr>
<tr>
<td>LV</td>
<td>AC voltages up to 1000V generally used to describe 230/400V or 230/460V systems</td>
</tr>
<tr>
<td>SCADA</td>
<td>System Control and Data Acquisition</td>
</tr>
<tr>
<td>Secondary Distribution Substation</td>
<td>A secondary substation that supplies the LV and HV distribution network</td>
</tr>
</tbody>
</table>

1 The term designer is used in this document to refer to the person responsible of assessing risks and compiling the documentation for construction; these responsibilities are carried out from early planning to detail design. For Connections and CiC schemes, the designer is appointed by the Customer.
4 Initial Considerations

The majority of new secondary substations are installed to supply new developments for a single customer or a group of customers. Therefore the need for a substation has to be established from the early stages of the project to ensure that the location is optimised for the electrical requirements of the development and the long-term sustainability of the site (e.g. access, ventilation).

The requirements of the Construction Design and Management (CDM) Regulations shall be considered. CDM includes a requirement to identify, remove or reduce risk at the design stage and the need to liaise with other designers involved in project to develop safe and comprehensive designs.

In line with CDM regulations and UK Power Networks policies and standards, substations shall be located to ensure that they are safe, secure and sustainable whether they are installed for new business, reinforcement or for network alteration/diversion.

A risk assessment shall be carried out for all new and existing secondary substations and include as a minimum the following aspects:

- Risk to the public
- Fire safety
- Environmental impact
- Noise and vibration nuisance
- Flood
- Pollution of the ground with oil
- Electric and magnetic fields (EMF) exposure

4.1 Risk to the Public

The Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 require the risk of interference, vandalism or unauthorised access to an asset by the public to be assessed and any risk to be reduced to an acceptable level.

A risk assessment and mitigation shall be carried out for all new and existing substations in accordance with EOS 09-0061.

4.2 Fire Safety

A fire risk assessment shall be carried out in compliance with the Regulatory Reform (Fire Safety) Order 2005. It is essential that the fire risk assessment and the fire plan are developed in conjunction with the local fire brigade representative.

Local planning requirements that may affect the design of the substation enclosure shall be taken into account at pre-design stage. In some areas, particularly around town centres, additional fire resistance of walls and ceilings may be necessary and the positioning of doors and ventilation louvres may be restricted.

For oil filled equipment a four metre clearance around the oil container shall be considered as the extent of the Fire Damage Zone (FDZ). Four hour fire resisting obstructions located within the required FDZ can reduce the extent of it. Existing and planned buildings/structures within the FDZ shall be accounted for in the fire risk assessment.

UK Power Networks does not have any requirement for fire-fighting equipment in substations. Sprinkler systems shall not be fitted in substations and customer systems shall be external to the substation.
4.3 **Environmental Impact**

The design shall have due consideration for the local environment and comply with the relevant Environment Agency and Local Authority requirements. The designer or planner is responsible for providing information regarding the environmental conditions likely to affect the substation.

When considering the location of a new substation it is essential to consider the ecological impact and design suitability.

4.4 **Noise and Vibration Nuisance**

The design, construction and positioning of substations shall be such that noise and vibration are not transmitted into sensitive areas, particularly in residential areas or at locations where low frequency noise is likely to be a nuisance.

Where there is a possibility of noise or vibration being transmitted to adjacent properties, evidence that suitable measures have been taken to avoid potential problems, shall be provided. Specialist input will generally be required. A pre-construction noise survey shall establish a baseline noise level with which to assess post-commissioning noise levels.

For integral substations, it is important to assess the effect of the 100Hz standing waves emitted by transformers, as this can induce resonance on the larger structure.

500kVA transformers and above shall be mounted on approved anti-vibration pads.

4.5 **Flood**

New substations shall avoid areas liable to flooding and they shall be built above the flood level of the building(s) receiving the power supply.

Flooding can be caused by the rise of watercourses, breaches of coastal defences, surface water run-off or water main failure. These factors shall be assessed as detailed below and if it is found that the proposed site is affected by flooding, an alternative site should be considered. If it is not possible to source a different location, flood mitigation measures shall be taken.

When assessing fluvial and coastal flood risk the following aspects shall be considered:

- Local and historical information about the site.
- Location of nearby watercourses.
- Topographical conditions which may cause flooding from surface water run-off.
- Existing condition in terms of development or future redevelopment plans. This could impact on the degree of surface water run-off that could affect the site. Hardstanding/hard landscaping in place of grassed/soft landscaped areas will reduce the time in which surface water reaches the site and is likely to increase the water volume affecting the site.

The Environment Agency website provides maps indicating areas and degree of flood risk. The flood maps are available from [www.environment-agency.gov.uk](http://www.environment-agency.gov.uk).

