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# NSP/008/001 - Guidance on Distribution Substation Design: Substation Heating Lighting and 240/415V Socket Outlets

## 1. Purpose

The purpose of this document is to provide design guidance on heating and lighting systems installed in distribution substations installed on the Northern Powergrid network. It has been prepared to satisfy the requirements of ESQCR.

This document supersedes the following documents, all copies of which shall be destroyed.

Reference	Date	Version	Title
NSP/008/001	July 2012	1.0	Guidance on Distribution Substation Design: Substation Heating Lighting and 240/415V socket outlets

## 2. Scope

This design guidance shall be applied to all new or refurbished distribution substations on the Northern Powergrid network.

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### 3. General

The heating, lighting and 230/400V sockets shall be in accordance with current editions of BS7671 (the IET Wiring Regulations). The arrangements whilst varying greatly in detail from site to site shall be generally as shown in the drawings included within this document.

Components and equipment must be of a type approved for use in Northern Powergrid substations.

#### 3.1. Substation Heating

##### 3.1.1. Design Principles

Where rooms within the substation contain electrical apparatus (other than the heating, lighting etc. that is the subject of this specification) or other items which require protection from low temperatures (water pipes, cisterns, compressors etc.) then heating shall be provided. In any room of less than 50m<sup>3</sup> in size, the presence of a power transformer within the room will provide sufficient heating of the immediate area, and additional heating is not required. Heating installations as shown on the general layout drawings are based on the following principles which shall be applied where the standard layout is being adapted to a particular project:-

The substation heating is to be designed to maintain a minimum temperature of 5°C in each of the rooms with an external temperature of -5°C. The building heat loss shall be taken as 0.45W/m<sup>2</sup>C.

Heaters shall be:

- tubular; with guard;
- finned type with wire guards;

Each heater or bank of heaters shall have a fused, double pole switched; connection unit fitted with neon indication.

For secondary substations, all the heaters within each room shall be controlled by a single thermostat. Thermostats set at 15°C.

Thermostats are to be placed, so far as reasonably practicable:

- Away from any equipment that could produce heat and cause incorrect operation;
- 1 metre above floor level;
- Near cable trenches and external doors.

Thermostats shall control the heating and be LOT 20 compliance.

#### 3.2. Substation Lighting

##### 3.2.1. Internal Lighting (including transformer enclosures)

The standard lighting arrangements are shown in the Standard Heating and Lighting Layout drawings included within this document and are based on the following principles that shall be applied where the design is being adapted to a particular project:

Lighting is designed to 200 lux but the height and position of equipment will dictate the quantity and size of lighting required. Rarely accessed areas to the rear of switchgear and transformers need not be illuminated to the 200 lux level but shall still be at least 100 lux, to permit basic inspections activities. Where substation dimensions require, extra light fittings shall be installed to provide adequate luminance to all areas.

General purpose luminaries shall be twin LED, impact resistant type to comply with BS 4533 and shall be fitted with a polycarbonate prismatic diffuser, preferred size is 1500mm. / LED Wattage (37w).

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LED lights shall comply with BS EN 62560 and have a colour temperature of 3500K (white appearance).

Luminaires shall have a minimum degree of protection of IP42 to BS EN 60529. If substation is susceptible to water ingress (underground, vault, basement etc.) install in lieu of others IP 56 rated light switches to BS EN 60529 and IP 65 rated corrosion resistant luminaires to BS 4533.

Within cable basements where LED luminaires are fixed directly to conduit boxes, the final circuit wiring may be terminated within the luminaire.

The wiring shall enter each luminaire at the conduit entry nearest to the terminal block and, where a loop in wiring system is used, leave by the same entry. Wiring shall not pass through the luminaire.

Substations with multiple rooms shall have an intermediate light switch at each room access.

If the ceilings are higher than 2.5m then consideration of wall mounted fittings with reflectors shall be provided, wherever possible mounted 2m from floor level for ease of maintenance. Whilst the above is a guide consideration shall be made as to the reflectivity of the ceiling, walls and floor to enable the correct lighting levels to be achieved.

Consideration must be given to the requirements for maintaining both ceiling, suspended and wall mounted fittings. Fittings must not be wall mounted directly above open exposed LV Wall Board and careful consideration of placement for ceiling fittings placed adjacent to or in front of the open exposed LV Wall Board should be carried out.

Light switches shall be carefully positioned such that the lighting is controlled without accessing the room beyond the main access door area. The switch shall be positioned at no more that 1200mm from FFL and in one of two places as indicated below dependent upon the door arrangement:

- Single door arrangement – Switch to be positioned on the internal wall to which the door locks.
- Double door arrangement – Switch to be positioned on the internal wall up on which the opening door is hung.

