

Company Directive

STANDARD TECHNIQUE: SD5A/3

Design of Low Voltage Domestic Connections

Author: Andy Hood

Implementation Date: December 2017

Approved by



Policy Manager

Date:

12 December 2017

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IMPLEMENTATION PLAN

Introduction

This document specifies the requirements for the design of low voltage domestic connections to Western Power Distribution's network.

Main Changes

The WinDebut loop impedance values have been amended to align with the latest version of ST: SD5R. Where new buildings are proposed to be constructed in the proximity of an existing substation WPD shall, as far as possible, ensure the minimum distances specified in 8.1.1 are maintained.

Impact of Changes

The changes are relevant to all staff involved with the design, construction and maintenance of WPD LV networks.

Implementation Actions

Managers shall ensure that all relevant staff and contractors are made aware of, and follow the requirements, of this document.

Implementation Timetable

This Standard Technique shall be implemented with immediate effect for new or modified connections. Clause 8.1.4 relating to the construction of new buildings and the extension of existing buildings in the proximity to WPDs substations also apply with immediate effect.

REVISION HISTORY

Document Revision and Review Table		
Date	Comments	Author
Dec 2017	<ul style="list-style-type: none">• Clause 7.1 - WinDebut phase to neutral impedances changed to align with ST:SD5R• Clause 8.1.4 - New buildings constructed in the proximity of a WPD substation shall, as far as possible, satisfy the requirements of 8.1.1.	Andy Hood
Nov 2016	<ul style="list-style-type: none">• Table 1 and Table 2 have been modified to take account of electric vehicle charging points.	Andy Hood
Sep 2015	<ul style="list-style-type: none">• Table 2 corrected	Andy Hood
Feb 2014	<ul style="list-style-type: none">• References to G12/3 have been replaced with ST:SD6E	Andy Hood

1.0 INTRODUCTION

- 1.1 This document provides guidance on design of low voltage domestic connections.
- 1.2 Western Power Distribution staff and contractors use Windebut software to carry out load flow and protection studies for domestic connections. Independent Connection Providers (ICPs) may either use Windebut or other alternative systems as long as the criteria specified in this document are satisfied.
- 1.3 Where there is any difficulty in implementing this ST the Policy Team shall be notified who will 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 WPD staff / contractors on the minimum information requirements is included in Standard Technique NC1Y. For domestic connections the following information is required:

- Customer name and address (correspondence address) and other contact details
- Site address.
- Site plan at an appropriate scale to indicate the site boundary, layout of buildings and roads.
- Letter of authority where the applicant is acting as an agent of the customer.
- Indicative date when the customer requires the connection(s) to be made.
- Total maximum capacity (kVA) requirement and interim capacity requirements for phased developments.
- The extent of any Contestable work to be carried out by the customer.
- The maximum capacity required at each metering point.
- The number of bedrooms associated with each domestic connection.
- Details of the type and rating of the heating load and the time period when the heating load is will be operating (i.e. switching regime for off peak heating) for each connection.
- Summary technical details of any electricity generator that is required to operate in parallel with the supply stating as a minimum the number, type (e.g. photovoltaic) and size (rating and number of phases) for each connection.
- Summary technical details of any customer owned equipment that is likely to cause disturbance to the electricity supply stating as a minimum the number, type (e.g. motors, welders, heat pumps, kilns, large switched loads, electric vehicle charging points etc.) and rating (starting/striking current and frequency of operation) for each of these items of equipment.
- Details of any street lighting or other un-metered connections to be installed within the development.
- Any payment that is required to be made in advance for the service to be provided.

3.0 LOAD ESTIMATES

3.1 The after diversity maximum demand (ADMD) and the annual kWh consumption 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 of highest demand on the substation or LV circuit.

3.2 Substation and LV Circuit Ratings

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 Windebut, the software used by WPD for LV network design. Windebut uses this information to calculate load requirements. Further guidance on the use of Windebut is provided in ST:SD5K.

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 (less 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.