The risk of flooding by burst water main or, to a lesser extent sewer, shall be considered when deciding the location of the substation. The local water service provider shall be contacted to establish the size, location and, where possible, age of any mains water feeds.

The design shall consider the risk of inundation of the substation from any mains greater than 150mm in diameter within the vicinity of the proposed site and incorporate protection against (e.g. raised threshold at street level entrance of substation) or early warning of flood events where appropriate.
Where it can be established that flood mitigation measures are not required due to the presence of third party maintained flood defences (e.g. Thames River London City flood defences) the site may be considered safe from tidal or fluvial (or both) flooding mechanisms, and therefore only the risk of flooding from water mains failure needs be assessed.

4.6 Pollution of the Ground with Oil

The Water Resources Act 1991, the Environment Act 1995 and the Environmental Protection Act 1990 state 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. The Control of Pollution (Oil Storage) (England) Regulations 2001 rules apply to transformers that have a connected oil supply tank with a capacity of 201 litres or more, in the form of transformer header tank connected to the transformer by a one-way feed pipe.

The approved range of distribution transformers does not use a header tank therefore this regulation is not applicable in most situations. However, where the substation is located within 10 metres of a watercourse or 50 metres of a water abstraction point, a secondary oil containment shall be provided regardless of the type of transformer being installed.

An assessment of oil containment shall be carried out, including the decommissioning of existing and delivery of new equipment, particularly if there is a risk of oil leakage into the ground or added protection is needed for local watercourses.

4.7 Electric and Magnetic Fields (EMF)

Substations generally produce magnetic fields indistinguishable from those present in domestic properties. Guidelines published by the International Commission on Non-Ionising Radiation Protection (ICNIRP, 1998), set the maximum permitted exposure levels to magnetic fields up to 360μT and for electric fields up to 9000V per metre. Reference levels above which further investigation into screening and control is recommended for the public are 100μT for magnetic fields and 5000V per metre for electric fields. If the area outside the substation is not a habitable space, such as garden, the occupational exposure limit is 6000μT.

Reference levels exposing the public to 100μT and/or 5000V per metre are likely to require EMF screening and control measures. If required, EMF screening and control measures shall be external to the substation construction.

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2 Electric and Magnetic Fields: the facts ENA January 2012
3 Control of Electromagnetic Fields at Work Regulations 2016
5 Substation Location

5.1 All Substations

The location of any new secondary substation shall be approved by UK Power Networks before construction starts. Any non-standard arrangement requires the authorisation from the UK Power Networks Distribution Planning Manager or Connections Design Manager.

Except for the exceptions outlined later in this standard, the location of all secondary substations shall be:

- At or near the electrical load centre of the network to be supplied.
- At ground level.
- Provided with safe and adequate 24 hour access from the public highway for operational personnel and vehicles, including plant delivery vehicles with a lorry mounted crane. Access from road junctions and major roads shall be avoided. Where necessary, unrestricted access via a dual locking arrangement is acceptable; access via recourse to a 3rd party (e.g. Security) is not acceptable.
- Positioned such that obstruction is not caused with the doors open (e.g. over the public footpath).
- In a visible location to deter vandals.
- Sited where ventilation is to free air and not adjacent to escape routes. Venting into loading bays, undercrofts or underground car parks is not acceptable.
- Positioned a minimum of ten metres from residential properties, where possible, to mitigate potential noise nuisance.
- Positioned a minimum of four metres away from the nearest building to mitigate the fire risk; if the substation is less than four metres away from the nearest building the introduction of fire mitigation measures will be required.
- Away from livestock, horses or locations where footwear is not worn (e.g. outdoor swimming pools, showers etc.). Refer to EDS 06-0014 for further information.

In some cases where load growth is anticipated, space for an additional transformer and switchgear may be required. Where provision of additional space will require expenditure by UK Power Networks, this shall be approved by the Distribution Planning Manager. In the first instance customers should discuss this with their UK Power Networks contact.

Additionally, where low voltage service connections are being provided directly from the substation the meter position shall be located no more than 20 metres from the substation. Refer to EDS 08-2100 for further details.

5.2 Customer Substation

A customer substation is defined, for the purposes of this document, as a substation supplied at 20kV, 11kV or 6.6kV that supplies a single customer at HV or LV.

In addition to the requirements detailed in Section 5.1 a customer substation shall be located on the customer’s property with unrestricted access in the customer’s site boundary.

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. Joint switchrooms with shared ownership HV switchboards and bus-section metering are not permitted. The only exceptions to this are some IDNO locations as specified in EDS 08-1101.

For further information on HV and LV supply arrangements refer to EDS 08-3100 and EDS 08-2100 respectively.
6 Substation Types

A flowchart to assist with the secondary substation selection and approval process is included in Appendix C.

