IMP/001/911/002 - Code of Practice for Point of Connection Assessment using Standard Design Rules for New and existing Low Voltage Connections up to 60kVA

1. Purpose

The purpose of this document is to provide standard design rules for determining the point of connection for new Low Voltage (LV) connection(s) to the existing LV distribution systems of both Northern Powergrid (Northeast) plc and Northern Powergrid (Yorkshire) plc. The maximum total diversified connection capacity is 60kVA with any individual single or three phase connection limited to 80A per phase.

The standard design rules are for use by both Northern Powergrid employees and accredited Independent Connection Providers when self-determining a point of connection to underground three phase LV systems only.

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

Reference	Version	Date	Title
IMP/001/107	4.0	Nov 2018	Code of Practice for point of Connection assessment using Standard Design Rules for Low Voltage connections up to 60kVA

2. Scope

This document applies to the determination of point of connections for the following:

Service Line	ReportingCode
One low voltage single phase **domestic or non-domestic** service connection, where there is norequirement to extend the low voltage network	ECGS2A
Two to four low voltage single phase **domestic** service connections, where there is no requirement toextend the low voltage network	ECGS2B
One to four low voltage single phase **domestic** service connections involving an extension to the lowvoltage network	ECGS2B
One low voltage three phase domestic or non-domestic **whole current metered connection**, where thereis no requirement to extend the low voltage network	ECGS2B
One low voltage three phase domestic or non-domestic **whole current metered connection**, involving anextension to the low voltage network.	ECGS3A
Up to 20 low voltage single phase gas heated domestic service connections which could involve anextension to the Low voltage Network	ECGS3A
Two to six new low voltage single phase **domestic** service connections, with G98 compliant PVInstallations.	ECDGS3A
Two to six low voltage single phase **domestic** service connections, with heat pumps up to 32A/phase and compliant with BS EN 61000-3-2 and BS EN 61000-3-3 involving an extension to the Low voltage Network.	ECGS2B

One low voltage single or three phase whole current metered, service connection where the Load to beconnected includes disturbing loads that comply with either BS EN 50160 or can be connected without assessment under P28	ECGS2A/ECGS2B

2.1. General

This document provides the Standard Design Rules (SDRs) for the self-determination of a Point of Connection (PoC) and is applicable for new connections to the existing distribution system, and for the permissible modifications specified within this code of practice only. This document does not cover any modifications or additional load requirements to any existing connections where such modifications will result in the maximum diversified supply requirements of that connection exceeding 80A per phase.

The standard Northern Powergrid termination will be protected by an 80A fuse.

The standard service length for all new connections is 20m as per Code of Practice for Economic Development of LV Systems, IMP/001/911. However where this standard length can't be achieved, in exceptional cases and following additional checks, the service can be extended up to a maximum length of 40m. Due to unmetered connections using 16mm^{2}Cu service cables the maximum length for unmetered connections is limited to 20m.

The available transformer capacity will be determined by the number and type of existing customers and customers to be connected. This should be assessed at the design stage[1], [2].

Connections are only allowed to be made to three phase underground cable networks . The minimum size cables that can be used to comply with the SDRs are specified for both metered and unmetered connections. The minimum sizes specified ensure compliance with the maximum earth loop impedance to provide fault clearance within 30 second disconnection to the end of the mains cable and minimises the risk of a supply being provided outside of statutory voltage limits.

Where records and data are unclear, or the criteria determined in the SDRs cannot be met; a higher level design engineer[1] shall be consulted or refer to Northern Powergrid for further information.

This document applies to:

- The Low Voltage (LV) distribution systems of Northern Powergrid (Northeast) plc and Northern Powergrid(Yorkshire) plc.
- All extensions to the LV distribution system for new connections.; and
- All assets with a nominal operating voltage of 230/400V ac three phase, at a HV to LV substation including theHV to LV transformers.

It is not a requirement to apply this Code of Practice retrospectively, but when work is being carried out on the LV system, the opportunity shall be taken to improve sections of system to comply with the Code of Practice when it is practicable and economic to do so.

Connection arrangements, including those for multi-occupancy premises and embedded 'independent' networks, are covered in the Code of Practice for Standard Arrangements for Customer Connections IMP/001/010.

[1] As defined in section 3.9

[2] A design calculator is available which will determine the minimum size of acceptable transformer

2.2. Table of Contents

3. Standard Design Rules (SDRs)

3.1. Introduction

A subset of point of connections can be determined using Standard Design Rules (SDRs). This code of practice provides the following:

- the process to be applied when self-determining a LV point of connection to the existing LV distribution system.
- the standard design rules that will assist in assessing the capacity that can be connected to the existing LVdistribution system.
- guidance in identifying whether the connection to the LV system can be designed utilising the SDRs.
- guidance as to which type, and capacity, of low voltage connection can be connected under certain conditions.
- points to consider before connecting under the SDRs; and
- limitations under SDRs and additional assessments that should be made prior to establishing the point ofconnection and completion of the design.

3.2. Standard Design Guidance Flow Charts

The appendices to the code of practice, detailed below document the considerations behind the SDRs including the flow charts. They provide guidance as to the suitability of the LV system to accept a connection.

- Appendix 1 – Connection limits for single phase metered connections for one to six domestic supplies (including Low Carbon Technologies) or one single phase commercial supply.
- Appendix 2 – Connection limits for single phase metered connections for seven to twenty non electrically heated domestic supplies or up to six single phase electrically heated domestic properties (including Low Carbon Technologies), two to four single phase commercial supplies or a single three phase connection, domestic or non-domestic;
- Appendix 3 – Unmetered connections.
- Appendix 4 – Earthing; and
- Appendix 5 – Justification for values utilised within the SDR guidance flowcharts.

3.3. Design Loads – Metered Connections

3.3.1. General Domestic Connections

General domestic connections are premises that are typical centrally gas heated and do not have any form of electric heating installed or have a requirement for an Electric Vehicle (EV) charging point.

For general domestic connections the SDRs use the ADMD formula specified in Section 3.4.2.1 of the Code of Practice for the Economic Development of the LV System, IMP/001/911, for assessing the number of connections that can be connected to the LV system without the requirements to undertake LV system studies. The formula calculates the nth customer ADMD and consequentially the design demand (kW) for the maximum permissible number of connections that can be connected to the LV system ensuring the projected capacity does not exceed 60kVA. The maximum permissible number of single phase general domestic properties across a three phase supply, which can be connected using the SDRs istwenty. The maximum diversified demand for each individual connection shall be limited to the service cut-out fuse rating of 80A per phase.

The SDRs shall only be used for developments where the total number of general domestic connections on completion ofthe development will not exceed twenty connections. Multiple connections of ≤ 20 for one development (i.e. possibly happening as a phased development) shall not be allowed under the SDRs.

3.3.2. Electrically Heated Properties

This section covers conventional resistive forms of heating only (for heat pumps see section 3.3.3). These include but are not exclusive to:

- Storage Heaters, using off peak electricity.
- Direct Acting Space Heating (DASH), panel heaters available for use 24 hours a day; and
- Flow Boilers (up to 9kW only[3]).

These devices will result in higher demands on the LV system than those using gas heating systems covered in General domestic connections section 3.3.1. The SDRs allow a maximum of six electrically heated connections to be made. The maximum diversified demand for each individual connection shall be limited to the service cut-out fuse rating of 80A per phase. This ensures that the quality of supply to both existing and new connections is maintained within statutory limits.

3.3.3. Heat Pumps (HPs)

SDRs in this code of practice only allow heat pumps compliant with both BS EN 61000-3-2 (Harmonic distortion) and BS EN 61000-3-3 (Voltage fluctuation - flicker) standards to be connected to the LV system without further technical assessment[4].

Any requests for the connection of heat pumps under the SDRs must be submitted using the appropriate application form and be duly signed by the applicant. Multiple heat pump connections with similar characteristics could be submitted with a single form.