Table 1 Estimated Annual Consumption for Domestic Properties

Description of Heating	Windebut Profile	1 Bedroom		2 Bedroom		3 Bedroom		4 Bedroom		5 Bedroom	
		Day kWh	Night kWh	Day kWh	Night kWh	Day kWh	Night kWh	Day kWh	Night kWh	Day kWh	Night kWh
Gas Central Heating	OFFER 1	1900+A+E		2650+A+E		3600+A+E		4200+A+E		4800+A+E	
Electric E7 Heating	OFFER 2	1900 +A+E	1300 +B+C+F	2700 +A+E	1560 +B+C+F	3500 +A+E	1950 +B+C+F	4100 +A+E	2200 +B+C+F	4650 +A+E	2200 +B+C+F
Electric E10 Heating	ECO10	1900+D+E		2650+D+E		3600+D+E		4200+D+E		4800+D+E	
Heat Pumps	See Table 2	Use ADMD method (See Table 2)		Use ADMD method (See Table 2)		Use ADMD method (See Table 2)		Use ADMD method (See Table 2)		Use ADMD method (See Table 2)	
Other Non-electric Central Heating	OFFER 1	2150+A+E		2900+A+E		3900+A+E		4600+A+E		5300+A+E	

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 car charging points.
- F = 300 x total kW rating of any car charging points.

Table 2 Estimated ADMD Values (kW) for Domestic Properties

Description of Heating	Windebut 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	OFFER 1	0.9+A+E		1.3+A+E		1.7+A+E		2.0+A+E		2.3+A+E	
Electric E7 Heating	OFFER 2	1.3 +A+E	1.3 +B+C+E	1.8 +A+E	2.0 +B+C+E	2.3 +A+E	2.5 +B+C+E	2.7 +A+E	2.8 +B+C+E	3.1 +A+E	2.9 +B+C+E
Electric E10 Heating	ECO10	1.3+D+E		1.8+D+E		2.3+D+E		2.7+D+E		2.9+D+E	
Heat Pumps	OFFER 1	0.9+D+E		1.3+D+E		1.7+D+E		2.0+D+E		2.3+D+E	
Other Non-electric Central Heating	OFFER 1	0.9+A+E		1.3+A+E		1.7+A+E		2.0+A+E		2.3+A+E	

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. For existing connections add together the unrestricted and restricted units together.
- E = 0.5 x total kW rating of any electric vehicle charging points.

3.3 Service and Cut-out Ratings

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

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

- $MD = 2 \times ADMD + 8kW$

Properties with Economy 7 Electric Heating:

- $MD \text{ (day)} = 2 \times ADMD \text{ (day)} + 8kW$
- $MD \text{ (night)} = ADMD \text{ (night)} + 4kW$

Properties with Economy 10 Electric Heating or a Heat Pump:

- $MD = ADMD \text{ (day)} + 4kW$

- 3.3.2 If, for example, a two bedroom property has 2.5kW of direct heating and 8kW of electric storage heaters fitted and uses an Economy 7 off peak tariff (or equivalent) then the following values would apply:

- $ADMD \text{ (Day)} = 1.8 + 0.2 \times 2.5 = 2.3kW$
- $ADMD \text{ (Night)} = 2.0 + 1.0 \times 2.5 + 1.0 \times 8.0 = 12.5kW$
- $MD \text{ (Day)} = ADMD \text{ (day)} \times 2 + 8kW = 2.3 \times 2 + 8 = 12.6kW$
- $MD \text{ (Night)} = ADMD \text{ (night)} + 4kW = 12.5 + 4 = 16.5kW$

The service, cut-out and cut-out fuse will all have to be suitable for at least 16.5kW (i.e. 71.7A at 230V). In this case WPD'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 maximum generation and minimum demand. Under these circumstances the following "rules of thumb" may be applied.

- For circuit / substation design purposes the Minimum Demand associated with domestic load is assumed to be $0.2 \times \text{Maximum Demand}$.
- Diversity should be assumed between wind turbines and PV systems (as maximum PV output is unlikely to occur during periods of high wind). 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 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 6pm and 6a.m.

4.0 THERMAL REQUIREMENTS

- 4.1 Substations, cables, overhead lines, services and cut-out 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, spring/autumn ratings used for overhead lines and then 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).

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% ^{[1][2]}.
 - Voltage drop along single phase services shall be limited to 2%^[1]. 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% ^{[1][2]}.
- 5.2 Windebut checks that the maximum voltage drop across mains and service cables / lines is less than 6%^[1]. (based on unity power factor). The maximum voltage drop across the transformer is assumed to be 2%^[1] or less.

Note 1: Percentage values of voltage drop and voltage rise are based on 230V.

Note 2: Where high levels of generation are installed in an LV network it is acceptable to lower the tap position of the distribution transformer by one 2.5% step (i.e. increasing the tap by +2.5%), where this is possible. Where this is carried out the maximum voltage drop across the LV network shall be reduced by 2.5%^[1] and the maximum voltage rise across the LV network shall be increased by 2.5%^[1].

- 5.3 Where Windebut is used to check voltage rise, a separate study must be carried out to determine the voltage rise across the transformer (as voltage rise / drop across the transformer this is not checked by Windebut as standard).