In both the above cases, if the switch is located adjacent to an exposed LV wall board then a substantial barrier (Perspex or Plywood) shall be affixed to the wall between the switch and the LV wall board, this barrier shall be 1m in length and protrude sufficient distance (approx. 300mm) and positioned, such as to prevent inadvertent contact with the LV wall board whilst trying to locate the switch in the dark. This barrier shall not touch or interfere with the normal operations on the LV Board.

### 3.2.2. Emergency Internal Lighting

There shall be no requirement for provision of emergency lighting.

### 3.2.3. Exterior Lighting

Building exterior lighting whilst generally not required, will when deemed necessary be provided by 240 V, IP44 or better, Vandal proof, low energy bulkhead LED fittings, with screw fixing diffuser mounted as directed. Bulkhead lighting will be controlled by a switch mounted internally adjacent to the substation main access door or door used to access the outdoor area and labelled as “Outside Lighting”. Care must be taken when selecting fittings and lamps to ensure that they are suitable for this purpose.

### 3.2.4. Compound Lighting

Building exterior compound lighting whilst generally not required will where required provide substation compound illumination to give general background lighting of 20 lux average via wall or column mounted IP55 Vandal proof LED flood lights. The compound lighting is to be switched from inside the substation main access door or door used to access the outdoor area and labelled as “Outside Lighting”.

Wall mounted lighting shall be used where possible but where necessary this shall be supplemented by hinged column mounted floodlights. Lighting columns located within live compounds shall be hinged and

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be a maximum of 3m high (typically a Stainton Tyne column reduced to 3m) to allow ease of maintenance. Lighting columns shall be installed a minimum of 2m from any fence and suitably earthed.

Where lights are installed it is necessary to ensure electrical clearances are sufficient to allow maintenance of the equipment.

### 3.3. Vandal Prone Areas

Where vandalism is known to exist, special measures shall be taken to prevent damage to the external lighting system. Such measures shall include high vandal-resistant bulkhead fittings with additional robust steel mesh or perspex covers where necessary. Where such measures would not be effective consideration may be given to omitting exterior lighting where street lighting provides sufficient illumination.

### 3.4. 240V Sockets

Distribution substations require minimal power sockets and these are only to facilitate maintenance activities on an infrequent basis. If Unit Distribution Equipment (UDE) is installed within a typical purpose built UDE enclosure or building then the installation of a socket in addition to the one provided as part of the UDE plant is required as noted on the layout drawings.

In non UDE distribution substations then additional socket outlet(s) shall be provided and positioned where its use for future maintenance would be most beneficial, whilst reducing the risk from trailing leads. It is not expected that all rooms will require a socket to be fitted (i.e. store rooms/passageways etc.). The socket shall not be positioned so close to an exposed LV board that its use would give rise to increased risk (recommend positioning at least 1.5m horizontal distance away).

The guide to socket positioning is shown in the Standard Heating and Lighting Layout drawings. Socket positioning shall not restrict the installation of future equipment.

Fittings shall be corrosion resistant, PVC, surface mounted complying with BS 1363.

Install as a minimum one No.13A twin switched socket outlet (to BS 1363 Part 2).

Residual current devices where included in sockets shall comply with BS 61009 with a tripping sensitivity of 30mA and an operating time of 40ms at x 5 of the operating current. NPS 006 002

Unless otherwise specified, sockets and switching devices shall be of the surface mounted type.

In external areas or in areas subject to dust or splashing water accessories are to be IP65 rated.

Switched/unswitched fused connection units shall be fitted adjacent to all low voltage fixed equipment.

If a substation is susceptible to water ingress (underground, vault, basement, etc.) all fittings shall be IP 56 rated and conform to BS 1363 and BS EN 60529.

### 3.5. Distribution Board

Plastic 6 way 8 module (minimum) (to BS EN 60439-3 and BS 5486-12, -13) (unless installed within open bus bar environment then insulated board to be fitted) to include:

- Double pole 100A isolator.
- MCBs (to BS EN 60898) with 15kA breaking capacity to provide: Refer to layout drawing.
- RCBO (to BS EN 61009 )
- Potential circuits as listed below:
  - i. Socket circuit.
  - ii. Lighting circuit.
  - iii. Heating circuit (if applicable).

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- iv. RTU unit circuit.
- v. Fault passage indicator.
- vi. Circuit Breakers are to be Type D for Battery Chargers.
- vii. Leave spare ways for future requirements complete with blanking plates.

Ratings of protective devices are as shown on layout drawings. The maximum prospective fault current shall be tested at the consumer unit upon completion to ensure the value is not greater than the short circuit capacity of the protective device, Alternative protective device may be required in this is the case.

Where the distribution board is fed directly from the LV distribution network then the incoming device needs to be an appropriately rated switch fuse or MCCB.