The SDRs allow for the connection of up to ten heat pumps that are fully compliant with the required standards. However, because clusters of heat pumps on the LV system could potentially cause power quality and thermal issues, connections under SDRs shall only be made if the additional requirements detailed below are met:

- Any heat pump connected to an individual property shall not result in the maximum demand of the property exceeding the service cut-out rating up to a maximum of 80A per phase;
- No more than one compliant heat pump shall be connected to an individual premise; and
- The total electrical load of each individual heat pump, including boost and back up[5], should not exceed 16A per phase; or
- If the total electrical load of the heat pump is between 16A and 32A per phase these can be connected followingfurther checks to ensure that the total number of heat pumps connected on the feeder is no more than ten. If checks suggest that the total number of heat pumps (including the new one) exceeds ten, the connection falls outside the SDRs and a full PoC design shall be carried out.

The above requirements will ensure that the total load connected to the LV system will not exceed 60kVA. The nth customer ADMD and consequentially the design demand for a property with a heat pump and

[3] Based on IMP/001/911 – Other electric heating = 1kW + 100% on installed load 6 units at 1kW + 9kW = 60kW. SDR limit is based on assumption of unity power factor.

[4] The customer application should confirm that the Heat Pump is marked as "connect & notify" in the ENA Heat Pump Database https://www.energynetworks.org/industry-hub/resource-library/low-carbon-technologies-heat-pump-database.xls. If the heat pump is marked as 'apply to connect' this would fall outside the standard design rules.

[5] Consideration in regard to operation of additional heating elements like back up or boost should be given i.e. if this heating comes on very infrequently, once for 5 minutes/week, then the rating of the additional heating can be ignored.

general domestic load is calculated using the formula in Section 3.4.2.2 of the Code of Practice for the Economic Development of the LV System, IMP/001/911.

3.3.4. Domestic Electric Vehicle (EV) Chargers

Up to nine domestic EV Chargers up to 32A can be connected under the standard design rules. The following requirements must also be considered when assessing the connection of domestic EV chargers.

- The total number of domestic EV chargers connected on the network (including those that are already connected) does not exceed nine otherwise this connection falls outside the SDRs and a full PoC design shall be carried out;
- The maximum demand, including the general domestic load, for each individual connection shall not exceed theservice cut-out rating up to a maximum of 80A per phase.
- Where the application is for connection of an EV charger to an existing supply, checks shall be made to ensure the adequacy of the existing cut-out for the new load required and.
- No more than one EV charger (up to 32A) is installed to an individual premise connection.

The above requirements will ensure that the total new load connected to the LV system will not exceed 60kVA. The nth customer ADMD and consequentially the design demand for a property with an EV charger and general domestic load is calculated using the formulae in section 3.4.2.3 of the Code of Practice for the Economic Development of the LV System, IMP/001/911.

3.3.5. Public Electric Vehicle Charging Points (EVCP)

As per IMP/001/911, public EVCP can be both metered and unmetered and provided from dedicated charging points or street lighting columns with a charging outlet. Where EVCP's are to connect to street lighting columns, they must be connected by a dedicated service to an LV mains cable and there shall be only one EVCP connected per lighting column.

The SDRs allow the connection of a combination of 16A and/or 32A per phase public EV charging points as per Table 1. Where EVCP have a different rating than 16A or 32A, the checks should assume they are the higher of the ratings. i.e. 25A rated EVCP should be assumed to be 32A for the purpose of using Table 1.

		16A EV Charging Point															
32A EV Charging Point		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No
	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
	7	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No
	8	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
	9	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No

Table 1 – Combination of public EV charging points

The maximum size fuse that shall be installed in a 25A public lighting cut-out is 20A. A 20A fuse can provide a supply of 25A per Appendix 9 of IMP/001/921.

As per IMP/010/011 Code of Practice for Earthing LV Networks and HV Distribution Substations (section 3.15.15), Public EVCP shall always have a TT earthing system by installing a separate earth electrode and fitting appropriate protection in accordance with BS 7671 (e.g. an RCD).

3.3.6. Domestic Heat Pumps and EV Chargers

Increasingly customers are installing both Heat Pumps and EV Chargers to domestic premises. Table 2 indicates the combinations of Heat Pumps (up to 16A) and EV charging points (up to 32A) that will be allowed under the standard design rules.

- The total number of domestic EV chargers and heat pumps connected on the network (including those that are already connected) does not exceed the values in table 2 otherwise this connection falls outside the SDRs and a full PoC design shall be carried out.
- The maximum demand, including the general domestic load, for each individual connection shall not exceed theservice cut-out rating up to a maximum of 80A per phase.
- Where the application is for connection of a Heat Pump and EV charger to an existing supply, checks shall be made to ensure the adequacy of the existing cut-out for the new load required and;
- No more than one EV charger and one Heat Pump is installed to an individual premise connection.

		Heat Pump										
EV Charge Point		0	1	2	3	4	5	6	7	8	9	10
	0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
	8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
	9	Yes	No	No	No	No	No	No	No	No	No	No

Table 2 – Combination of Heat Pumps and EV charging points

3.3.7. Photovoltaic (PVs)

Under the SDRs up to six premises with PV compliant with EREC G98 can be connected. Any application containing units with an outputthat exceeds 16A per phase will fall outside the SDRs.

When assessing the numbers of compliant PV systems that can be connected to the LV system under the SDRs, thediversity factors and minimum demand as per IMP/001/911 have been used.

The selection of the maximum circuit lengths as per section 3.5 ensures that any voltage rise created by the installationof six 16A per phase PV systems will not exceed the maximum statutory voltage limits at times of minimum demand.

3.3.8. Commercial Loads

Commercial loads generally have a higher demand profile than general domestic therefore under the SDRs the maximumcommercial connections have been limited.

The SDRs allows for only one single phase 80A connection to be provided if the source transformer is a 200 kVA unit. Up to four single phase 80A commercial connections or a one three phase 80A per phase connection can be connected but will require a minimum distribution transformer size of 200 kVA. Where developments have a requirement for a number of connections above this level, the connection shall be referred to a higher level designer.

The full development must be considered as one application, multiple applications for one development shall not be allowed.

3.3.9. Connection of Welders and Motors without Assessment

Planning Limits for Voltage Fluctuations Caused by Industrial, Commercial and Domestic Equipment, EREC P28- Addendum 1 covers electric motors that can be connected without prior agreement. Table 3 below is an extract from P28 and covers single phase and phase motors which can be connected to the LV system that don't start more frequently than once a minute. The following table has been extended for the SDRs:

Type	Normal running rating expressed in terms of either:		Values used in NPg Standard Design Rules
	OUTPUT (kW)	INPUT (kVA)	INPUT (kVA)
Single-phase 240V	0.75	1.7	3.87 (3.68kW)
Single-phase 480V	3.00	4.5	Not considered within the Standard Design Rules
Three-phase 415V	4.50	6.0	6.0
Three-phase 415V (star delta/ soft start/VSD)	Not considered in P28	Not considered in P28	10.0

Table 3: P28 (1989) Addendum 1 – Motors (Direct on Line) Table B

The single phase values shown above, extracted from P28 are based on an earth loop impedance of 0.4 + j0.25 (Z =0.47Ω). The 1.7kVA value is considered too conservative, given many domestic appliance motors are above this value and Northern Powergrid experience has shown these sized motors rarely cause issues. Therefore, this value was scaled up using an earth loop impedance of 0.2Ω giving a value of 3.87kVA for DOL single phase motors.

For three phase DOL motors the value of 6kVA from the table in P28 was taken directly, as experience has shown DOL motors above this size usually require more analysis. Given their lower starting currents, it has been decided, star delta and VSD connected motors up to 10kVA[6] can be connected without further studies as per Table 4 below.

