Electricity Distribution

nationalgrid

Company Directive

STANDARD TECHNIQUE: SD5A/6

Design of Low Voltage Domestic Connections

Policy Summary

This Standard Technique specifies the requirements for the design of LV domestic connections to National Grid's distribution networks.

Author: **Matthew Pope & Seth Treasure**

Implementation Date: **October 2022**

Approved by:

Carl Ketley-Lowe
Engineering Policy Manager

Date: **6th October 2022**

Target Staff Group	**Staff involved in the design, installation, maintenance and operation of the LV system.**
Impact of Change	**Amber - Changes affect staff involved in the design, installation, maintenance and operation of the LV system.**
Planned Assurance checks	**Managers shall ensure that all staff involved in the design, installation, maintenance and operation of the LV system are familiar with, and follow, the requirements of this document.**

IMPLEMENTATION PLAN

Introduction

This document specifies the requirements for the design of low voltage domestic connections to National Grid's network.

Main Changes

This document has been updated as follows:

- References to Western Power Distribution and WPD have been replaced;
- ADMDs associated with Heat Pump heated homes have been amended;
- A Heat Pump section has been added, including the definition and assessment requirements for 'Cold Load Pick-up';
- Standard Import Capacities, offered to new or substantially modified whole-current metered premises, have been amended, from 15kW per phase to those in Table 3;
- A reference to the additional mechanical protection requirement, for above ground service cables has been included (see also ST: OH6A);
- Clarity has been added to inform that, when a termination is to be housed in an outside meter box, a three-phase meter box should be utilised, irrespective of phase availability;
- Ducting sizes have been standardised;
- Clarity around the acceptability of single-phase PMTs has been included;
- A small number of examples for where it is still acceptable to use single-phase service assets have been included;
- A requirement for developers to vary / rotate the phases to which single-phase equipment is connected in three-phase installations has been included;
- Information has been included for National Grid's preferred cable bunching methodology;
- Non-exhaustive sections on Temporary Supplies and Service Alterations & Augmentations have been added;
- A section on multiple connections to a single premises has been added;
- The term 'multi-phase' has been replaced with 'polyphase';
- References to WinDebut have been altered to refer to Connect/LV;
- Housekeeping.

Impact of Changes

Staff involved in the design, installation, maintenance and operation of the LV system must be made aware of the latest amendments to this document, as changes have been introduced to how domestic connections to National Grid's distribution networks are designed.

Target Staff Group	**Staff involved in the design, installation, maintenance and operation of the LV system.**
Impact of Changes	**Amber - Changes affect staff involved in the design, installation, maintenance and operation of the LV system.**

Implementation Actions

Changes to this document shall be disseminated to the business by the Policy Dissemination Engineers in Q4 2022 and Q1 2023.

Implementation Timetable

This Standard Technique shall be implemented with effect from 1st January 2023, for any new or substantially modified connections. Revisions that impact upon stock levels shall have an implementation date of 1st April 2023, to allow existing stock to be run down.

Quotations issued prior to the implementation date, and that were designed in accordance with ST: SD5A/5, may continue to completion, so long as the milestones outlined in their Connection Offer are met. Should any quotation require revision on or after the implementation date (e.g. in the event that a milestone is not achieved), this document ST: SD5A/6 must be applied in full.

REVISION HISTORY

Document Revision and Review Table		
Date	**Comments**	**Author**
October 2022	• References to Western Power Distribution and WPD have been replaced with National Grid; • ADMDs associated with Heat Pump heated homes have been amended; • A Heat Pump section has been added, including the definition and assessment requirements for 'Cold Load Pick-up'; • Standard Import Capacities, offered to new or substantially modified whole-current metered premises, have been amended, from 15kW per phase to those in Table 3; • A reference to the additional mechanical protection requirement, for above ground service cables has been included (see also ST: OH6A); • Clarity has been added to inform that, when a termination is to be housed in an outside meter box, a three-phase meter box should be utilised, irrespective of phase availability; • Ducting sizes have been standardised; • Clarity around the acceptability of single-phase PMTs has been included; • A small number of examples for where it is still acceptable to use single-phase service assets have been included; • A requirement for developers to vary / rotate the phases to which single-phase equipment is connected in three-phase installations has been included; • Information has been included for National Grid's preferred cable bunching methodology; • Non-exhaustive sections on Temporary Supplies and Service Alterations & Augmentations have been added; • A section on multiple connections to a single premises has been added; • The term 'multi-phase' has been replaced with 'polyphase'; • References to WinDebut have been altered to refer to Connect/LV; • Housekeeping.	Matt Pope

CONTENTS

1.0 INTRODUCTION

1.1 This document provides guidance on design of low voltage domestic connections.

1.2 National Grid staff and contractors use Connect/LV software to carry out load flow and protection studies for domestic connections. Independent Connection Providers (ICPs) may either use Connect/LV[1] or other alternative systems as long as the criteria specified in this document and ST: SD1F are satisfied.

1.3 Where there is any difficulty in implementing this Standard Technique (ST) the Engineering Policy Team shall be notified and shall determine whether or not a variation is appropriate.

2.0 CUSTOMER INFORMATION

2.1 The first stage is to obtain relevant information on the connection requirements from the customer / developer. Further guidance for National Grid staff / contractors on Minimum Information requirements is included in ST: NC1Y.

3.0 LOAD ESTIMATES

3.1 The estimated annual kWh consumption and the After Diversity Maximum Demand (ADMD) of each property can be estimated using Table 1 and Table 2, respectively. The ADMD of a property is the maximum demand that is assumed at the time at which peak demand occurs on the substation or LV circuit.

3.2 <u>Substation and LV Circuit Ratings</u>

3.2.1 The preferred method of determining the maximum demand on a substation or on an LV circuit is to enter the estimated annual consumption information and the expected profile type for each connection into Connect/LV, the software used by National Grid for LV network design. Connect/LV uses this information to calculate load requirements. Further guidance on the use of Connect/LV is provided in ST: SD5H.

3.2.2 An alternative method of determining the maximum demand requirements for a substation or a substantial LV circuit is to sum the ADMD values estimated for each connection. This method is likely to under estimate the load if applied to a low number of connections (fewer than 20). Where a small number of connections are made to the substation or cable then it is more appropriate to sum the Maximum Demand (and not the ADMD) for each individual connection.

[1] Connect/LV is National Grid's favoured LV load flow software. At the time of writing this document, Connect/LV was not widely available outside of National Grid. It was, therefore, assumed that ICPs would be using an alternative system, such as WinDebut, to fulfil the requirements of this document.

Table 1 Estimated Annual Consumption for Domestic Properties

<table>
<tr><th rowspan="2">Description of Heating</th><th rowspan="2">Connect/LV Profile</th><th colspan="2">1 Bedroom</th><th colspan="2">2 Bedroom</th><th colspan="2">3 Bedroom</th><th colspan="2">4 Bedroom</th><th colspan="2">5 Bedroom</th></tr>
<tr><th>Day kWh</th><th>Night kWh</th><th>Day kWh</th><th>Night kWh</th><th>Day kWh</th><th>Night kWh</th><th>Day kWh</th><th>Night kWh</th><th>Day kWh</th><th>Night kWh</th></tr>
<tr><td>Gas Central Heating</td><td>Elexon 1</td><td colspan="2">1900+A+E</td><td colspan="2">2650+A+E</td><td colspan="2">3600+A+E</td><td colspan="2">4200+A+E</td><td colspan="2">4800+A+E</td></tr>
<tr><td>Electric E7 Heating</td><td>Elexon 2</td><td>1900 +A+E</td><td>1300 +B+C+F</td><td>2700 +A+E</td><td>1560 +B+C+F</td><td>3500 +A+E</td><td>1950 +B+C+F</td><td>4100 +A+E</td><td>2200 +B+C+F</td><td>4650 +A+E</td><td>2200 +B+C+F</td></tr>
<tr><td>Electric E10 Heating</td><td>Economy Ten</td><td colspan="2">1900+D+E</td><td colspan="2">2650+D+E</td><td colspan="2">3600+D+E</td><td colspan="2">4200+D+E</td><td colspan="2">4800+D+E</td></tr>
<tr><td>Heat Pumps</td><td>See Table 2</td><td colspan="2">Use ADMD method (See Table 2)</td><td colspan="2">Use ADMD method (See Table 2)</td><td colspan="2">Use ADMD method (See Table 2)</td><td colspan="2">Use ADMD method (See Table 2)</td><td colspan="2">Use ADMD method (See Table 2)</td></tr>
<tr><td>Other Non-electric Central Heating</td><td>Elexon 1</td><td colspan="2">2150+A+E</td><td colspan="2">2900+A+E</td><td colspan="2">3900+A+E</td><td colspan="2">4600+A+E</td><td colspan="2">5300+A+E</td></tr>
</table>

Where:

A = 640 x total kW rating of any direct heating.
B = 160 x total kW rating of any direct heating.
C = 800 x total kW rating of any ‘off peak’ heating (e.g. storage heaters).
D = 800 x total kW rating of the electric heating and electric water heating load. For existing connections add together the unrestricted and restricted units together.
E = 1000 x total kW rating of any electric vehicle charging points.
F = 300 x total kW rating of any electric vehicle charging points.