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 currents produced by equipment connected to public low-voltage systems with inputs current $\leq 16\text{A}$ per phase.
- BS EN 61000-3-3: Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage systems, for equipment with rated current $\leq 16\text{A}$ per phase and not subject to conditional connection.
- BS EN 61000-3-11: Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage systems - equipment rated current $\leq 75\text{A}$ per phase and subject to conditional connection.
- BS EN 61000-3-12: Limits for harmonic currents produced by equipment connected to public low-voltage systems with inputs current $> 16\text{A}$ and $\leq 75\text{A}$ per phase.

It should be noted that BS EN 61000-3-11 and BS EN 61000-3-12 define requirements for the maximum system impedance and minimum fault level at the exit point which the equipment is connected to. These requirements shall be met when designing networks and when assessing whether reinforcement is needed (before such equipment may be connected).

6.2 The LV network shall be designed in accordance with:

- ENA Engineering Recommendation G5/4: Planning levels for voltage distortion and connection of non-linear equipment to transmission systems and distribution systems in the UK.
- ENA Engineering Recommendation P28: Planning limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the UK.
- ENA Engineering Recommendation P29: Planning limits for voltage unbalance in the UK.

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 BS88 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 shall be in accordance with ST:SD5R. Windebut is set with a maximum earth fault loop resistance of 0.19Ω (mains only) and 0.22Ω (mains and service) in order to ensure the 0.25 ohm loop impedance value for new LV circuits is satisfied.
- Cut-out fuses or metering circuit breakers shall operate within 5s for faults on the terminals of the cut-out or circuit breaker.
- The standard cut-out fuse rating is 80A although alternative sizes may be used. Further guidance on standard cut-out arrangements is included in ST:SD5D.

7.2 All the above criteria assume 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 BS7671 (IET Wiring Regulations).

8.0 PHYSICAL DESIGN REQUIREMENTS

8.1 Substation Requirements

8.1.1 Where a substation is required this shall be located:

- Close to the load centre.
- At least 5m from the living areas (living rooms, kitchen, bedrooms etc.) of domestic properties to minimise the risk of receiving noise complaints.
- At least 9m from earthed LV metalwork (e.g. steel framed buildings) where the HV and LV earths of the substation need to be segregated. Further guidance on earthing requirements is provided in ST:TP21D.

8.1.2 All new ground mounted substations shall be installed on anti-vibration pads (to minimise vibration and noise) and either within GRP enclosures 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 SPEC16.

- 8.1.4 Where new buildings are proposed to be constructed in the proximity to an existing substation, WPD shall, as far as possible, ensure that the minimum distances stated in 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 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.
- 8.2.3 LV circuits shall normally be arranged as multi-branched radial feeders. Un-used ways in the substation LV feeder pillar shall be cabled and end boxed outside the substation to enable future circuits to be added without making the feeder pillar dead. The end boxes shall not have PME earth electrodes installed as this may compromise the separation of the HV and LV earth electrode systems.
- 8.2.4 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 150mm diameter rigid ducts.
- 8.2.5 Underground service cables shall be installed in black 38mm (internal diameter) alkathene ducts.
- 8.2.6 Services shall not be looped.
- 8.2.7 Link boxes (or equivalent cabinets) should be installed to provide back-feeding facilities between substations, where this is reasonably practicable. Where a link box or cabinet is installed the circuit feeding the link box should not be tapered. Where link boxes or cabinets are provided the associated additional costs shall be borne by Western Power Distribution and not by the developer / customer, as this does not constitute the minimum cost scheme. Where the network is to be installed by an ICP, WPD should specify the requirement for any link boxes / cabinets and the associated additional costs (to be borne by WPD) shall be agreed in advance.
- 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.

8.3 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. 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 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. Where Western Power Distribution or the Meter Operator provide an isolation switch this may also be located inside the meter cabinet.
- 8.3.4 Meter cabinets shall be supplied by Western Power Distribution or by an Independent Connection Provider to Western Power Distribution specification EE SPEC37. Meter cabinets are 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. Western Power Distribution hold stocks of various types of meter cabinet door and reserve the right to charge building owners / customers for replacing damaged doors.
- 8.3.5 Cut-out / meter positions may be located inside domestic properties as long as the following criteria are satisfied.
- The air temperature surrounding the cut out must not exceed 30°C.
 - The cut-out / metering equipment is easily accessible and placed in a well lit area.
 - Sufficient space shall be provided for and dedicated to the cut-out and metering equipment (e.g. 600mm x 400mm) and sufficient space shall be provided in 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 entire cut-out / meter position shall be positioned between 500mm and 1800mm above the finished floor level.
 - The cut-out / meter position shall not be located in a bathroom, toilet, shower-room or close to a source of water that could damage the equipment or cause an electrocution risk.
 - The cut-out / meter position 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°C.
 - The cut-out / meter position shall be located so that a minimum separation distance of 300mm is maintained between any gas meter and the electrical installation (service cable, cut-out, metering and meter tails).
 - The service cable can be easily accessed and replaced.