Equipment	Rating
Welders	16A
Single Phase Motors	3.87kVA (3.68kW) Direct on line start
Three Phase Motors	6kVA Direct on Line start
Three Phase Motors	10kVA Star Delta Start, soft start and VSD

Table 4: Maximum input welder and motor ratings allowed under the SDRs

[6] Flicker calculations for a star delta start 10kW motor indicates a potential 1.24% flicker on starting at the point of common coupling for the maximum circuit impedance allowed under the SDRs. This allows a starting frequency of approximately once every 40 seconds.

3.3.10. Transformer Ratings

The addition of demand to smaller transformers without undertaking a load assessment on the transformer is a risk that has been assessed when deciding on the minimum sizes of transformer to be used within the SDRs. The risks associated with connecting any load to transformers with a capacity of less than 200kVA is deemed unacceptable due to the potential for overloading the transformer and the additional impedance it inserts in the circuit.

The use of 200kVA transformers is acceptable but only for additional loads that will add a total diversified load to the transformer of no more than 12% of the transformer rating. It has therefore been calculated that up to six single phase domestic connections (max diversified load for six EVs = 33kVA) or one single phase commercial connection (18.4kVA) ortwenty unmetered connections can be added with a minimal risk of creating an unacceptable overload on a 200kVA transformer.

The connection of any three phase metered connection, or two to four single phase commercial connections, or seven to twenty domestic connections pose an unacceptable risk of overload to a 200kVA transformer and therefore any systemto which connections of these types are made will have to be supplied by a transformer with a minimum capacity of 200kVA. For unmetered connections where the prospective ELZ is within permissible limits and the source transformer is a unit of 50kVA or greater then up to 6 unmetered supplies can be connected without referral to design.

3.3.11. Unmetered Connections

This section covers new supplies to all unmetered connections including unmetered connections to street lightingcolumns. Unmetered connections may include street lighting columns with charging outlet for electric vehicles. However,the connection of such unmetered connections falls outside the scope of this CoP and will not be discussed in the SDRs.For further guidance on such connections refer to the Code of Practice for the Economic Development of the LV System. For street lighting connections only, the SDRs cover both new connections, and the replacement of existing lighting columns. This section of the SDRs therefore caters for;

- New unmetered connections;
- Transfer of existing lighting columns; and
- The replacement/transfer of columns fed via a looped service or 5th core network.

Street lighting authorities have a number of existing connections from networks that were designed prior to the current requirements of IMP/001/911 and the replacement of those networks to meet IMP/001/911 is not always economically viable when changing a street lighting column.

Requirements for the replacement of existing looped or 5th core street lighting networks are detailed in Section 3.3.10.2 below.

3.3.11.1. New Unmetered Connections

When connecting any new unmetered supply whether to a pillar, cabinet or a lighting column they shall be provided via adirect service fed from a mains cable as per IMP/001/911. The SDRs provide both maximum mains and service cable lengths, along with the minimum sizes, which can be used whilst ensuring compliance with the requirements of IMP/001/911.

The maximum number of new unmetered connections that can be made to a dedicated LV main shall be 20. Mains extensions to facilitate new unmetered connections are allowed providing the extended mains cable does not exceed themaximum lengths permitted in section 3.5.2 Table 6 for unmetered connections.

Code of Practice for the maximum load of unmetered supplies, CNN/006/001 allows for a maximum capacity of 1.38kW for unmetered connections. No diversity exists for street lamps and therefore calculations have been made with each potential connection being at a maximum of 1.38kW.

Twenty unmetered connections at 1.38 kW = 27.6kW.

Where there are more than 50 unmetered connections on a feeder a maximum of 6 unmetered connections can be added without referral to a higher level designer.

3.3.11.2. Replacement or Transfer of Existing Lighting Column Services

When replacing any existing street lighting column, the replacement shall have a dedicated direct service from a passing main wherever practicable. This is to minimise the earth loop impedance and operational issues surrounding the use of switched control lamp systems.

A transfer is deemed to be the replacement of an existing column by a new column situated within 3 metres of the existing column. This minimises the risk of any significant increase in the potential earth loop impedance of the original network whilst allowing for the erection and connection of a new column with minimal delays in the transfer of the service.

Where no main exists within close proximity, (less than 20metres) then the existing looped network may be maintained provided the following rules are complied with:

- The first column on the looped network supplied from the LV mains shall be used as a control column[7] and the total power consumption of all the columns on the looped service cable should be under 1.38kW. A sub-fuse rated at 25A shall be installed in the first (control) column and co-ordinated with the impedance to the last lighting column such that a fault shall be cleared in 5s to protect the outgoing looped cable. A 25A first column fuse will so protect loop impedance up to 1Ω.
- Only transfers of existing lighting columns are permitted and no additional columns can be installed.
- A service can be classified as a transfer on a looped or 5th core system, only if it is within 20metres of the position of the existing column; and the new column should not be located further away from the route of the looped service cable than the original column.
- The maximum length of the looped service cable shall not be extended beyond the existing last column. This means that the last column can only be relocated closer to the supplying LV mains cable and not moved further away.
- Where the looped service arrangement is supplied from a mains network that has been converted to PME thenthe neutral conductor shall be bonded to an earth electrode at the following positions:
    i. The first column (control column) supplied from the mains cable;
    ii. The last column on the looped service arrangement.
- Where the existing service cable extends beyond the last column then the service cable shall be disconnectedand abandoned at the last column.

3.4. Earthing

Code of Practice for Earthing LV Networks and HV Distribution Substations, IMP/010/011 states that we should normally provide all new customers with an earthing terminal. As part of the design work to identify the point of connection an assessment of the existing network, and the customers' requirements shall be undertaken to identify the type of earth that can be provided. The proposed earthing arrangement shall be provided on all designs submitted for approval. Guidance as to the type of earthing systems employed and the earths that can be offered is detailed in Appendix 4.

[7] Drawing C1010662 Termination Arrangement for a public lighting control column

It is accepted that in a few special circumstances further consideration needs to be given before offering an earth, these special circumstances are also identified in Appendix 4. If connections are to be made to these premises referral to a higher level designer shall be made.

3.5. Permitted Cable Lengths and Sizes

Relative to the impedance of long cable lengths the impedance of ground mounted transformers becomes negligible. For example, a 200kVA transformer can be connected with 230m of 95mm2 Wf Al/Cu cable before reaching maximum limits; however this cable length only increases to 270m when the transformer is changed to 1000kVA. Given these marginal increases in lengths, for simplicity it has been assumed the maximum cable lengths should be based on the smallest transformer size of 200kVA.

The maximum lengths and minimum sizes of cables for both metered and unmetered connections in the SDRs have been set so that the statutory voltage limits are not breached and hence do not affect the quality of supply. This also ensures that a 400A fuse will blow within 30 seconds to the end of any newly installed main, or 60 seconds to the service position at any metered cut out.

3.5.1. Maximum Service Cable Lengths and Minimum Sizes

The standard type and size for service cables differs between metered connections and unmetered connections. The standard size cable for all metered connections is 35mm^{2}Al/Cu cable. Unmetered connections require the use of a 16mm^{2}Cu cable due to the terminal size available in a 25A cut out which is used for unmetered connections. In order to maintain the earth loop impedance limits, to ensure adequate fault clearance times, the maximum permitted service lengths are;

- Metered connection in private – 40 metres (20 metres of service cable in public and 20m service cable in private)
- Metered connection in public – up to 20 metres
- Unmetered connection – 20 metres

These lengths have been selected to maintain the maximum flexibility between service length and mains cables.

3.5.2. Maximum Mains Cable Lengths for Existing Systems

The table below show the maximum earth loop impedance to which a service can be connected for both metered and unmetered connections under the SDRs.

Service Type	Connection to new circuits	Connection to existing circuits
CNE service	250mΩ	350mΩ
SNE service	250mΩ	350mΩ

Table 5: Maximum earth loop impedance values

3.5.3. Mains Extensions

Low voltage mains extensions are permitted under the SDRs providing that the maximum earth loop impedance from thesubstation to the end of the new extended main will not exceed 250mΩ as laid down in IMP/001/911.