Table 2 Estimated ADMD Values (kW) for Domestic Properties

Description of Heating	Connect/LV Profile	1 Bedroom		2 Bedroom		3 Bedroom		4 Bedroom		5 Bedroom	
		Day kW	Night kW	Day kW	Night kW	Day kW	Night kW	Day kW	Night kW	Day kW	Night kW
Gas Central Heating	Elexon 1	0.9+A+F		1.3+A+F		1.7+A+F		2.0+A+F		2.3+A+F	
Electric E7 Heating	Elexon 2	1.3 +A+F	1.3 +B+C+F	1.8 +A+F	2.0 +B+C+F	2.3 +A+F	2.5 +B+C+F	2.7 +A+F	2.8 +B+C+F	3.1 +A+F	2.9 +B+C+F
Electric E10 Heating	Economy Ten	1.3+D+F		1.8+D+F		2.3+D+F		2.7+D+F		2.9+D+F	
Heat Pumps	Constant	0.9+D+E+F		1.3+D+E+F		1.7+D+E+F		2.0+D+E+F		2.3+D+E+F	
Other Non-electric Central Heating	Elexon 1	0.9+A+F		1.3+A+F		1.7+A+F		2.0+A+F		2.3+A+F	

Where:

A = 0.2 x total kW rating of any direct heating.
B = 1.0 x total kW rating of any direct heating.
C = 1.0 x total kW rating of any 'off peak' heating (e.g. storage heaters).
D = 1.0 x total kW rating of the electric heating and electric water heating load.[2,3,4]
E = 0.7 x total kW rating of any Heat Pump compressors.
F = 0.5 x total kW rating of any electric vehicle charging points.

[2] For existing connections add together the unrestricted and restricted units;

[3] Including any immersion, back-up or boost heating elements, but excluding Heat Pump compressors;

[4] For Heat Pumps only: Any electric water heating load which is: i) not used in normal operating conditions; ii) only operated intermittently (i.e. no more than once per week) for a short period of time (circa five minutes) to prevent legionnaires' disease in the water system; and iii) only used as back-up if the Heat Pump fails, may be excluded from the ADMD calculation, as the heating element is assumed to be accounted for in the maximum electrical input power of the Heat Pump.

3.3 Service and Cut-out Ratings

3.3.1 Unless formally agreed otherwise, in writing (e.g. in an Acknowledgement Letter or a Connection Agreement), the standard import capacities that shall be offered to individual whole-current metered connections[5] are shown in Table 3, below:

Table 3 Standard Import Capacities for Whole-Current Metered Connections

Connection Use	Metered Phases		
	Single-Phase	Split / Two-Phase[6,7]	Three-Phase
Domestic	18.4kW *(80A)*	27.6kW *(60A)*	41.4kW *(60A)*
Non-Domestic	18.4kW *(80A)*	36.8kW *(80A)*	55.2kW *(80A)*

All connections shall be designed in accordance with ST: SD5D, and fused appropriately.

3.3.2 When building a network model, the single 'worst case'[8] whole-current metered connection in said network shall be modelled as a fixed maximum demand using the most applicable value from Table 3, for voltage drop considerations and to ensure service assets are adequately sized. Where it has been formally agreed for National Grid to supply a greater import capacity than those in Table 3, this greater capacity shall be used.

Where more than one phase is utilised, by the 'worst case'[8] connection, and it is reasonable to believe that consumer loads will be unbalanced, the connection shall be modelled as an unbalanced load, in accordance with ST: SD5H.

3.3.3 The Maximum Demand (MD) for a single domestic connection can normally be determined using the following formulae, however, where the customer is known to have additional electrical equipment that is likely to increase the demand then these values may need to be increased. Examples of such additional equipment include multiple high power electric showers, kilns etc.

Properties with Gas Central Heating or other Non-Electric Heating:

- MD = 2 x ADMD + 8kW

Properties with Economy 7 Electric Heating:

- MD (day) = 2 x ADMD (day) + 8kW
- MD (night) = ADMD (night) + 4kW

Properties with Economy 10 Electric Heating or a Heat Pump:

- MD = ADMD (day) + 4kW

[5] These capacities apply to whole-current metered connections that were designed on or after the implementation date of this Standard Technique: SD5A/6. Whole-current metered connections designed before this date are likely to have an Agreed Import Capacity of 15kW (65.2A) per metered phase, unless agreed otherwise;
[6] Two phases of a three-phase system;
[7] Two-phase connections shall not be provided where the mains cable or overhead line has three-phases available.
[8] The 'worst case' connection, for the purposes of this document, is the connection that, when modelled at its Agreed Supply Capacity (including unbalance, where applicable), creates the greatest voltage drop.

3.3.3.1 Example 1:

A two bedroom property has 2.5kW of direct heating and 8kW of electric storage heaters and uses an Economy 7 off peak tariff (or equivalent). The following values apply [9]:

- ADMD (Day) = 1.8 + (0.2 x 2.5) + (0.5 x 7.36) = 3.64kW
- ADMD (Night) = 2.0 + (1.0 x 2.5) + (1.0 x 8.0) + (0.5 x 7.36) = 16.18kW
- MD (Day) = ADMD (day) x 2 + 8kW = (3.64 x 2) + 8 = 15.28kW
- MD (Night) = ADMD (night) + 4kW = 16.18 + 4 = 20.18kW

The service, cut-out and cut-out fuse will all have to be suitable for at least 20.18kW (i.e. 87.7A at 230V). In most cases where load exceeds 80A, it is preferable to offer multiple phases. In some cases, however, the use of a 100A fuse may be acceptable, subject to the requirements of this document and those within ST: SD5D being satisfied.

3.3.3.2 Example 2:

A three bedroom property has a heating system that comprises a 5kW Heat Pump module plus a 3kW back-up heating element, intended to be used in normal operating conditions, and also has a 7.36kW EV charge point. For an unrestricted tariff, the following values apply:

- ADMD = 1.7 + (1 x 3.0) + (0.7 x 5.0) + (0.5 x 7.36) = 11.88kW
- MD = ADMD + 4kW = 11.88 + 4 = 15.88kW

The service, cut-out and cut-out fuse will all have to be suitable for at least 15.88kW (i.e. 69.0A at 230V). In this case National Grid's standard 80A cut-out fuse would be applicable.

3.4 Generation

Where domestic customers utilise generation it is often necessary to carry out studies to represent periods of maximum generation and minimum demand. Under these circumstances the following 'rules of thumb' may be applied:

- For circuit / substation design purposes the 'Minimum Demand'[10] associated with domestic load is assumed to be as detailed in ST: SD5H.

- Diversity may be assumed between wind turbines and PV systems, due to the unlikelihood of the maximum outputs of these two technology types occurring simultaneously. It is advised to use either 100% of the rating of the PV + 50% of the rating of the wind turbines or 50% of the rating of the PV systems + 100% of the rating of the wind turbines, whichever is the greater.

- No diversity is to be applied between the same type of generator or between other types of generation (other than wind and PV).

- The output of PV systems is assumed to be zero between 9pm and 5am.

[9] Section 3.5.1 of this Standard Technique: SD5A requires all new and substantially modified connections to domestic properties to be assessed with a 32A EV charge point included in calculations. Some exceptions apply – See footnote 11.

[10] Connect/LV calculates the 10th percentile Maximum Demand, to use as 'Minimum Demand' in Volt Rise calculations.

- Hybrid systems, which consist of both PV and Energy Storage Systems (ESS) – most commonly batteries – connected to the DC side of a single converter (inverter), should be considered as a non-intermittent technology type, due to the ESS element being able to export active power at any time of day or night.

3.5 Low Carbon Technology

3.5.1 Electric Vehicle Charge Points

3.5.1.1 This document should be read in conjunction with Standard Technique: SD5G Parts 1 and 2, when considering the installation of Electric Vehicle (EV) Charge Points.

3.5.1.2 With the increase in up-take of EV, and in line with '*The Building Regulations – Part S: Infrastructure for the charging of Electric Vehicles*', it is typical for developers to install:

- For new domestic housing: A 32A (7.36kVA) EV Charge Point for each new property that includes a driveway or dedicated parking; and

- For new flats with dedicated parking: A 32A (7.36kVA) EV Charge Point for 20% of those parking spaces and the *provision* for the future installation of an Electric Vehicle Charge Point (e.g. the installation of the required ducting and wiring) for the remainder.

The installation of a *provision* for an EV Charge Point will now only meet what is recommended for 80% of flats with dedicated parking, and not for standard domestic housing.

3.5.1.3 As Battery Electric Vehicles (BEV) become ever more popular, there is an increasing likelihood that existing properties will also include an EV Charge Point, which could considerably increase the property's electricity demand.

3.5.1.4 For these reasons, all[11] new or substantially modified connections to domestic properties shall be modelled with a 32A EV Charge Point included within the customer installation.

3.5.1.5 Diversity shall be allowed, between multiple domestic EV Charge Points connected to a single feeder (except for on assets that will see the full load current, such as service cables and cut-outs), by using one of the following methods:

- Calculating a connection's Estimated Annual Consumption, using Table 1 (*P-Q approach*);

- Calculating a connection's ADMD, using Table 2 (*ADMD approach*); or

[11] Exceptions may be made where it has been deemed that the installation of an EV Charge Point is highly unlikely – For example:

- Multi-Occupancy Buildings (particularly those in which customer supplies originate from a Multi-Service Distribution Board) where EV Charge Points are planned to be connected to the building's landlord – In such cases, it may be pertinent to discuss an increased capacity for said landlord supply, to accommodate the EV Charge Points;
- A property that does not have a driveway (dedicated or shared), or one or more dedicated parking spaces;
- A property with a dedicated car port (or other location intended for parking vehicles) which derives an electricity supply from another connection to the distribution network (i.e. has a dedicated connection).

- Utilising a suitable EV Charge Point profile within LV load flow software (e.g. 'EV Charger (Domestic)' within Connect/LV)[12] (*alternative P-Q approach*).

3.5.1.6 New domestic connections to the distribution network are required, under Part S of the Building Regulations, to include an EV Charge Point, making their inclusion within analysis and costing part of the Minimum Scheme.