6.1 Preferred Enclosure Type

The preferred substation type is a freestanding brick-built enclosure located at ground level, as it gives a robust and long-lasting housing to the equipment whilst providing an acceptable fire resistance to protect the public and adjacent infrastructure. This type shall be considered first when planning a new substation.

6.2 Alternative Enclosures

6.2.1 GRP Substations

GRP enclosures have no tested fire resistance, therefore GRP substations shall be located at least four metres away from the nearest building unless a four-hour fire barrier is provided between the substation and the next building (e.g. 215mm thick brick wall as tall as the substation enclosure).

This substation type shall be used where the risk of fire spreading to other buildings is controlled during the whole-life cycle of the substation. This is the case in secured compounds where access to the public is restricted and new building developments are not permitted within four metres of the substation or where fire barriers can be erected.

6.2.2 Integral Substations

Site constraints may require the location of the substation within a larger building, an integral substation. The integral substation shall be positioned such that at least one wall is an external wall.

6.2.3 Basement Substations

Where every alternative has been explored and a ground level substation is not possible, a basement substation may be considered with the agreement of the UK Power Networks Connections Design Manager or Distribution Planning Manager.

The following situations may prove to be suitable for a basement location, providing that all approvals are in place:

- Listed buildings where planning restrictions preclude substation access at ground floor level (it should be noted that some listed buildings can be adapted to enable a ground level substation).
- Locations where the customer cannot obtain safe and secure ground level space due to evident reasons. Loss of commercial/residential space at ground floor is not considered a valid justification.

New basement substations shall have a confined space classification of Type A as defined in Table 6-1. Type A substations have stairway access such that egress in an emergency is straight forward and quick and they may be entered by a trained person working alone, providing all necessary safety precautions. Note: New substations of Type B or Type C confined space classification are not permitted.
Any 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.

Basement substations shall have a free air ventilation system. Forced ventilation is not permitted.

An acceptable level of security consistent with its location and surroundings shall also be provided.

Form EDS 07-3101B shall be completed and submitted to UK Power Networks for review. See Appendix B.

Table 6-1 – Confined Space Definitions

<table>
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<tr>
<th>Confined Space</th>
<th>Typical Locations</th>
<th>Access and Egress Characteristics</th>
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<tr>
<td>Type A</td>
<td>• Underground substations and plant rooms.</td>
<td>• Accessed by stairway.</td>
</tr>
<tr>
<td></td>
<td>• Areas where heating boiler present.</td>
<td>• Egress in an emergency is relatively straight forward and quick.</td>
</tr>
<tr>
<td>Type B</td>
<td>• Underground substations, cable pits, air receivers and plant rooms.</td>
<td>• Accessed by vertical ladders, step irons or steep steps e.g. raked/ships ladder.</td>
</tr>
<tr>
<td></td>
<td>• Oil Pits, vessels including conservator tanks.</td>
<td>• Recovery of an injured casualty is likely to be difficult.</td>
</tr>
<tr>
<td></td>
<td>• Areas with height restrictions or obstructions such as cables or plant.</td>
<td></td>
</tr>
<tr>
<td>Type C</td>
<td>• Tunnels.</td>
<td>• Number of access/egress points.</td>
</tr>
<tr>
<td></td>
<td>• Ducts, culverts.</td>
<td>• Accessed by vertical ladders or step irons or by other means.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Work may be some distance from egress point and at depth where communication becomes difficult.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recovery of an injured casualty is likely to be difficult.</td>
</tr>
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6.3 Pad-mount Substations

Where permitted by EDS 08-3000 and EOS 09-0061 a pad-mount (micro or compact) substation without an enclosure may be used. Note, an external margin of 500mm around the concrete base of pad-mount substation is required for the installation of the earthing system.

6.4 Pole-mounted Substations

Where permitted by EDS 08-3000 and EOS 09-0061 a pole-mounted transformer may be used in place of a substation. The pole-mounted transformer shall be:

- On a pole that supports an 11/6.6kV overhead line. New free-standing pole mounted transformers are not permitted.
- As near as practical to the electrical load centre of the network to be supplied.
- Provided with safe and adequate 24 hour access for operational personnel and vehicles, including plant delivery vehicles with a lorry mounted crane.
- Installed using the safety clearances detailed in Overhead Line manual.
6.5 Outdoor Substations

The installation of new outdoor (unroofed brick or fenced enclosure) secondary substations is not permitted with the exception of Area of Outstanding Natural Beauty (AONB) schemes where a combination of pad-mount substations and ring main units may be required to provide additional network flexibility and accommodate a small load. Approval from the Distribution Planning Manager shall be obtained for any outdoor substation.

7 Land Rights and Planning Permission

As and when required all Land Rights shall be secured in accordance with the property and consents acquisition policy EDP 08-0009 or CON 08 111.