The only LV mains cables permitted for extensions to the LV system is 300 mm^{2}Wf Al/Cu for all mains extensions (including all road crossings), other than for short tail end spurs where there is limited opportunity it will be required to extend in the future (e.g., cul-de-sacs) where 95 mm^2 Wf Al/Cu is acceptable, as per IMP/001/911.

3.5.4. Minimum Cable Sizes and their Equivalents

The minimum size cable that can be in circuit on an existing system is 70 mm^2 Wf Al and its equivalents which are, 0.06 $inch^2$ Cu, and 0.1 $inch^2$ Al.

3.6. Installation of Cables in the Public Highway

All cables shall be installed in the footpath/verge where possible. However, this may not always be reasonably practicable and where this is the case the installation of both mains and service cable in the public highway should be kept to a minimum. All cable installations must comply with Policy for the Installation of Distribution Power Cables, NSP/002.

3.7. Situations Requiring Special Consideration

- Within urban networks, there are low voltage mains cables that are not three-phase, when considering any connection point if there is any doubt about the number of live phases in the mains cable advice should be sought from a higher level designer to validate the point of connection;
- Where a feeder already supplies a large three phase customer, or multiple small three-phase customers,guidance should be sought from a higher level designer to validate the point of connection;
- For any connections on triple concentric or two-phase cable network, guidance from a Higher Level Engineer should be sought; and
- IDNO connection demand should be treated as a commercial connection utilising the capacity stipulated in the BCA.

3.8. Maximum Number of Connected Customers

Customer numbers are used as a proxy to estimate feeder demand. Without load checks, the following customer number limits must be adhered to (the IIS limits are in place for new housing development, however the limits listed below are to be used for connecting to existing Feeders);

Mains	Existing + New Connections	Connection Method
Large Section	≤160[8]	Connect
Large Section	≥ 161	Seek guidance from higher level designer to assess the demand on the Feeder and make recommendations for any reinforcement that may be required
Small Section	≤70	Connect
Small Section	≥ 71	Seek guidance from higher level designer

3.9. Accept on Existing Requests – Low Carbon Technologies

Applications for low carbon technologies fall into two distinct categories. Should the application comply with all notification criteria in Table 3 the customer can connect the piece of equipment and provide notification to Northern Powergrid (connect and notify).

If all the criteria in Table 3 are not met, then the application will be 'apply to connect'. If an application is received where equipment has already been installed without the application complying with the below criteria a 'notice to disconnect' should be issued to the customer as soon as we are made aware.

[8] This scenario is likely to be to in areas of high-density housing, of which many will be terraced housing with no off-street parking. Therefore, it is likely that the only new LCT being installed would be a heat pump. Based on historical data around the ADMD of these areas, even with a heat pump connection the new ADMD would be around 1.8 kW meaning this would be below the 301 kVA rating of a 300wf and in line with the rating of a 400A fuse.

Section B – Notification Criteria		
All Equipment Types	☐	Only connecting one additional piece of equipment (EV Charge Point or Heat Pump)
	☐	DNO cut-out rating known
	☐	No safety concerns over integrity of DNO service equipment
	☐	No other issues identified with adequacy or integrity of the DNO service equipment
	☐	Not a Looped Service
	☐	Metered supply
	☐	Maximum Demand less than the known cut-out rating
	☐	Maximum Demand less than 13.8kVA per phase OR the premises is CT metered OR the premises load is limited to below the known cut-out fuse rating
HP only	☐	Heat pump system under single controller only
	☐	Total heat pump system Maximum Demand ≤32A
	☐	Model marked at 'Connect and Notify' in the ENA's HP Database
EVCP only	☐	AC Output
	☐	Premises MD ≤13.8 kVA per phase OR where CT metered: Maximum AC output of EV charge points ≤30% of the Maximum Import Capacity

Table 6 – Connect and notify criteria for low carbon technologies

3.10. Unmetered to Metered

If an upgrade is requested on an unmetered supply and the new load exceeds 1.38kW the connection must be upgraded to a metered supply.

The existing supply will require a disconnection and a new service should be provided from the closest suitable LV mains.

3.11. Upgrade on a Direct Supply

If a request for an increase in demand is received due to the installation of LCT equipment and the maximum demand is 60A or below, the application should be checked against the notification criteria, as set out in Table 7. If there is an error in the application and it meets with the notification criteria an 'AOE- no work required' letter should be sent. The guaranteed standard should be category changed to 'IS AoE (5)'.

An application that falls out of the scope of these SDR's should be checked with a higher level designer before proceeding to quote.

For all requests above 60A up to a maximum demand of 80A the assessment should start with the existing service cable size. [9]Unless there is clear evidence the cable has been laid direct, we should use the ducted current rating, see Table 8. If the cable size is inadequate then a scheme should be raised to disconnect the existing cable and replace with a new connection from the nearest adequate mains cable. Under the schedule of rates price book a new service connection will also include the replacement of the cut-out and fuse.

[9] An example of this would be the records stating the cable is laid direct

Conductors		Construction		Current Rating (Ducted)	
mm²/ in²	Material	Insulation	Sheath	(A)	(kVA)
0.007	Cu	Paper	Split Concentric	46	11
0.0225	Cu	Paper	Split Concentric	91	21
0.04	Cu	Paper	Split Concentric	129	30
0.007	Cu	Paper	Pb	51	12
0.0225	Cu	Paper	Pb	100	23
0.04	Cu	Paper	Pb	137	31
4	Cu	PVC	Split Concentric	44	10
16	Al	PVC	Split Concentric	70	16
16	Cu	PVC	Concentric	85	19
4	Cu	PVC	Concentric	44	10
25	Al	PVC	Concentric	95	22
35	Al	PVC	Concentric	116	27

Table 7 – Service cable ratings (Ducted) IMP/001/013

If the cut-out rating is unknown, then a picture should be requested from the applicant or a site visit arranged to confirm the rating and type of cut-out. This can be assessed against the ENA cut-out guidance:

https://www.energynetworks.org/assets/images/Resource%20library/LCT_Cut-Out%20Rating%20Guidance%20to%20EV-HP%20Installers%20v1.1.docx.pdf

If the customers' existing arrangement is adequate for the load they require but is of a design known to be inadequate or dangerous this can be replaced at no charge to the customer and should be transferred to the General Enquiries team for the work to be carried out.

3.12. Upgrade on an Existing Looped Supply

If the connection is looped it should be assessed against Table 9. This table sets out how many LCTs can be connected dependant on how many properties are connected to the looped service and the number of existing LCTs. Under a number of scenarios it is acceptable to connect the LCT without providing a direct connection.

No. of looped house	No. of HPs/EVCP's/PV/BESS	Un-loop
1 (2 houses on 1 service)	1	No
2 (3 houses on 1 service)	1	No
2 (3 houses on 1 service)*	2	No
3 (4 houses on 1 service)	1	No
Any other combination		Yes

Table 8 – Low carbon technologies looped service guidance

In addition to Table 5 the following conditions must also be taken into consideration:

- Overhead line main conductor <0.05
- Heat pumps are DOL or EV exceeds 32A
- Loop service and heat pump/EV combination as per Table 5

* In this scenario, the shared service should be 0.04 Pb or larger.

Should any of the above conditions apply to the customers supply then a new direct service must be provided. If no work is required, the 'AoE- no work required' letter should be sent to the customer. The guaranteed standard should be category changed to 'IS AoE (5)'.

If un-looping is required, the first assessment is the customer's existing service cable. If the service cable is rated below the customer's demand request a scheme should be raised.

3.13. Upgrading the Connection to a Three Phase Supply

Whole current metered three phase supplies can be provided following a request for an increase in supply above 18kVA and/or the installation of three phase equipment. The maximum demand should not exceed 60kVA in line with this document.

If the existing single phase connection has associated looped services, the neighbouring supplies should be re-serviced.