3.5.1.7 Where a proposed EV Charge Point is rated ≤32A per phase, and does not include a DC output (Mode 4 charging), it shall be assumed that the EV Charge Point meets the technical requirements of BS EN 61000-3-2 and BS EN 61000-3-3. See ST: SD5G Part 1 for further detail.

3.5.1.8 Modified connections (e.g. augmentations) shall also be designed and costed to include a 32A EV Charge Point within the customer installation, as a part of the Minimum Scheme. Where it is determined that remedial works are required to accommodate the modified connection, designers should refer to ST: NC1P and ST: SD5G Part 1 or 2 (as applicable) for charging methodology.

3.5.2 Heat Pump Systems

3.5.2.1 This document should be read in conjunction with Standard Technique: SD5G Parts 1 and 2, when considering the installation of Heat Pump systems.

3.5.2.2 A Heat Pump system will typically consist of one or more compressors and one or more back-up and/or boost heating elements. The maximum electrical power (kVA), inclusive of any back-up and boost elements must be established, for electrical design purposes, and can often be found in the ENA's Heat Pump Database or National Grid's equivalent.

3.5.2.3 During day to day operation, a Heat Pump's compressor would typically be expected to run at a nominal power level, of approximately 50% of its maximum rating. However, to maintain the same internal temperature during particularly cold weather conditions (e.g. a '1 in 20' winters day), Heat Pumps will operate at a higher duty cycle, of around 75% of maximum rating.

Due to lower ambient temperatures providing greater thermal headroom, during particularly cold weather conditions, and the use of Autumn or Intermediate (Cool) ratings in National Grid's LV load flow software, it is considered acceptable to include just **70%** of the maximum rating of Heat Pump compressors, in ADMD calculations. This is reflected in Table 2 ADMD calculations.

3.5.2.4 As mentioned in 3.5.2.2, it is common for Heat Pump systems to include back-up and/or boost heating elements. Separate back-up and/or boost heating elements (including immersion heaters) may also exist, in addition to the Heat Pump system.

Any back-up or boost heating elements that are:

- not used in normal operating conditions;

[12] The EV Charger (Domestic) P-Q profile is only suitable for the assessment of EV Charge Points in domestic settings.

- only operate intermittently (e.g. once a week) for a short period of time (circa five minutes) to prevent legionnaires' disease in the water system; and
- are used as back-up if Heat Pump compressors fail

May be discounted from ADMD calculations, as the heating element is assumed to already have been accounted for in the maximum electrical input power of the Heat Pump.

In all other cases, these elements shall be considered to operate at 100% of their maximum rating during particularly cold weather (e.g. a '1 in 20' winters day).

3.5.2.5 Where a high penetration of Heat Pump systems is planned, for a new or augmented development (e.g. a Local Authority upgrading their housing stock's heating from night storage to Heat Pump systems), designers shall also consider the effects of:

- Following an outage; the summation of Heat Pump compressor starting currents, as power is restored to them; and
- Following an extended outage; 'cold load pick-up'[13] occurring, whereby all of the Heat Pump systems operate at 100% of their maximum ratings, for an extended period.

a) Summation of Heat Pump compressor starting currents

To avoid protection operating upon re-energisation of a section of network, due to the starting currents of all Heat Pump compressors in the affected section summating, designers shall request that developers or installers (as applicable) either:

- include automatic restarts with suitably staggered restart times; or
- do not include automatic restarts at all, requiring property owners to manually restart their Heat Pump systems.

Developers and installers are permitted to choose one or both of these mitigation methods.

b) 'Cold Load Pick-up'

A 'cold load pick-up' assessment is required where load flow models, for normal operating conditions, show that asset utilisation and/or voltage drop are close to their respective limits.

The majority of planned outages are only expected to last for a relatively short duration, and to be prearranged to affect as few connections as possible.

[13] 'Cold load pick-up' is an overcurrent condition that occurs when a distribution circuit is re-energised following a prolonged outage. With regard to electrical heating loads; as the power supply has been unavailable for some time, the internal temperatures of properties are likely to have reduced, and upon re-energisation, heating loads must overcome thermal inertia and raise the internal temperatures to set levels (often dictated by individual thermostat settings).

Unplanned outages may affect a larger number of connections and, for some of these, may be longer in duration. When an unplanned outage occurs, National Grid will endeavour to restore supplies to as many connections as is practicable, in as short a time as is practicable, further reducing the number that will contribute towards a ‘cold load pick-up’ condition.

As such, significant ‘cold load pick-up’ events are likely to occur only very infrequently and, thus, greater tolerance may be allowed when considering such an event in design stages.

For the avoidance of doubt, a ‘cold load pick-up’ assessment requires the use of LV load flow software, such as Connect/LV, to determine whether thermal or voltage limits have been exceeded.

Cold load pick-up assessment considerations:

Demand considerations:

- Pre-event: Table 2 ADMD approach.

  - For example;

    A four bedroom house which includes an 8kW Heat Pump module, with 3kW back-up element (intended to boost the heating system, during cold conditions), and a 7.36kW EV charge point:

    ADMD = 2.0 + (1.0 x 3.0) + (0.7 x 8.0) + (0.5 x 7.36) = 14.28kW
    MD = ADMD + 4kW = 14.28 + 4 = 18.28kW (79.5A, single-phase)

- Post-event: Table 2 ADMD approach, increased to include 100% Heat Pump compressor rating.

  - For example:

    Using the same installation details as above (pre-event):

    ADMD = 2.0 + (1.0 x 3.0) + (<u>1.0</u> x 8.0) + (0.5 x 7.36) = 16.68kW
    MD = ADMD + 4kW = 16.68 + 4 = 20.68kW (89.9A[14], single-phase)

Thermal considerations:

- Pre-event: As per Section 4.0 of this ST: SD5A;

[14] In this example, if the property were to be single-phase metered, it may be advisable to consider designing the connection to be fused at 100A, to prevent maloperation during ‘cold load pick-up’ conditions. N.B., an Agreed Supply Capacity greater than those in Table 3 would not have to be offered, unless explicitly requested by the customer or dictated by the MD calculation in Section 3.3.3. The designer would, however, need to ensure the earth fault loop impedance, at the Connection Point, was adequately low to permit the use of 100A fusing (see ST: SD5R).

- Post-event:

    - Overhead Lines – Load shall not exceed variable load pre-fault ratings (ST: SD8A)
    - Underground Cables – Load shall not exceed Distribution ratings (ST: SD8B Part 1)
    - Distribution Transformers – Load shall not exceed a transformer's enhanced rating (ST: SD8D)

Voltage considerations:

- Pre-event: As per Section 5.0 of this ST: SD5A;

- Post-event:

    - Voltage on the LV network shall remain within statutory limits (i.e. 253V to 216.2V).
    - Voltage drop, across the LV network (including services) and local distribution transformer[15], shall not exceed 10%[16] (N.B., this results in the designer only being able to accept up to a maximum volt drop of **7.67%**[17] displayed anywhere in their Connect/LV 'cold load pick-up' model).

4.0 THERMAL REQUIREMENTS

4.1 Substations, cables, overhead lines, services and cut-outs shall be rated for the expected demand and, where applicable, generation. The Meter Operator and the customer shall ensure that their equipment is also adequately rated.

4.2 When designing new or augmented networks, where the load is predominantly domestic, the Maximum Demand normally occurs during the autumn or winter periods and loads can normally be assumed to be cyclic (i.e. with a load factor of 0.68 or lower). In such cases Autumn Cyclic ratings should be used for cables, Intermediate (Cool) ratings used for overhead lines and the name plate rating used for new transformers. Where load is to be added to an existing transformer the enhanced rating of the transformer may be used (as defined in ST: SD8D).

4.3 If the demand or generation is expected to be high during other times of year (e.g. during the summer) then equipment ratings shall be reduced appropriately. Further guidance is provided in ST: SD8A (overhead lines), ST: SD8B (cables) and ST: SD8D (distribution transformers).

4.4 See Clause 3.5.2.5 b) for 'cold load pick-up' conditions, associated with a high penetration of Heat Pump systems.

---

[15] In line with Connect/LV and WinDebut logic, the voltage drop across the local distribution transformer's LV windings shall be taken as 2% (of 240V), unless the calculated voltage drop exceeds this, in which case, the larger voltage drop value shall be used.

[16] This equates to a voltage drop that is 2% of 230V (4.6V) greater than that used for standard design purposes, as detailed in Section 5.0. This assumes that the phase to neutral voltage at the transformers LV terminals will normally exceed 234.6V.

[17] Connect/LV and WinDebut use 240V in their calculations. 7.67% of 240V = 18.4V = 8% of 230V.

5.0 VOLTAGE REQUIREMENTS

5.1 The voltage on the LV network shall remain within statutory limits (i.e. 253V to 216.2V). In order to achieve this requirement:

- The voltage drop across the LV network (including services) and local distribution transformer shall not exceed 8%[18].
- Voltage drop along single-phase services shall be limited to 1%[18]. This requirement helps to control potential differences between PME earth terminals and the general mass of earth.
- Voltage rise (due to generation) across the LV network and local distribution transformer shall not exceed 1.5%[18].

5.2 Connect/LV checks that the maximum voltage drop across mains and service cables / lines is less than 6%[18] (based on unity power factor). The voltage drop across the transformer is assumed to be 2% or less. Where the calculated volt drop across the transformer exceeds 2%, the difference is added to all network objects downstream of the transformer and, thus, included in displayed results.

5.3 Where Connect/LV is used to check voltage rise, this will be included in the outputs shown in the load flow model, following an assessment run. There is no assumed voltage rise across the transformer. The calculated volt rise across the transformer is always included in displayed results.