8.3.6 The standard method of service entry into the meter cabinet shall be by means of a white, ultra violet proof PVC preformed tube (the “hockey stick”) with an outside diameter of 38 mm and a wall thickness of 2 mm. The tube shall be fixed to the outside wall using appropriate cleats.

8.3.7 Service cables shall be installed within black alkathene service ducting (as specified in 4.2.6). The alkathene service ducting should be laid from the service joint directly and connect to the hockey stick.

8.4 Street Lighting

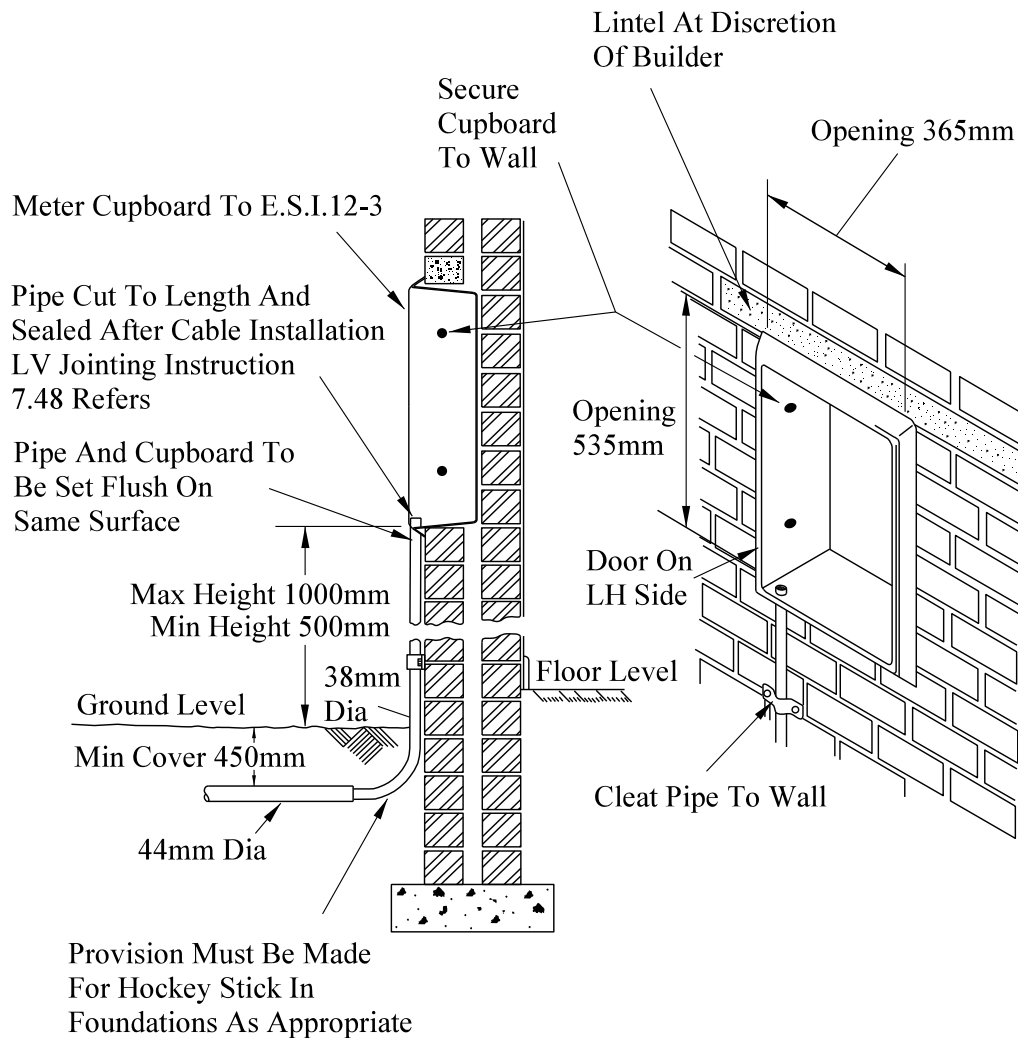
8.4.1 The design of street lighting connections shall be in accordance with ST:SD5P.