3.14. Load Limiters

In some instances, a customer will choose to install a load limiting device to maintain supply below a demand threshold. In line with ENA guidance, the maximum demand stated by the customer with a load limiting device can be used as the maximum customer demand for quotation purposes.

3.15. Roles

The SDRs refer to two key roles; these roles are fulfilled by individuals who are deemed competent to self-determine points of connection.

ICPs accredited under the NERS are deemed competent to determine the point of connection.

3.15.1. Low Level Designer

A Low level designer is a person deemed competent to use the SDRs for self-determining a point of connection. Where the SDRs does not cover the point of connection the Low level designer will refer to a designer with a higher level of technical competence to determine the Point of Connection and guidance for the outline design.

3.15.2. Higher Level Designer

A Higher level designer is a person deemed competent to assess the asset records and standards to achieve a point of connection that can be used. ICPs accredited under the NERS Point of Connection Self Determination are deemed competent to determine the Point of Connection as well as all Northern Powergrid design engineers and design technicians.

4. References

4.1. External Documentation

Reference	Title
ENA Engineering Recommendation P28	Planning limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the United Kingdom
Engineering Recommendation G98 Issue 2	Recommendations for the Connection of Type Tested Small-scale Embedded Generators (Up to 16A per Phase) in Parallel with Low-Voltage Distribution Systems
BS EN 61000-3-2 (harmonic distortion)	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16A and ≤ 75A per phase
BS EN 61000-3-3 (Voltage fluctuation -flicker)	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems. Equipment with rated voltage current ≤ 75 A and subject to conditional connection

4.2. Internal Documentation

Reference	Title
IMP/001/911	Code of Practice for the Economic Development of Low Voltage Networks
IMP/001/010	Code of Practice for Standard Arrangements for Customer Connections
IMP/010/011	Code of Practice for Earthing LV Networks and HV Distribution Substations
NSP/002	Policy for the Installation of Distribution Power Cables

4.3. Amendments from Previous Version

Reference	Title
Document	References to G83 changed to G99
3.3.12.1 & Appendix 1	Removed formula and reference IMP/001/911Service cable lengths changed to align with IMP/001/911.
3.3.32.1 & Appendix 1	Deleted reference to Form A and minor editorial changes Edited reference to overhead network back to source substation
3.3.43.3.3	Edited section to refer to domestic EV chargers only, added 32A chargers and added a tablethat shows the permitted combination of 16A and 32A chargers. Deleted EV ADMD formula and reference IMP/001/911.Threshold for heat pumps increased to 10
3.3.53.3.4-3.3.3	Added new section on public EV charging points. Threshold for EV altered and tables updated.
3.3.103.3.10 & Appendix 1	Reference to street lighting columns with charging outlet for EV Threshold for connecting to transformers without further checks reduced to 200 kVA.
3.3.11	Guidance added on number of unmetered connections
3.5 & Appendix 1/2/3	Threshold for connecting to transformers without further checks reduced to 200 kVA.
3.5.1 & Appendix 1 & 2	Service cable lengths changed to align with IMP/001/911.
3.5.2 & Appendix 1 & 2	Maximum mains lengths removed, replaced with maximum ELZ figures
3.5.4	Section edited around the distinction of metered and unmetered acceptable mains and cable equivalent tables removed.
3.7	Guidance added on triple concentric and 2ph networks, and IDNO sites.
3.8 & Appendix 1/2	Maximum customer numbers altered, and guidance included on smaller section mains cables.
3.9-3.14	New sections added to offer guidance for additional load requests.
Appendix 4 & 5	New sections added to offer guidance for additional load requests.
Appendix 4	Previous appendix removed
Appendix 5	Earthing section, now Appendix 6

5. Definitions

Term	Definition
SSEG	Small-scale embedded generation
Service cut-out	Service cut out consists of the service cable feeding the premise, the cut out and the cut-out fuse.
Large three phase	Greater than 100 amps per phase
NERS	National Electricity Registration Scheme
Accredited	Accreditation means accreditation awarded to an ICP under the National Electricity Registration Scheme (NERS)
DOL	Direct on Line
ADMD	After Diversity Maximum Demand
Point of Connection (PoC)	This is the point (or points) of physical connection between the extended network and the existing Distribution System
LCT	Low Carbon Technologies like heat pumps, EV charging points and photovoltaic systems
VSD	Variable Speed Drive
IDNO	Independent Distribution Network Operator
BCA	Bilateral Connection Agreement

6. Authority for Issue

6.1. CDS Assurance

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

		Date
Liz Beat	Governance Administrator	29/11/2023

6.2. Author

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

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

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes

		Date
Richard Proctor	Design Team Manager	04/12/2023

6.3. Technical Assurance

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

		Date
Mark Callum	Smart Grid Development Manager	04/12/2023

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Mark Nicholson	Director of Engineering	06/12/2023

Appendix 1 – Connection limits for metered connections – up to six single phasedomestic or one single phase commercial metered connections

Design selection criteria

Appendix 1 covers the following connections

I. Up to 6 x single phase domestic connections (electrically or non-electrically heated or LCT); or
II. 1 x single phase commercial connection.

Each individual connection can include;

I. A single Heat Pump conforming to FORM A no larger than 16A per phase, (without network checks); or
II. A single Heat Pump conforming to FORM A >16A and ≤ 32A per phase, where a network check showthat the new HP will not result in more than 6 heat pumps on the feeder.
III. An Electric Vehicle Charger up to 32A per phase;
IV. A G98 compliant Photovoltaic system up to 16A per phase;
V. A Welder up to 16A per phase ; and
VI. A Single phase motor up to 3.68kVA or 16A per phase
VII. Or a combination of the above up to the maximum of 60kVA