5.4 See Clause 3.5.2.5 b) for ‘cold load pick-up’ conditions, associated with a high penetration of Heat Pump systems.

6.0 POWER QUALITY REQUIREMENTS

6.1 Equipment rated up to 16A per phase must comply with the following standards:

- BS EN 61000-3-2: Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
- BS EN 61000-3-3: Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.

6.2 Equipment with a rating greater than 16A and up to 75A per phase is generally expected to comply the following standards[19]:

- BS EN 61000-3-11: Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection

---

[18] Percentage values of voltage drop and voltage rise are based on 230V.

[19] Equipment rated > 16A and ≤ 75A per phase may also be tested to meet the technical requirements of the standards mentioned in Clause 6.1

- BS EN 61000-3-12: Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase

It should be noted that BS EN 61000-3-11 and BS EN 61000-3-12 may define requirements for the maximum system impedance (Z_{max} or $Z_{max\ 100A}$) at the Connection Point and minimum fault level (Min. S_{sc}) at the Point of Common Coupling to which the equipment is connected. These requirements shall be met when designing networks and when assessing whether reinforcement is needed (before such equipment may be connected).

6.3 The LV networks shall be designed in accordance with:

- ENA Engineering Recommendation G5: Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom;

- ENA Engineering Recommendation P28: Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom;

- ENA Engineering Recommendation P29: Planning Limits for Voltage Unbalance in the United Kingdom.

7.0 PROTECTION REQUIREMENTS

7.1 The following protection criteria shall be satisfied for new and substantially modified LV designs:

- LV circuits shall be protected by HRC (high rupturing capacity) fuses that comply with BS 88 Part 5, located at the substation;

- Circuits shall not normally be designed to be sub-fused;

- LV fuses shall be designed to grade with HV transformer protection – Further information on distribution transformer protection is included in ST: TP4B;

- Mains cables and main overhead lines shall be protected against short circuit current;

- The clearance time for faults on mains cables and main overhead lines shall be 60s or below;

- The phase to earth loop impedance and the Phase to Neutral Loop Impedance (PNLI) shall be designed in accordance with ST: SD5R;

- The maximum PNLI of an LV circuit's main route conductors shall be:

    - for circuits fed by a distribution transformer rated ≤ 315kVA: ≤ 0.245Ω; and
    - for circuits fed by a distribution transformer rated > 315kVA: ≤ 0.144Ω;

- Connect/LV is set with 'Source Loop (operating)'[20] Impedance thresholds of 144mΩ, at the end of the main route conductor, and 250mΩ, at the end of the main and service conductors;

- The impedance requirements will help to facilitate the installation of Low Carbon Technologies with a rating ≤ 32A per phase (up to the thermal capacity of the circuit), without the need for more in depth power quality analysis;

- Cut-out fuses or metering circuit breakers shall operate within 5s for faults on the terminals of the cut-out or circuit breaker; and

- The standard cut-out fuse rating is 80A, although alternative sizes may be used – Further guidance on standard cut-out arrangements are included in ST: SD5D (see also Table 3).

7.2 All the criteria in Clause 7.1 assume that that there is zero resistance at the point of fault.

7.3 The customer (or customer's electrical installer) is responsible for ensuring the customers installation is adequately protected in accordance with BS 7671 (IET Wiring Regulations).

8.0 PHYSICAL DESIGN REQUIREMENTS

8.1 <u>Substation Requirements</u>

8.1.1 Where a substation is required this shall be located:

- As close to the centre of load as is reasonably practicable, with consideration being given to likely earthing arrangements (e.g. declaration of a 'High EPR' or 'Low EPR' substation), site specific layout and conditions (e.g. ground type, flood risk areas, ecological impact, noise, EMF concerns, etc.);

- At least 5m from the living areas of domestic properties (e.g. living rooms, kitchen, bedrooms, etc.), to minimise the risk of receiving noise complaints;

- At least the calculated separation distance from earthed LV metalwork (e.g. street furniture and steel framed buildings) where the HV and LV earths of the substation need to be segregated – Further guidance on earthing requirements is provided in the TP21 policy suite of policy documents.

[20] Connect/LV's 'Source Loop (operating)' Impedance is the Phase to Neutral Loop Impedance (PNLI), including HV network contribution.

8.1.2 All new ground mounted substations shall be installed on anti-vibration pads (to minimise vibration and noise) and either within a GRP enclosure or within a dedicated building. Requirements for substation foundations and enclosures are specified in ST: NC1V.

8.1.3 All new LV fuse cabinets associated with HV/LV transformers shall include a means of connecting temporary LV generation. Further information is included in EE SPEC: 16.

8.1.4 Where new buildings are proposed to be constructed in the proximity to an existing substation, National Grid shall, as far as possible, ensure that the minimum distances stated in Clause 8.1.1 are maintained.

8.2 Requirements for LV Mains and Services

8.2.1 Supplies to new groups of customers shall normally be provided by underground cables. Exceptionally, overhead lines may be used where the use of underground cable is not reasonably practicable.

8.2.2 Mains cables shall normally be laid direct in the ground unless there are other good reasons to install the cables in ducts (e.g. to deal with traffic management issues). Where mains cables are laid in or across roads they shall be installed in rigiduct with an internal diameter of 125mm or 150mm, as applicable.

8.2.3 Mains cables shall normally be laid along one side of the road (in the footpath or service strip). Road crossings shall be provided to service properties on the opposite side. Mains cables may be installed on both sides of the road to accommodate large concentrations of load or as a means of reinforcing existing developments. Detailed cable installation requirements are specified in ST: CA6A.

8.2.4 LV circuits shall normally be arranged as multi-branched radial feeders. Unused ways in the substation LV feeder pillar shall be cabled out, to beyond the 'High EPR' separation distance (if applicable), and pot ended to enable future circuits to be added without making the feeder pillar dead.

8.2.5 Link boxes (or equivalent cabinets) should be installed to provide back-feeding facilities between National Grid owned substations and LV feeders, where it is reasonably practicable to do so. Where a link box or cabinet is installed, the circuit feeding the link box should not be tapered. Where the network is to be installed by an ICP and adopted by National Grid, National Grid should specify the requirement for any additional link boxes or cabinets that have not been included in the ICP design, where it is reasonably practicable for them to be included. This requirement excludes link boxes or cabinets that are proposed to be installed at the boundary between National Grid's LV network and the LV network of an IDNO. Where a link box is specifically required or requested at this ownership boundary, the associated costs shall be borne by the party requiring the link box, in accordance with ST: NC6A.

8.2.6 New and modified LV overhead lines shall be designed in accordance with ST: OH4K.

8.2.7 In accordance with ST: OH6A, additional mechanical protection shall be provided for all above ground service cables that are installed in an accessible position and that are:

- (external) below 2.4 metres above finished ground level; or
- (internal) below 1.8 metres above finished floor level.

This requirement is inclusive of any portion of service cable that passes through the wall of a property, below these heights.

For the avoidance of doubt, only the portion of service cable that is below the aforementioned heights must receive this additional mechanical protection.

Additional mechanical protection shall normally be provided, for such service cables, in the form of PVC conduit.

8.2.8 Networks shall be designed for PME earthing as standard unless there are good safety reasons for not providing PME. Further guidance on LV system earthing is included in ST: TP21D.

Information on the provision of earth terminals to customers LV installations is given in ST: TP21E.

8.2.9 Where multiple phases are available at the LV mains cable to which a connection is being made (i.e. three-phase, split-phase or two-phase), providing that it is reasonably practicable to do so, new and substantially modified connections shall be installed as polyphase[21], rather than single-phase, with an order of preference as outlined below:

- Three-phase;
- Split-phase;
- Two-phase[22] (i.e. two phases of a three-phase network); and
- Single phase (where the provision of multiple phases has been deemed to be impracticable).

For single-phase customers being connected to a network with multiple phases available, a three-phase service cable (connected, colour true, to all of the available phases) and cut-out shall be installed. An appropriately sized fuse shall be fitted in only one of the fuse carriers, whilst the remaining fuse carriers are to be left empty and sealed, to allow for possible future conversion to polyphase or to alter the phase to which the customer is connected (e.g. for phase balancing). A suitable label shall be included on or immediately adjacent to the cut-out, dictating which phase the fuse is to be inserted, to make the Meter Operator aware of which phase to connect the metering.

[21] For the purposes of this document, split-phase shall be included in the term ‘polyphase’, although this isn’t strictly correct.
[22] Two-phase connections shall not be provided where the mains cable or overhead line has three-phases available.

Meter Operators shall not be permitted to alter the on-site phasing arrangement or fuse size without prior agreement from National Grid.

8.2.10 For all new and modified connections, the designer shall dictate, on the design plan, the phase(s) that is to be made available to the customer, for the purposes of metering.

Designers should roll the phase(s) that is made available to each connection (e.g., for single-phase metered connections: L1, L2, L3, L1, L2, etc.), in order to optimise phase balance, as far as is reasonably practicable.

8.2.11 Where multiple phases are not available at the LV mains cable to which a new or substantially modified connection is being made, the designer should consider the merits of installing three-phase service assets, in readiness for future network conversion, where this can be considered reasonably practicable.

8.2.12 In scenarios where a new or augmented pole-mounted transformer is proposed to be installed, to serve a small number of connections, and the connections only require single-phase metering, it is acceptable for a single-phase transformer to be utilised, in line with National Grid company policy[23], where this constitutes the Minimum Scheme.

8.2.13 Unless explicitly requested by the developer, or required to cater for the requested loads or customer equipment, single-phase metered connections fed via a Multi-Service Distribution Board do not need to be allocated more than one outgoing fuseway. This is due to the Building Network being the responsibility of the Building Network Operator (BNO), which will normally be a third party, and not National Grid.

At the planning stage, designers should ascertain how the customer intends to accommodate vehicle charging, for the Multi-Occupancy Building, so that this may be included in their design, where required.