APPENDIX A

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
Drawing Number ST:SD6A/3	Flush mounted slim line meter cabinet – single phase

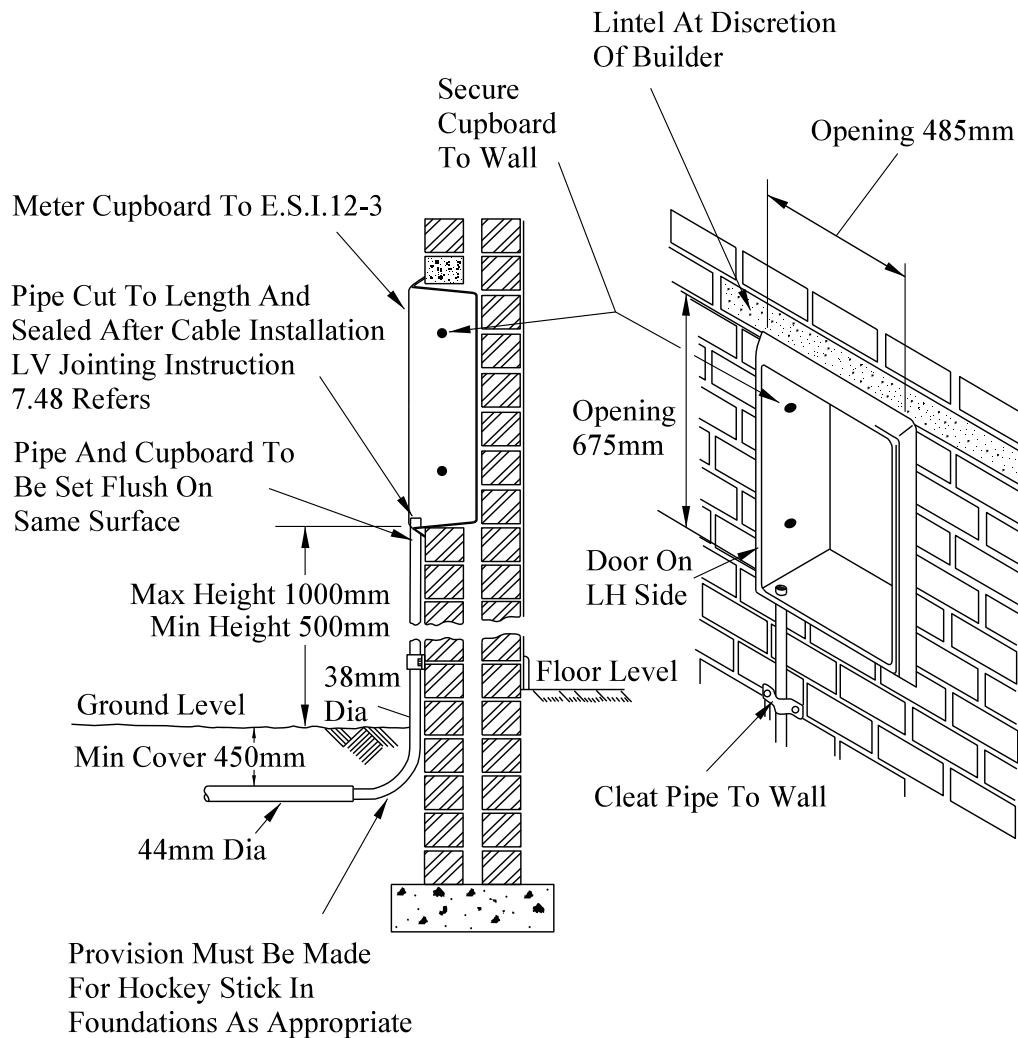
All dimensions in mm




4	RJB			11/11	TITLE CHANGED		
Rev No	Drawn	Chk'd	App'd	Date	Revision		
ORIGINAL ISSUE		DATE		WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.		 WESTERN POWER DISTRIBUTION	
Drawn	JR	2.87					
Checked				Title GENERAL ARRANGEMENT FOR FLUSH MOUNTED METER CABINET - SINGLE PHASE		Drg. No. OG/65/4418	Rev No 4
Approved							
SCALE		N.T.S.					