Maximum service cable length

I. Maximum service length should be no more than 40m, with no more than 20m in public

Maximum earth loop impedance

I. 350 mΩ when connecting to an existing main
II. 250 mΩ when installing a new main

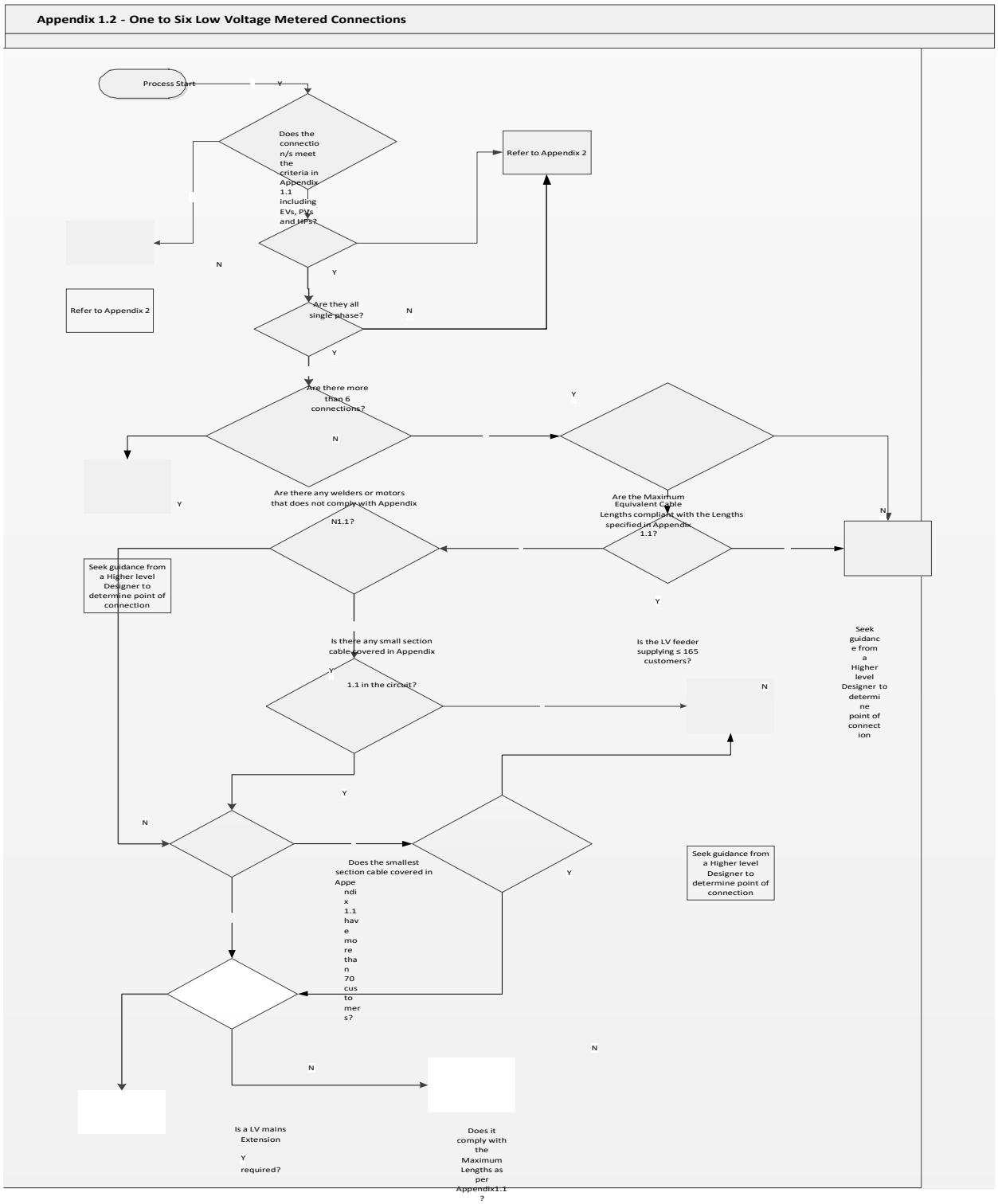
Minimum transformer rating

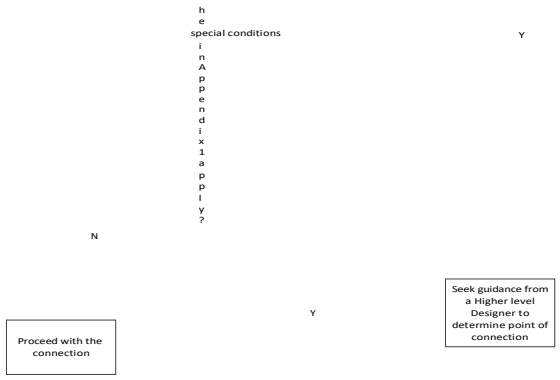
I. 200kVA is the minimum transformer size

Special conditions where appendix 1 does not apply;

I. The LV System is not 3 phase
II. The new load requires a 3 phase supply
III. Connection is to be made on triple concentric or two phase cable network
IV. Loads requirements for individual connections exceed 80A per phase
V. Total number of customers on the LV feeder after connection of the new supplies exceeds 160 customers.
VI. Total number of customers supplied by the small section cable (0.06 Cu, 0.1AL, 0.1Cu, 0.15Al, 95 mm2wf Al) exceeds70 customers.
VII. The LV feeder already supplies large, or multiple small, 3 phase connections.

One to six LV metered connections flowchart





NOTE – Minimum transformer required is 200kVA – Max service length 40 metres.

Appendix 2 – Connection limits for metered connections – seven to twenty single phase domestic (non-electrically heated), or two to four single phase commercial, or a single three phase connection

Design selection criteria

- **Appendix 2.1 covers the following connections**

  I. Up to 20 x single phase non electrically heated domestic connections.; or
  II. Up to 6 x single phase electrically heated domestic or LCT connections; or
  III. Up to 4 x single phase Commercial connections; or
  IV. 1 x three phase connection Commercial or Domestic up to 80 A per phase

- **The installation can include up to a maximum of:**

  I. Up to 6 x Heat Pumps conforming to FORM A no larger than 16A per phase[10]; or
  II. Up to 6 x Heat Pumps conforming to FORM A >16A and ≤ 32A per phase, where a network check showsthat the new HP will not result in more than 6 heat pumps on the feeder.
  III. Up to 6 x Electric Vehicle Chargers no larger than 32A per phase;
  IV. Up to 6 x Photovoltaic systems no larger than 16A per phase;
  V. Welders - Three phase up to 16A per phase
  VI. Motors - One single phase motor up to 3.68kVA or 16A per phase; or
  VII. One DOL three phase motor up 6kVA; or
  VIII. One Star Delta or Soft start three phase motor up to 10kVA; or
  IX. Or a combination of the above up to the maximum of 60kVA

- **Maximum service cable length**

  I. Maximum service length should be no more than 40m, with no more than 20m in public

- **Maximum earth loop impedance**

  III. 350 mΩ when connecting to an existing main
  IV. 250 mΩ when installing a new main

- **Minimum transformer rating**

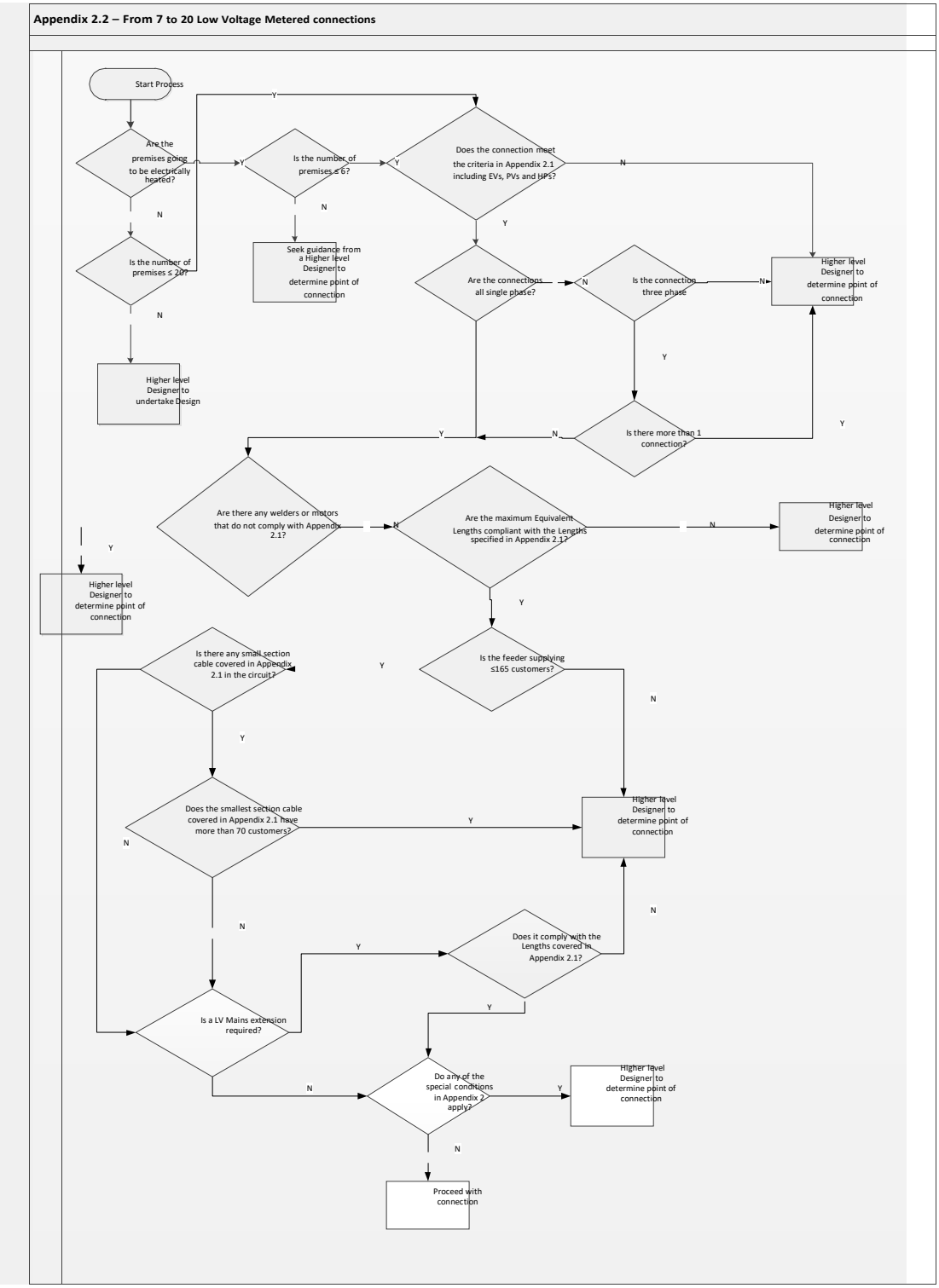
  I. 200kVA is the minimum transformer size