Further guidance on LV connections to Multi-Occupancy Buildings is included in ST: SD5C.

8.2.14 For connections where the installation of Low Carbon Technologies (inclusive of EV charge points, heat pumps, generation and Energy Storage Systems) is highly improbable (for example, a gas centrally heated terrace property with no off-road parking, and premises that only require lighting and sockets (such as sheds, small stable blocks or storage units)), single-phase service assets may be utilised, where this is sufficient to cater for the customer's requirements.

When deciding whether it is appropriate to use single-phase service assets, for such connections, the designer should consider whether the installation of Low Carbon Technologies can reasonably be foreseen within 50 years of the service's planned energisation date or within the expected life of the service assets (whichever is lesser).

8.2.15 Where a developer wishes for their properties to be polyphase metered, and their proposed installation will primarily comprise single-phase equipment, the designer shall request that the phases to which equipment is connected are varied, from one property to the next, in order to achieve the most efficient phase balance on the distribution network possible, thus, also reducing voltage unbalance and losses.

[23] Notable company policy documents include (but are not limited to): ST: SD1H, ST: SD4A, and EE SPEC: 6.

For example; if a developer were to propose a development of ten dwellings, each to be three-phase metered, and each comprising:

- Standard single-phase domestic loads (e.g. lighting, sockets, etc.), totalling a nominal 2kW;
- A 32A (7.36kW) single-phase EV Charge Point; and
- An 8kW Heat Pump system.

They may wish to connect this load as is shown in Table 4:

Table 4 Example Single-Phase Equipment in a Three-Phase Installation

Phase Connection	L1	L2	L3
Example Property	Domestic Load	EV Charge Point	Heat Pump System
Load (kW)	2	3.68[24]	4[25]

If the same phases were to be connected to the same equipment, in every property, this could cause significant phase unbalance, overall:

Table 5 Example Single-Phase Equipment in a Three-Phase Installation with No Variation

Phase Connection	L1	L2	L3
All Properties	Domestic Load	EV Charge Point	Heat Pump System
Total Load (kW)	20	36.8	40

Unbalance (%) = 100 x Neutral Current / ∑ Phase Currents
= (100 x 80.902) / (86.957 + 160 + 173.913)
= 8090.2 / 420.87 = ***19.223 %***

If, however, the developer were to vary the phase connections, a much lower phase unbalance could be achieved:

Table 6 Example Single-Phase Equipment in a Three-Phase Installation with Variation

Phase Connection	L1	L2	L3
Properties 1, 4, 7 & 10	Domestic Load	EV Charge Point	Heat Pump System
Properties 2, 5 & 8	Heat Pump System	Domestic Load	EV Chard Point
Properties 3, 6 & 9	EV Charge Point	Heat Pump System	Domestic Load
Total Load (kW)	31.04	32.72	33.04

Unbalance (%) = 100 x Neutral Current / ∑ Phase Currents
= (100 x 8.09) / (134.957 + 142.261 + 143.652)
= 809 / 420.87 = ***1.922%***

In this example, varying the phases to which each single-phase load is connected has reduced the phase unbalance by a factor of ten.

[24] An average of 50% of the maximum EV Charge Point rating has been considered, in this example (for illustration purposes only).
[25] A nominal consumption of 50% of the maximum compressor rating has been considered, in this example (for illustration purposes only).

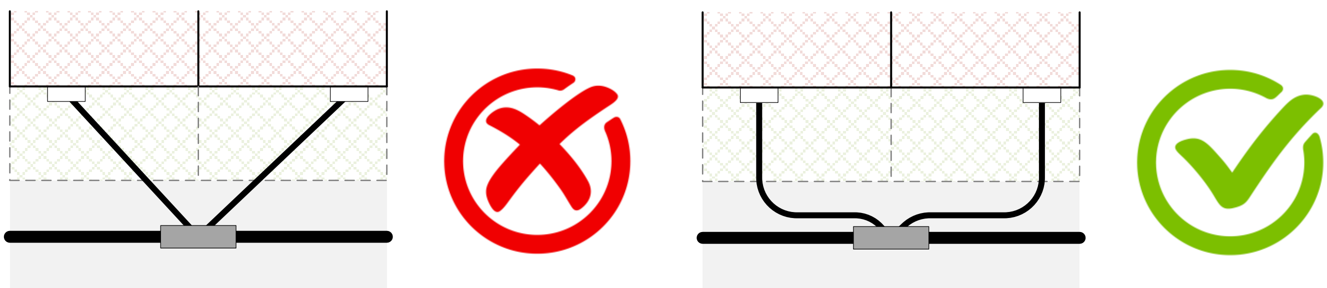
This can be seen to be even more advantageous for larger development sites and for larger discrepancies between the capacities of single-phase loads.

8.2.16 In order to aid future identification of the service cable routes, and to avoid accidental damage by property owners / occupiers, wherever it is reasonably practicable to do so, National Grid service cables shall be installed on as direct a route as possible, from the public footway to the termination / metering position, taking the shortest route across privately owned land[26].

This requirement will often result in the service cable being installed in a straight line, perpendicular (at 90°) to the meter cabinet, with the service trench not deviating beyond the width of said meter cabinet. Once the service route meets the public footway, it may be diverted towards the service joint (See Figure 1).

Services should only be laid on less direct routes to the mains cable (e.g. diagonally, across gardens or driveways) where a direct route is not reasonably practicable.

Figure 1 – Preferred Service Cable Routes from the Main



8.2.17 Underground service cables shall normally be installed in 50mm (internal diameter) black alkathene ducting. See also Clause 8.3.9.

8.2.18 Each connection shall be provided with a dedicated form of isolation (e.g. fuse or circuit breaker) that allows said connection to be isolated by the DNO or Meter Operator without interfering with the supply of another customer. This will normally dictate that each connection shall be provided with its own, dedicated cut-out, fuseway or circuit breaker (as applicable).

8.2.19 With the exception of connecting a compact 7 way Multi-Service Distribution Board (MSDB) above such a cut-out, where a standard 100A cut-out is used, no single fuse is to be shared between multiple customers.

8.2.20 Services shall not normally be looped [27].

[26] Customers will often assume that their service cable runs in a straight line, from the mains cable location (often in public footway) to their termination position (e.g. an outdoor meter cabinet). By designing service routes to be installed in such a way, it is thought that this will aid future service cable route identification and help to reduce inadvertent service cable damage.

[27] See ST: SD5D for exceptions.

8.2.21 For any new or modified connection, customer-owned assets, such as meter cabinets, should not be permitted to be mounted on company-owned assets, such as wood poles, keeping in mind future maintenance and replacement, and concerns regarding earthing. Instead, the customer should provide an appropriate structure that meets their needs.

8.2.22 Cable Bunching

8.2.22.1 Standard split-phase, two-phase and, in some cases, single-phase arrangements require the cores of three-phase cables to be bunched together. It can also be helpful to bunch cores together to reduce voltage drop on long single-phase services.

In order to minimise the risk of confusion the following steps shall be taken:

- Bunching shall be noted within National Grid's mapping system(s).

- Bunching is normally only allowed above ground – i.e. where the connections can be visually inspected (e.g. at pole terminations and cut-outs). The only exception is for split-phase and two-phase connections where a service cable is jointed to a mains cable that only has two phase conductors – i.e. a 2 core CNE or 3 core SNE cable.

- Incoming cables shall always be terminated colour true at each cut-out. Additional, adequately rated loops (between the bottom cut-out terminals) shall be installed where bunching is required. See ST: SD5D for details on standard cut-out arrangements.

- At Low Voltage; spare phase conductors shall normally be bunched with the neutral, to reduce phase unbalance and improve PNLI.

8.2.22.2 At the planning stage, any required cable bunching should be designed to achieve the desired outcome whilst not unnecessarily increasing or introducing unbalance between phase impedances. Consideration must also be given for future network development (e.g. conversion of single-phase networks to split-phase or three-phase).

The above requirements will normally result in one of the following standard bunching arrangements being adopted:

Table 7 Three-Phase Cable Bunching for Single-Phase Application

Cable Core	Connection	
	CNE	SNE
L1	L1	L1
L2	L1	L1
L3	N/E	N
N	N/E	N
E		E

Table 8 Three-Phase Cable Bunching for Spit-Phase or Two-Phase Application

Cable Core	Connection	
	CNE	SNE
L1	L1	L1
L2	L2	L2
L3	N/E	N
N	N/E	N
E		E

It should be noted that Tables 7 and 8 (above) refer to bunching arrangements for Low Voltage networks only.

8.3 Service Entry Requirements

8.3.1 On new housing developments the preferred method of service entry is via an external meter cabinet located in an accessible position on the front or side of the building. With National Grid's preference for a polyphase connection in mind, all new or substantially modified domestic properties that are to include an external meter box shall be designed to include a three-phase meter box, rather than a single-phase version[28], in accordance to ST: SD5D. When installed, the bottom of the meter box shall be no lower than 500mm and no higher than 1000mm above ground level.

8.3.2 Meter cabinets shall be installed in a manner that preserves the manufactured fire resistance values.

8.3.3 External meter cabinets should only contain equipment required to enable an electricity supply to be provided to the premises safely, as defined by relevant regulations.

Items permitted to be installed within electricity meter boxes/cupboards include: the local isolating device (e.g. main cut-out fuse), the electricity meter and communications hub, and may include a suitable isolation switch (installed between the electricity meter and consumer unit).

Customer equipment, with the exception of the tails that connect between the meter installation and customer's installation, shall not be installed within the meter cabinet.

8.3.4 Meter cabinets shall be supplied by National Grid or by an Independent Connection Provider to National Grid specification EE SPEC: 37.