Where no suitable supply can be safely obtained from the LV Distribution Wall Board/Cabinet then the supply shall be obtained from via an LV cut out serviced from the LV network. The consumer unit is to be fitted adjacent to a cut-out at a suitable height and location to allow operation from ground level.

### 3.6. 240V Auxiliary Equipment Un-switch Fused Connection Unit

Un-switched fused connection units will be installed to allow connection of existing auxiliary equipment within the substation and this is predominately battery charger units and system automation remote telemetry units & actuators.

The un-switch fused connection unit shall be placed adjacent to the equipment to be supplied and be easily identifiable as supplying that item of equipment. The connection cable from the equipment to the connection unit shall not be overly long and shall be securely affixed to the surface.

### 3.7. Cabling

Cables shall be 90°C thermosetting insulated LSF stranded copper with minimum sizes of 1.5sq.mm for lighting circuits, 2.5sq.mm for power circuits. Heating circuits shall be min. 2.5sq.mm, final size shall be calculated dependant on the number of heaters and the protective MCB's/RCBO's provided. Cables shall be 6491X – PVC insulated cables to BS 6004. Insulation shall be phase coloured. CPC size shall be equal to the Line conductors.

- RMU – To be sized accordingly.
- Transformer/UDE - 6mm<sup>2</sup> tails (cut-out to consumer unit).

All other LV wiring can be 90°C PVC insulated and for external sub main/final circuits LSF/XLPE/SWA.

Multicore flexible cables may be used for flex outlet wiring accessories, providing the voltage is 230V or below.

Cables shall be installed without joints other than at equipment and terminal fittings.

Armoured cables complying with BS 6724:2016 shall be used in external situations and other areas where the environment is considered unsuitable for conduit/ trunking enclosed cables. Armoured cable shall be installed:

- Secured adequately using proprietary clips and nonferrous screws.
- With galvanised steel guards where mechanical damage is likely.
- With moisture poof connection to fittings using sealed glands and PVC shrouds.

### 3.8. Trunking and Conduit

Cables shall be enclosed in heavy gauge PVC conduit of diameter 20/25mm diameter and fixed to surfaces with spacer bar saddles. In situations where trunking is more appropriate it shall be high impact white plastic and of minimum 50mm x 50mm.

With the exception of external armoured cables and consumer unit tails, all cables shall be enclosed in trunking or conduit.

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Trunking shall comply with the requirements of BS EN 61084. Sizes shall be determined to comply with the requirements of BS7671, including due allowance for all likely future supplies, unless otherwise described.

Cable trunking shall be installed either vertically or horizontally using manufacturer’s standard bends, elbows and tees with expansion joints fitted at all structural expansion points (where applicable). Support at intervals of no more than 2m horizontally or 2.5m vertically.

Size of trunking shall be adequate for the number of cables together with 25% spare capacity.

Non-flammable barriers shall be inserted where trunking passes through walls or ceilings to provide fire resistance.

Holes in trunking shall be made only by hole saw or other approved method.

Within open board areas all containments shall be high impact, non-flame propagating, self-extinguishing, heavy duty PVC to BS EN 50086. PVC conduit fittings shall comply with BS 4607.

Install sufficient junction boxes, draw in boxes and inspection fittings so that the cables can be inspected, withdrawn, and replaced if necessary.

The whole of the installation shall be arranged for a loop in type of system with joints being carried out at switches, isolators or appliance fittings.

All boxes and accessories shall be secured independently. Distance saddles shall be used to fix surface mounted conduit to provide a minimum clearance of 6mm. Saddles shall be placed at intervals of no more than 1.5m and not more than 200mm from any bend, joint or accessory.

Joints between conduits may be push fit, compression, mechanical locking or socket end sealed with PVC adhesive. Where weatherproof or watertight connection is required push fit arrangement alone is not acceptable.

Purpose made bends may be used providing the cable bending radius is maintained. Cracked or crinkled conduit is not acceptable.

Adaptable boxes and accessories shall be made from heat resistant insulating material.

All accessories shall be fitted with earthing terminals.

Trunking and accessories shall comply with BS EN 61084 and shall be of rigid PVC which is suitable for indoor use, self-extinguishing, and shall not propagate flames.

All PVC conduits & trunkings installed within escape routes or installed on ceilings shall comply with regulation 521.10.202 of BS 7671; this will also apply to accessories fixed to the ceiling.

Where substations are being refurbished or rewired and existing metal containment system exist, then these can be utilised for the wiring of new LV circuits providing they are in a sound condition and fit for purpose.

Please note any holes within the trunking not utilised for the wiring of the new LV circuits shall be ‘blanked off’ or made good, the trunking shall not be utilised as a CPC for the LV circuits and should be connected to internal substation earth in at least one position dependant on continuity readings of the trunking. Consideration shall be made on the type of earthing installed (Hot or Cold site).