- **Special conditions where appendix 2 does not apply**

  I. The LV System is not 3 phase
  II. Connection is to be made on triple concentric or two phase cable network
  III. Loads required are greater than 80A per phase
  IV. Total number of customers on the LV feeder after connection of the new supplies exceeds 160 customers
  V. Total number of customers supplied by the small section cable (0.06 Cu, 0.1Cu, 0.15Al, 95 mm2wf Al) exceeds 70customers
  VI. The LV feeder already supplies large, or multiple small, 3 phase connections.

[10] Subject to only 1 installation of HP, EV, PV per property

Seven to twenty LV metered connections flowchart



- **NOTE – Minimum transformer required is 200kVA – Max service length 40 metres.**

Appendix 3 - Connection limits for new unmetered connections

Design selection criteria

- **Appendix 3.1 covers the following connections**

I. Up to 20 x single phase unmetered connections

Unmetered connections may only be provided in line with the guidance contained within the Electricity (Unmetered Supply) Regulations 2001 and the guidance contained within the Balancing and Settlement Code. These requirements are explained in more detail in Code of Practice for the maximum load of unmetered supplies (CNN/006/001). The key requirement of both these documents is that, subject to other conditions, an unmetered supply may be given where the electrical load is of a predictable nature, and no greater than 1.38kW

- **Maximum service cable length**

II. Maximum service length should be no more than 20m

- **Maximum earth loop impedance**

V. 350 mΩ when connecting to an existing main
VI. 250 mΩ when installing a new main

- **Minimum transformer rating**

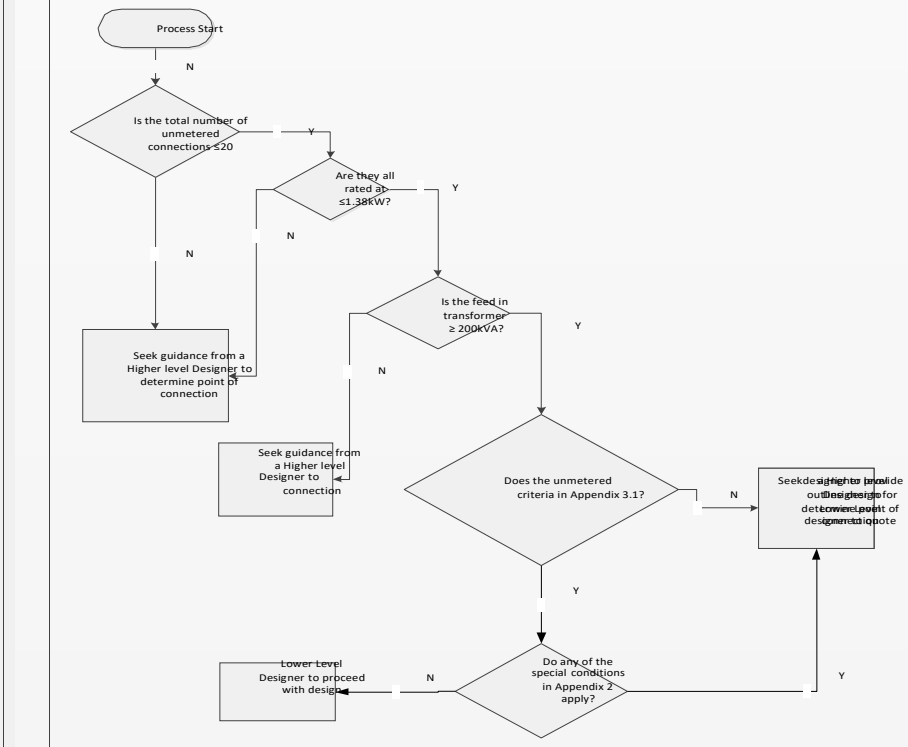
III. 200kVA Transformer is the minimum transformer size

- **Special conditions where appendix 3 does not apply**

IV. Overhead network is in circuit between the supplying substation and the connection point;
V. Any supply exceeds 1.38kW.
VI. Any replacement or transfers of existing lighting columns must comply with the requirements of section 3.3.10.2 of this CoP.

New unmetered connections up to 1.38kW

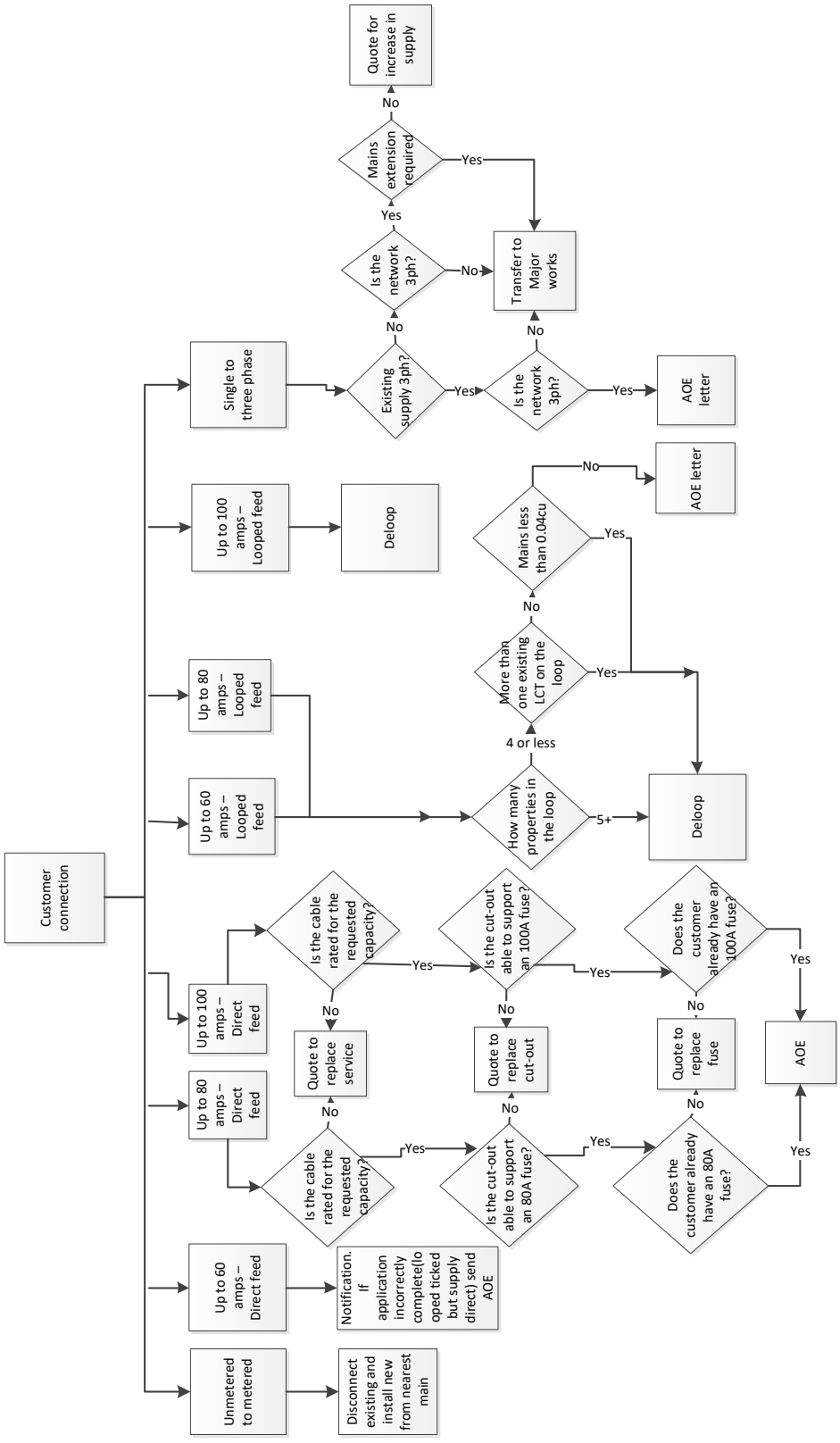
Appendix 3.2 - New Unmetered Connections, maximum capacity per connection 1.38kW