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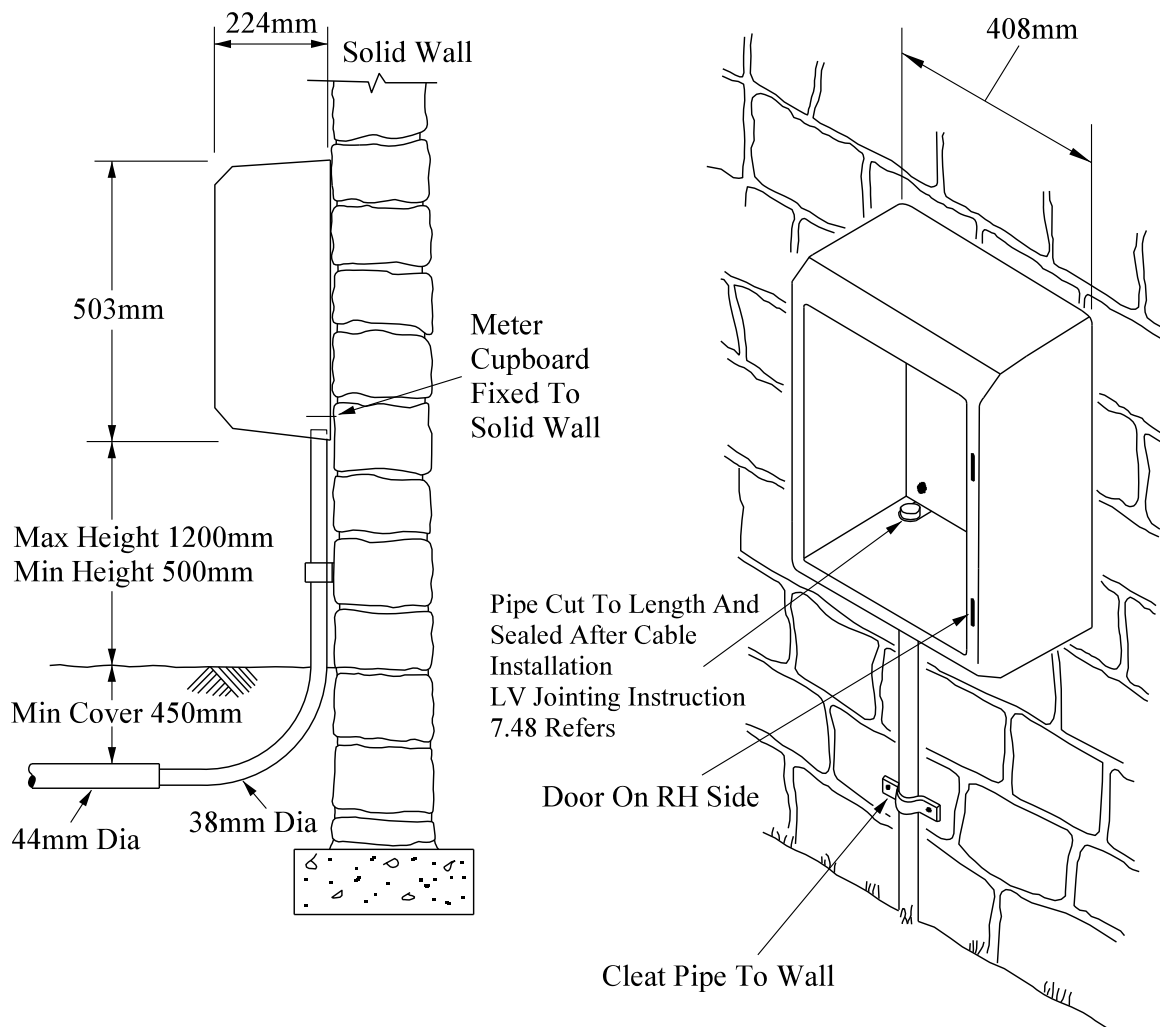
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4	RJB			11/11	TITLE CHANGED		
Rev No	Drawn	Chk'd	App'd	Date	Revision		
ORIGINAL ISSUE		DATE		<div>WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.</div> <div>Title</div> <div>GENERAL ARRANGEMENT FOR FLUSH MOUNTED METER CABINET - 3 PHASE</div>		<div><div>WESTERN POWER DISTRIBUTION</div><div></div></div> <div>Drg. No. OG/65/4418/3</div> <div>Rev No 4</div>	
Drawn	JR	2.87					
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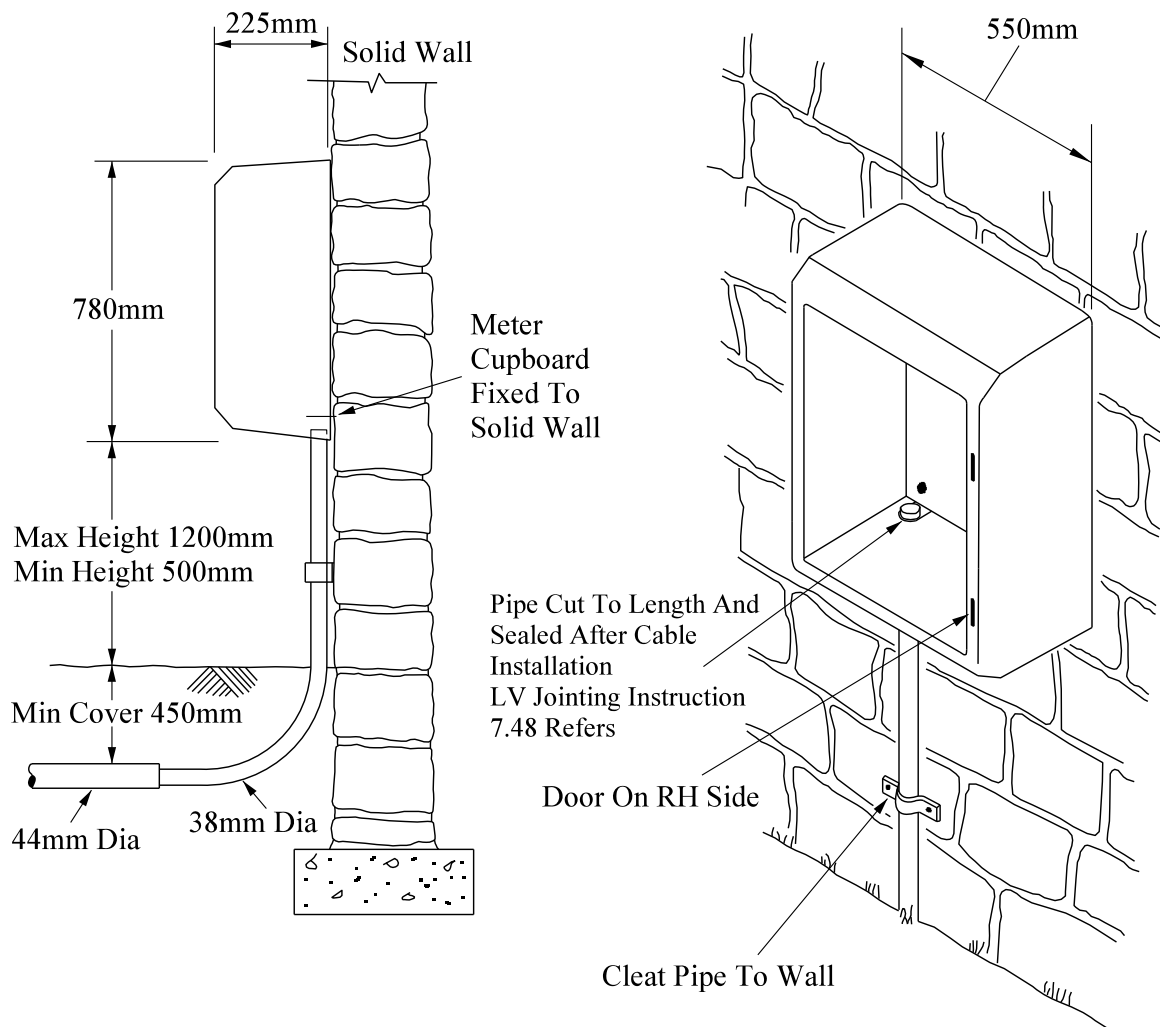
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ORIGINAL ISSUE					
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				WESTERN POWER DISTRIBUTION Design Department. Avonbank, Feeder Road, Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	
				Title	
				GENERAL ARRANGEMENT FOR SURFACE MOUNTED METER CABINET - SINGLE PHASE	
				Drg. No.	Rev No
				OG/65/4421	4