8.3.5 Meter cabinets are considered to be part of the fabric of the building and, therefore, ownership and the responsibility for their maintenance passes to the building owner once they have been installed. National Grid hold stocks of various types of meter cabinet door and reserve the right to charge building owners / customers for replacing damaged doors.

[28] This requirement is irrespective of whether single-phase or three-phase service assets are used, unless there is firm evidence that suggests the use of a three-phase meter box would not be reasonably practicable.

8.3.6 Cut-out / metering equipment (hereafter, in Clause 8.3.6 only, referred to as 'the equipment') may be located inside domestic properties so long as the following criteria are satisfied:

- The equipment is not located in a confined space;
- The ambient air temperature surrounding the cut-out does not exceed 30^{o}C;
- The equipment is easily accessible and placed in a well-lit, well-ventilated location;
- Sufficient space[29] shall be provided for and dedicated to the equipment, including sufficient space to the front of the meter position to enable the equipment to be maintained and replaced (e.g. a minimum depth of 1000mm should be provided);
- The equipment, in its entirety, shall be positioned between 500mm and 1800mm above the finished floor level;
- The equipment shall not be located in a bathroom, toilet, shower-room or close to a source of water that could potentially damage the equipment or cause an electrocution risk;
- The equipment shall not be located in an airing cupboard, boiler room, sauna, steam room or in any other type of room or enclosure that includes a heat source that is likely to increase the ambient temperature above 30^{o}C;
- The equipment shall be located such that the electrical installation (service cable, cut-out, metering and meter tails) is separated by a minimum distance of 150mm from any gas meter and a minimum distance of 25mm from any gas pipes;
- The equipment shall be located away from combustible materials;
- The equipment shall be located in a location to minimises the risk of accidental or malicious damage; and
- The service cable can be easily accessed, for inspection, maintenance and replacement.

8.3.7 The standard method of service entry into the meter cabinet shall be by means of a white, ultra violet proof PVC preformed tube ('hockey stick') with an external diameter of 48mm. The tube shall be fixed to the outside wall using appropriate cleats.

8.3.8 It is not acceptable for service cables to be installed within a cavity.

8.3.9 Service cables shall normally be installed within black alkathene service ducting (as specified in 8.2.14). The alkathene service ducting should be laid from the service joint to directly beneath the cut-out termination position. Where the use of a 'hockey stick' is applicable, the alkathene ducting should be directly connected to the 'hockey stick'[30].

8.3.10 Guidance found in '*Smart Meter Guidance for Domestic New Builds*'[31] suggests that smart meters (or the space to install smart meters) should be placed away from any metal objects, cladding, metallic based insulation panels, and pipework so as not to surround the smart meter on all sides, as the presence of such items is likely to interfere with communications. With this in mind, designers should inform developers that the use of metallic enclosures, for housing the cut-out and metering equipment should be avoided, where possible.

---

[29] In the majority of cases, minimum dimensions of 400mm x 600mm are believed to be sufficient. However, where a connection is planned to include a three-phase smart meter, 490mm x 690mm are the suggested minimum dimensions.

[30] The 48mm 'hockey sticks' used by National Grid have been designed to fit inside of a standard 50mm alkathene service tube.

[31] The Department for Business, Energy & Industrial Strategy, *Smart Meter Guidance for Domestic New Builds: Guidance for Developers and Architects, and relevant to all those involved in the specification of metering locations in new build premises* (May 2021)

8.4 Street Lighting

8.4.1 The design of street lighting connections shall be in accordance with ST: SD5P.

8.5 Temporary Supplies

8.5.1 Details relating to the provision of Connection Offers for temporary connections can be found in ST: NC2AA.

8.5.2 In most Temporary Supply cases National Grid shall not offer an earth terminal and the customer must employ TT earthing with their own earth electrode and RCD protection.

Full details relating to the provision of a National Grid earth terminal to a Temporary Supply can be found in ST: TP21E.

8.5.3 Although they are often preferred, due to their resilient nature, some Suppliers or Meter Operators have been known to refuse connection to a meter, for a Temporary Supply, within a metal housing. This is often due to a rule that dictates that there should be no extraneous conductive parts before and/or enclosing the RCD associated with such a connection.

Designers should make their customers aware of this, and encourage them to discuss meter housing requirements with their chosen Supplier(s).

8.5.4 In order to avoid damage to service assets, wherever it is reasonably practicable to do so, Temporary Supplies should be located on the perimeter of the development site, the developer should install adequate protection at the meter position, and run a private cable to their desired location.

Where this is impracticable, the cable serving the Temporary Supply should be routed as close as possible to its permanent position (where applicable), and consideration should be given to how best to safeguard the electricity assets (e.g. use of rigiduct).

8.6 Service Alterations & Augmentations

8.6.1 When a service is significantly modified, it shall be designed to comply with the same requirements as those for new connections, as described in this ST: SD5A.

8.6.2 If it is planned only to replace a portion of an existing single-phase service cable, and it has been deemed not to be reasonably practicable to replace it in its entirety, the replacement portion may be designed and installed using single-phase service assets.

8.6.3 Consideration should be given to using three-phase service assets where multiple phases are available on the mains conductor and it has been determined that it is either reasonably practicable and/or essential to replace an existing service cable in its entirety. This will generally be the case where Hybrid service cables are used or where the service length is not excessive.

8.6.4 For service alterations where it is anticipated that the existing cut-out and meter position will be utilised, but the service is planned to be replaced with a three-phase conductor; if the existing cut-out / meter position is not large enough to accommodate a three-phase cut-out, the three-phase service cable may be terminated, outside, as close to the meter position as is practicable, and a single-phase service cable installed, from this location to the cut-out / meter position.

8.6.5 Where it is proposed to alter the location of the cut-out and meter, the new location must meet the requirements set out in Section 8.3 of this document, including the minimum and maximum heights above finished floor level[32]. It is only acceptable (although still undesirable) to discount these height requirements for service renewals or replacements where the cut-out and meter remain in their existing, unaltered meter position. No new or alternative meter positions shall be offered that do not meet these requirements.

9.0 MULTIPLE CONNECTIONS

9.1 National Grid shall normally provide a single point of connection to each premises, but in some cases the customer may require more than one connection, for example, where enhanced security is required.

In almost all cases, this will not apply to domestic connections.

9.2 Where multiple connections are provided, this introduces a number of challenges including:

- a risk of paralleling National Grid's connections through the customer's network;
- complex earthing / bonding issues; and
- added complexity (e.g. means of electrically isolating the site under emergency conditions or when work is carried out).

a) Risk of Paralleling:

It is essential that the multiple connections are not paralleled though the customer's network. If this were to occur this could adversely affect the protection performance and/or cause current to flow through the customer's network. This flow of current could overload cables, switchgear, etc. or give rise to unexpected power flow through the metering.

In order to prevent the customer's network from being paralleled the customer shall either:

- Physically segregate the network supplied by each connection so that interconnection is impossible; or

[32] The minimum and maximum heights above finished floor level, mentioned in this document, are dictated by The Meter Operation Code of Practice Agreement (MOCoPA).

- Fit interlocking to prevent paralleling:

    - This interlocking shall either consist of mechanical interlocking (without over-ride facilities) and/or fail-safe electrical (hard wired) interlocking;
    - Where electrical interlocking is provided any mechanical closing facilities must be disabled to prevent it from being bypassed;
    - Software interlocking provided by programmable logic controllers (PLCs), programmable relays or equivalent are not acceptable.

b) Complex Earthing / Bonding:

The earthing systems of each connection may be derived from different earth electrodes / earthing systems. This could cause differences in potential between items of equipment, including charge points, connected / bonded to different connections, if adequate precautions are not taken.

Precautions shall include either:

- Ensuring metalwork and items of equipment that are connected / bonded to the earth terminal of different connections are physically segregated from each other to prevent anyone touching both items of equipment at the same time. Where this approach is used any item of equipment that could possibly transfer the potential from one earth zone to another must be removed / isolated (e.g. pipes, wiring, fences, communication cables etc.); or

- Ensure the earthing systems associated with each connection are common (i.e. physically bonded together). Where this approach is taken each connection must utilise the same type of earthing and it is not acceptable to bond different earthing types together[33]. Any such bonding must be rated for the current that is expected to flow through it. For LV installations the bonding shall satisfy the requirements for main equipotential bonding within the IET Wiring Regulations (BS7671).

Multiple connections provided at different voltages (e.g. one connection provided at 11kV and one at LV) should be avoided, where possible. Where this cannot be avoided precautions shall be taken to prevent earth potential rise caused by faults on the high voltage network from causing danger in the low voltage system. The simplest way of achieving this is to physically segregate the buildings / metalwork / equipment supplied by each connection.

Further guidance on earthing is included in the TP21 suite of policy documents.

[33] The only exception is that a PME connection may be bonded to a "SNE connection derived from a CNE network" since both options are considered to be a type of TN-C-S.

c) Isolation Requirements:

Where multiple connections are provided, the means of disconnecting and isolating the customer's network will be more complex than normal.

Appropriate schematic drawings and labels / notices shall be provided at each connection point that clearly state:

- That more than one connection point is provided; and

- Describe where the other points of disconnection / isolation are.

It is the customer's responsibility to provide such signage.

9.3 It is not acceptable for multiple connections to be provided to a customer site by different DNOs or IDNOs. Where such arrangements are proposed one DNO or IDNO shall adopt the all of the connections to the installation. The only possible exception is where the site is split into distinct geographical areas / buildings that are electrically and physically segregated from each other.

9.4 Where the Customer wishes to install an automatic changeover facility that automatically switches all, or part of their network from one incoming connection to another (e.g. following a supply failure) a 'break-before-make' system shall be used (i.e. the backup connection shall only be capable of being switched on after the normal connection has been disconnected).