Planning Permission is required in all instances where a new substation enclosure is to be established. For enclosures NOT exceeding 29 cubic metres permitted development rights exist under Class G, Section 17 of the Town and Country Planning (General Permitted Development) Order 1995. The Local Planning Authority should be notified of the intention to construct the substation either under Permitted Development or via a full Planning Application.

Where a customer connection or installation is made on land owned or operated by a developer, it is the responsibility of the landowner/developer to obtain all Planning Permissions prior to the commencement of any substation works to be carried out by UK Power Networks. A copy of the approval shall be provided to UK Power Networks prior to the design being agreed.

7.1 Ring Connected Substations or Substations with Interconnected LV

For land rights refer to property and consents acquisition policy EDP 08-0009 or CON 08 111.

7.2 Single Leg/Teed Connections without Interconnecting LV

Land rights are not required for substation sites and cables that do not form part of the distribution network, only supply single customers and are on land owned by the customer, provided they can be disconnected without interfering with other network operations.

Access and wayleave arrangements in such cases shall be contained in the Connection Agreement. This shall make it clear that the right to be and remain connected relies on rights for UK Power Networks equipment and access remaining in place. The Connection Agreement shall specify that in the event of the sale of land to a third party, easements shall be provided for cables and equipment on the land prior to the sale. In addition, easements shall be obtained for all cables crossing land owned by third parties.

7.3 Short Lease Times

Substations installed for customer supplies where lease times are limited shall be dealt with in accordance with the current customer connection charging standard. Where the intended life of a supply is five years or less the connection shall be treated as a temporary supply.
7.4 Plot Size Guidelines

7.4.1 Freestanding Brick-built Substations

Figure 7-1 – Freestanding Brick-built Substation Land Requirement

Figure 7-2 – Freestanding Two-Transformer Brick-built Substation Land Requirement
7.4.2 GRP Substations

Note that transformer deliveries to GRP substations use a crane to lift away the GRP enclosure, for this a 6.5m headroom is required at all times.
7.4.3 Integral Substations

Figure 7-4 - Integral Substation Land Requirement

Figure 7-5 – Integral Two-transformer Substation Land Requirement
7.4.4 Basement Substations

For basement substations room size refer to Section 7.4.2. Added to this, ducts for ventilation from basement to ground level shall be allowed for.

8 Records

All decisions and risk assessments completed at the pre-design stage shall be retained with the project file for reference and made available throughout next stage of the project where the detail design is developed.
9 References

9.1 UK Power Networks Standards

- EDS 06-0014 Secondary Substation Earthing Design
- EDS 07-3102 Secondary Substation Design and drawings
- EDS 08-1101 Guidance for the Application of ENA Engineering Recommendation G88 and G81 Inset Networks (IDNOs and other Licensed DNOs)
- EDS 08-2100 LV Customer Supplies
- EDS 08-3000 11/6.6kV Distribution Network Design
- EDS 08-3100 HV Customer Supplies
- EDP 08-0009 Property & Consents – Consent Acquisition Policy (internal document only)
- EOS 09-0061 Assessing the risk to the public from Distribution Network Assets
- CON 08 111 Competition in Connections ICP Consents Policy

9.2 National and International Standards

- Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002
- Construction Design and Management Regulations 2015 (CDM 2015) [Link]
- Environment Agency flood website [Link]
- Regulatory Reform (Fire Safety) Order 2005
- Control of Pollution (Oil Storage) (England) Regulations 2001
- Water Resources Act 1991
- Environment Act 1995
- Environmental Protection Act 1990
- Department of Energy & Climate Change Code of Practice ‘Power Lines: Demonstrating compliance with EMF public exposure guidelines’
- International Commission on Non-Ionising Radiation Protection (ICNIRP, 1998)
Appendix A – Pre-design Checklist
Form EDS 07-3101A contains a pre-design checklist to assist with applying this standard.

Appendix B – Substation Basement Justification Form
All basement substation substations require justification and individual approval by UK Power Networks Connections Design Manager or Distribution Planning Manager.

In order to ensure that all due consideration has been given to assessing the substation location options, form EDS 07-3101B shall be completed and submitted to UK Power Networks for assessment.
Appendix C – Secondary Substation Decision Flowchart

Substation Required

- Ground level freestanding brick-built substation?
  - YES
  - Substation integral to new/existing structure at ground level?
    - YES
    - Design and build in accordance with EDS 07-3102
    - UK Power Networks Connections or Distribution Planning to approve design
    - NO
    - GRP substation 4m away from nearest building?
      - YES
      - NO
      - CAN all safety, access, maintenance, and operational issues be addressed?
        - YES
        - NO
        - NO
        - YES
        - NO

Find alternative location

- NO