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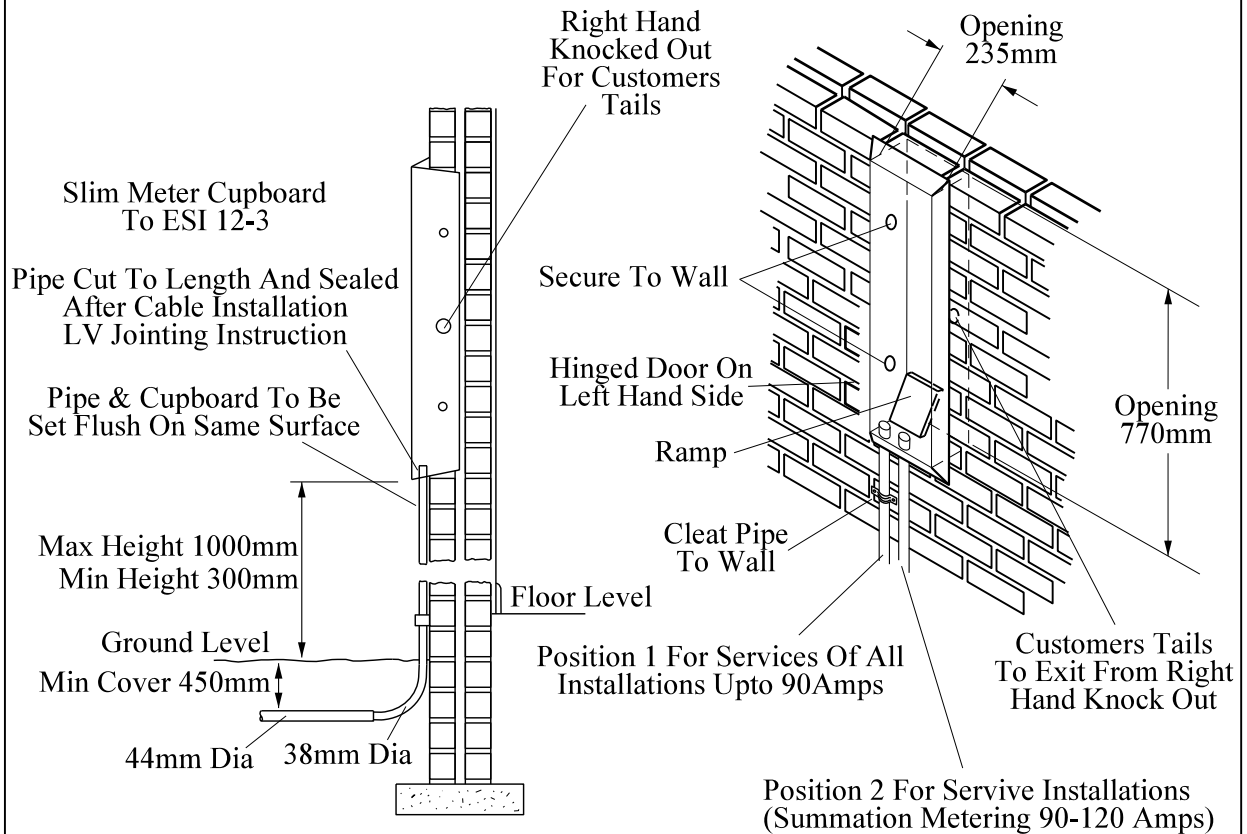
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3	RJB			10/08	BOX ALTERED		
Rev No	Drawn	Chk'd	App'd	Date	Revision		
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All dimensions in mm