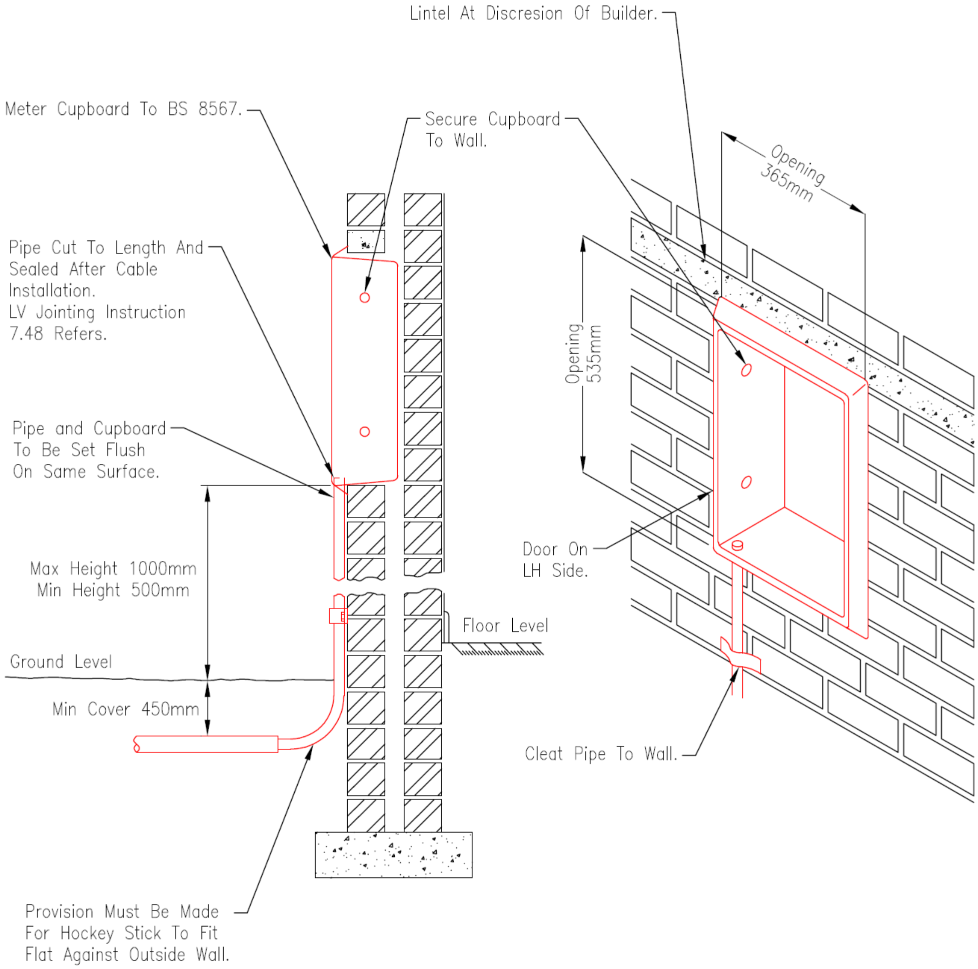
Automatic changeover systems shall either utilise a 'break-before-make' changeover switch (i.e. where the main contacts in the switch physically break one connection before they connect to the other connection) or comprise two switches that have a failsafe electrical (i.e. hard-wired) control or interlocking system that prevents the back-up switch from being closed until the first switch has opened. Software interlocking systems (e.g. those provided by programmable logic controllers (PLCs), programmable relays or equivalent) are not acceptable.

Automatic changeover systems shall be designed to prevent faults on the customer's system from being re-energised automatically more than once.

9.5 If generation is installed that is capable of operating in parallel with National Grid's system, its operation may need to be restricted to only allow it to run when connected to one of the connections. Where this is the case, the interlocking shall be designed to prevent parallel operation with the other connections. Any such restrictions shall be detailed in a formal Connection Agreement.

STANDARD DRAWINGS FOR METER CUPBOARDS/CABINETS

Drawing Number OG/65/4418	Flush mounted meter cabinet – single phase
Drawing Number OG/65/4418/3	Flush mounted meter cabinet – 3 phase
Drawing Number OG/65/4421	Surface mounted meter cabinet – single phase
Drawing Number OG/65/4421/3	Surface mounted meter cabinet – 3 phase



Rev No	Drawn	Chk'd	App'd	Date	Revision
5	JJH			09/22	AMENDED OPENING DIMENSIONS

ORIGINAL ISSUE		DATE
Drawn	JR	02/87
Checked		
Approved		
SCALE	NTS	

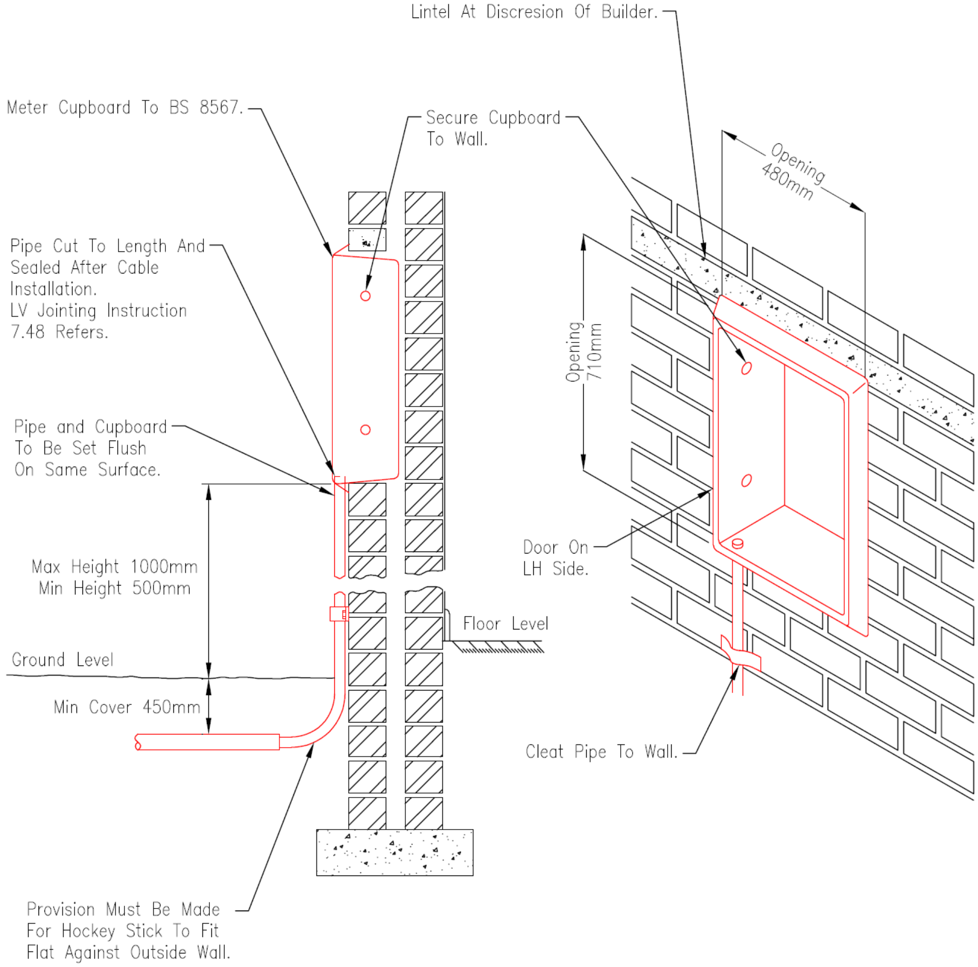
ORIGINAL SHEET SIZE: A4

nationalgrid Electricity Distribution

Engineering Design (South West) Avonbank, Feeder Road, Bristol, BS2 0TB

Title	Drg. No.	Rev No
GENERAL ARRANGEMENT FOR FLUSH MOUNTED METER CABINET – SINGLE PHASE	0G/65/4418	5

All Dimensions in mm.