### 3.9. Earthing and Bonding

Earthing systems shall comply with the BS Code of Practice 1013, IET wiring regulations BS 7671 and Northern Powergrid Earthing Manual IMP/010/011,

Full cross bonding to main earthing terminal of all exposed extraneous conductive parts (including water pipes etc.) shall be included in accordance with BS 7671 specifications and requirements.

Northern Powergrid Earthing Manual IMP/010/011 identifies requirements for situations where separation of earthing systems is necessary. Also identified is the acceptable size of conductor for bonding of building elements (roofs, doors etc.)

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### 3.10. Labelling

All labelling to comply with BS 7671 IET Regulations and all circuits shall be identified as per regulation 514.

### 3.11. Miscellaneous

All miscellaneous fittings (water heaters, fans, sump pumps, alarms, dehumidifiers, battery chargers, etc.) shall be connected via fused connection outlets or wired directly to the consumer unit and allocated a separate circuit and MCB/RCBO.

Armoured cable installations shall terminate at a suitable location within the substation, and connect to the internal wiring circuit via a fused connection outlet.

### 3.12. Testing and Certification

Upon completion of the works, the installation shall be tested in accordance with BS 7671, and an electrical installation certificate together with a schedule of test results as detailed in BS 7671 shall be forwarded to Northern Powergrid.

Statutory notices shall be installed as required to reflect recent changes in phase colours.

### 3.13. Preferred Equipment

The following list is provided in order to provide currently approved fittings. This also provides indication on the quality of fittings to be installed where otherwise not stated as part of the substation heating & lighting equipment:-

#### 3.13.1. Internal lighting

LED strip lighting.

Ansell Lighting or equivalent.

ATORPLED2X5/HO/1 for a 5ft double fitting Ansell Lighting 'Guardian'. or equivalent.

#### 3.13.2. External Bulkhead Lighting

Self-contained, surface mounted, IP56, emergency bulkhead.

#### 3.13.3. Light Switches Internal

Surface mounted heavy-duty PVC MK or equivalent

#### 3.13.4. Switched Fixed Appliance Connection Unit

Surface mounted heavy-duty PVC MK or equivalent.

#### 3.13.5. Non Switched Fixed Appliance Connection Unit

Surface mounted heavy-duty PVC MK or equivalent.

#### 3.13.6. Double Switched Sockets

Surface mounted heavy-duty PVC MK or equivalent.

#### 3.13.7. Heaters

Dimplex or equivalent Tubular Heaters with mounting stands and link kits and unearthed protective guards as required:

ECOT1FT - 40W - 408mm Length - 0.5kg - approx usage 0.18 amps



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ECOT2FT - 80W - 713mm Length - 0.6kg - approx usage 0.36 amps

ECOT3FT - 120W - 960mm Length - 0.8kg - approx usage 0.52 amps

ECOT4FT - 160W - 1323mm Length - 1.0kg - approx usage 0.70 amps

ECOT5FT - 200W - 1570mm Length - 1.1kg - approx usage 0.86 amps

ECOT6FT - 240W - 1933mm Length - 1.3kg - approx usage 1.04 amp

### **3.13.8. Consumer Unit**

5/8 way Module PVC unit. refer to layout drawings for requirements.

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## 4. References

### 4.1. External Documentation

Reference	Title
	IET wiring regulations BS 7671

### 4.2. Internal Documentation

Reference	Title
C1010061	Internal power and lighting details for 11KV HV panel Substation
C1010062	Internal power and lighting details for 11KV RMMU with optional extensible switch
C1010063	Internal power and lighting details for 315 – 1000KVA slide in UDE Substation
C1010064	Internal power and lighting details for 11KV RMU cable connected 1600KVA TX and 2500A ACB
C1117166CF	Internal power and lighting details for 315 – 1000KVA UDE Substation
IMP/010/011	Code of Practice for Earthing LV Networks and HV Distribution Substations.
NPS/003/031	Technical Specification for Room Thermostats, Humidistat's and Boost Facility

### 4.3. Amendments from Previous Version

Reference	Description
Full document review	

## 5. Definitions

Term	Definition
n/a	

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## 6. Authority for Issue

### 6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		<b>Date</b>
Liz Beat	Governance Administrator	11/03/2024

### 6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

**Review Period** - This document should be reviewed within the following time period.

Standard CDS review of 3 years	Non Standard Review Period & Reason	
Yes	Period: n/a	Reason: n/a
<b>Should this document be displayed on the Northern Powergrid external website?</b>		Yes
		<b>Date</b>
Mark Thompson	Specification and Design Manager	12/03/2024

### 6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		<b>Date</b>
Ben Wilson	Substation Design Engineer	25/03/2024

### 6.4. Authorisation

Authorisation is granted for publication of this document.

		<b>Date</b>
Dave Sillito	Head of Major Projects	21/03/2024