Cut Out And Ramp Shell Be Secured To The Left Hand Side

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SCALE		N.T.S.		Title		Drg. No.	Rev No
				GENERAL ARRANGEMENTS FOR FLUSH MOUNTED SLIM LINE METER CABINET - SINGLE PHASE		ST:SD6A/3	

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APPENDIX B

SUPERSEDED DOCUMENTATION

This document supersedes ST:SD5A/2 dated November 2016 which has now been withdrawn.

APPENDIX C

ASSOCIATED DOCUMENTATION

BS7671	IET wiring regulations
ENA ER G5/4	Planning levels for voltage distortion and connection of non-linear equipment to transmission systems and distribution systems in the UK
ENA ER P28	Planning limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the UK
ENA ER P29	Planning limits for voltage unbalance in the UK
EE SPEC: 16	LV Distribution Fuse Boards
EE SPEC: 37	Outdoor meter cabinets
ST: CA6A	The installation of underground cables
ST: NC1V	Standard foundation and enclosure details and specifications for 11kV Substation plant
ST: NC1Y	Minimum information requirements
ST: SD5D	Arrangements for LV cut-outs and multi-service distribution boards.
ST: SD5K	Use of Windebut software
ST: SD5R	Earth fault loop impedances and phase to neutral loop impedances at LV installations
ST: SD5P	Design of un-metered connections
ST: SD8A	Overhead line ratings
ST: SD8B Part 1	LV underground cable ratings
ST: SD8B Part 2	11kV underground cable ratings
ST: SD8D	Distribution transformer ratings
ST: TP4B	11kV and 6.6kV transformer protection
ST: TP21D	HV and LV system earthing
ST: TP21E	Provision of WPD earth terminals to customer LV installations

APPENDIX D

KEY WORDS

Earth Fault, Loop Impedance, Cut-out, IET Wiring Regulations, BS7671, PME, SNE, TT.