Rev No	Drawn	Chk'd	App'd	Date	Revision
6	JJH			12/21	AMENDED OPENING DIMENSIONS

ORIGINAL ISSUE		DATE
Drawn	JR	02/87
Checked		
Approved		
SCALE	NTS	

ORIGINAL SHEET SIZE: A4

nationalgrid Electricity Distribution

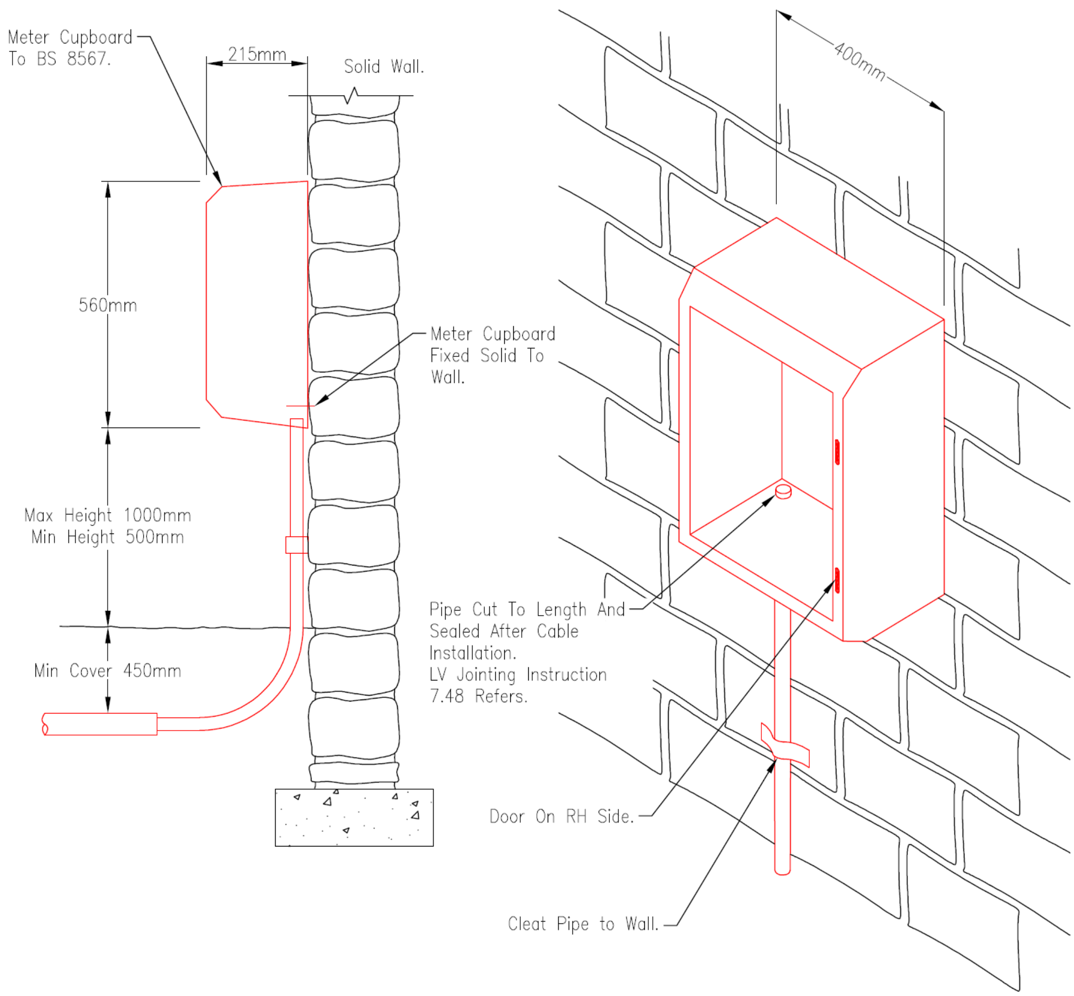
Engineering Design (South West) Avonbank, Feeder Road, Bristol, BS2 0TB

Title: GENERAL ARRANGEMENT FOR FLUSH MOUNTED METER CABINET – THREE PHASE

Drg. No. 0G/65/4418/3

Rev No 6

All Dimensions in mm.



Rev No	Drawn	Chk'd	App'd	Date	Revision
5	JJH			09/22	AMENDED DIMENSIONS

ORIGINAL ISSUE		DATE
Drawn	JR	02/87
Checked		
Approved		
SCALE	NTS	

ORIGINAL SHEET SIZE: A4

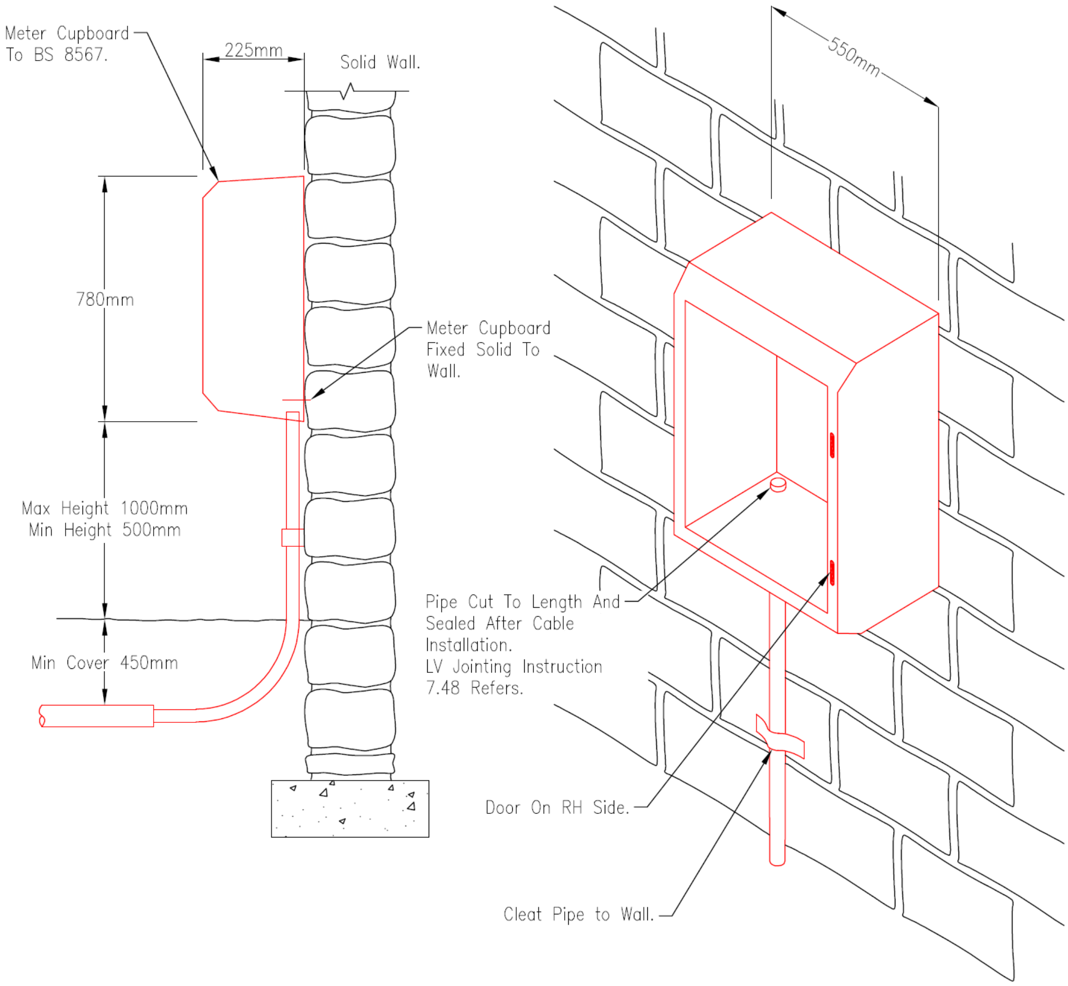
nationalgrid Electricity Distribution

Engineering Design (South West) Avonbank, Feeder Road, Bristol, BS2 0TB

Title: GENERAL ARRANGEMENT FOR SURFACE MOUNTED METER CABINET – SINGLE PHASE

Drg. No. 0G/65/4421 Rev No 5

All Dimensions in mm.



Rev No	Drawn	Chk'd	App'd	Date	Revision
4	JJH			10/21	AMENDED DIMENSIONS

ORIGINAL ISSUE		DATE
Drawn	JR	02/87
Checked		
Approved		
SCALE	NTS	

ORIGINAL SHEET SIZE: A4

nationalgrid Electricity Distribution

Engineering Design (South West) Avonbank, Feeder Road, Bristol, BS2 0TB

Title	Drg. No.	Rev No
GENERAL ARRANGEMENT FOR SURFACE MOUNTED METER CABINET – THREE PHASE	OG/65/4421/3	4

APPENDIX B

SUPERSEDED DOCUMENTATION

This document supersedes ST: SD5A/5 dated November 2020 which will be withdrawn on 1st January 2023.

APPENDIX C

RECORDING OF COMMENT DURING CONSULTATION

ST: SD5A/6 Comments

APPENDIX D

ASSOCIATED DOCUMENTATION

BS 7671	The IET Wiring Regulations
ENA EREC G5	Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom
ENA EREC P5	Design methods for LV underground networks for new housing developments
ENA EREC P28	Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom
ENA EREC P29	Planning Limits for Voltage Unbalance in the United Kingdom
EE SPEC: 6	11kV Distribution Transformers
EE SPEC: 16	LV Distribution Fuse Boards
EE SPEC: 37	Outdoor meter cabinets
POL: TP21	Fixed Earthing Systems
ST: CA6A	The installation of underground cables
ST: NC1P	Basis of Charges for Connection for Reinforcement of the Existing Distribution System
ST: NC1V	Standard Foundation and Enclosure Details for HV Substation Plant
ST: NC1Y	Minimum Information Requirements
ST: OH4K	Design of Insulated Aerial Bundle Conductor For LV Overhead Distribution Systems
ST: OH6A	Construction Techniques for Low Voltage Overhead Services
ST: SD1F	Procedure for Network Analysis by Independent Connection Providers (ICPs)
ST: SD1H	The Treatment of Losses in an Inclusive Network Design Process
ST: SD4A	Design of National Grid's 11kV and 6.6kV Networks
ST: SD5C	Low Voltage Connections to Multiple Occupancy Buildings
ST: SD5D	Arrangements for LV cut-outs and multi-service distribution boards.
ST: SD5G Parts 1 & 2	The Connection of Low Carbon Technology
ST: SD5H	Use of Connect/LV™ Software
ST: SD5P	Design of Metered and Unmetered Connections with a capacity up to 5kW
ST: SD5R	Earth Fault Loop Impedances and Phase to Neutral Loop Impedances
ST: SD8A	Overhead Line Ratings
ST: SD8B Parts 1 & 2	Underground Cable Ratings (LV & 11kV)
ST: SD8D	Distribution Transformer Ratings
ST: TP4B	11kV and 6.6kV Transformer Protection
ST: TP21D	11kV, 6.6kV and LV Earthing
ST: TP21DD	Design of Earthing Systems – Part D: Ground Mounted Distribution Substations
ST: TP21E	Provision of National Grid Earth Terminals to Customer LV Installations

APPENDIX E

KEY WORDS

ADMD, Earth Fault, Loop Impedance, Cut-out, IET Wiring Regulations, BS 7671, PME, SNE, TT, EV, Electric Vehicle, Electric Vehicle Charge Point, Heat Pump, Heat Pump System, Domestic, LV, Low Voltage.