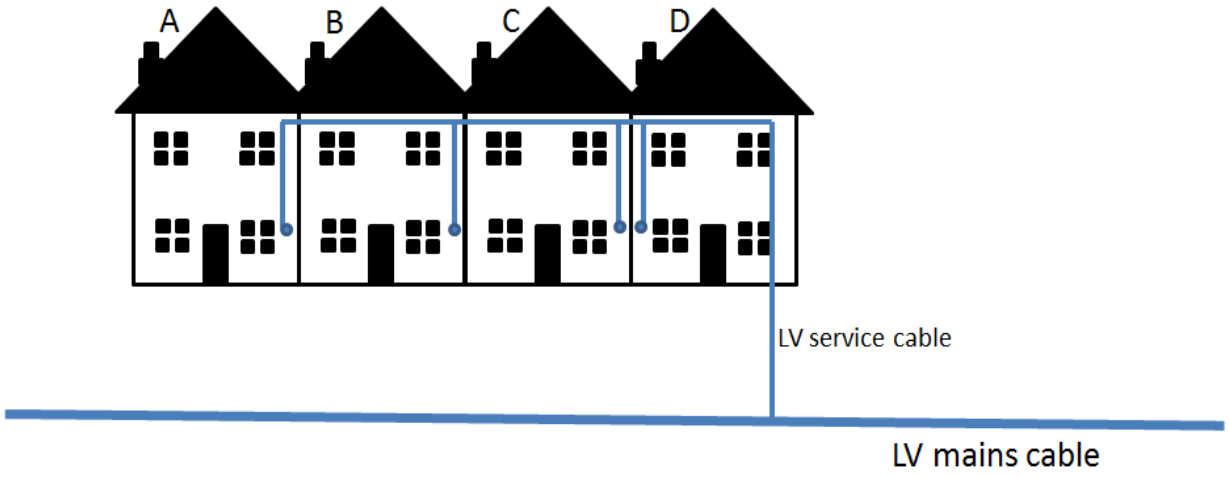
- **NOTE – Minimum transformer required is 200kVA – Max service length 20 metres.**

Appendix 4 – Quick Assessment Process Flow

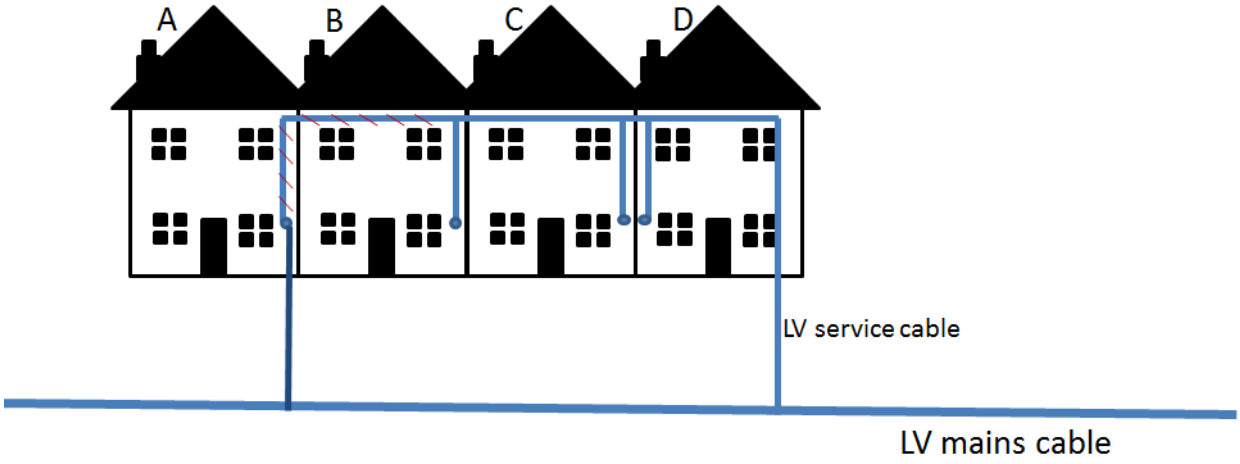
All decisions are subject to the relevant assessment being made as covered in the body of this document.



Appendix 5 – Supply Upgrade Example Scenarios



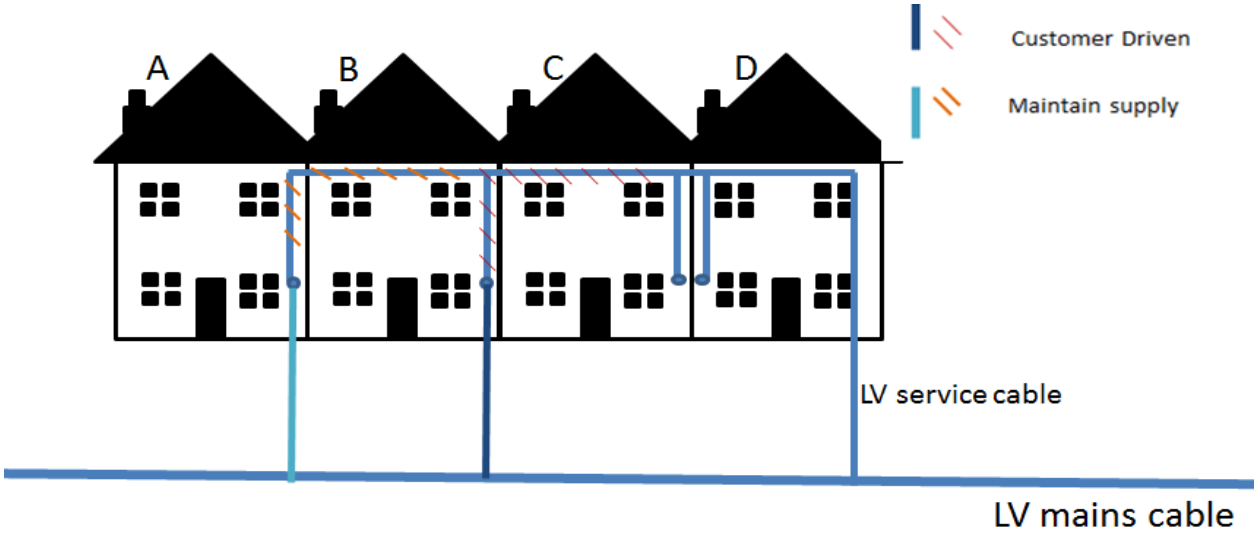
If after assessment is complete using section 3.5 and you have determined unlooping is required the following scenarios should be followed dependant on which house in the loop is our customer.



House A

Service size inadequate – Quotation at customers cost required to provide direct underground supply. The cost for the disconnection and removal of the span from B to A will also need to be included. In this scenario houses B, C & D's services will remain unaffected.

Service size adequate – If the service cable is rated above the maximum demand the customer is requesting but still requires de-looping a direct supply should be provided utilising the work programme number. In this scenario houses B-C remain unaffected.



House B

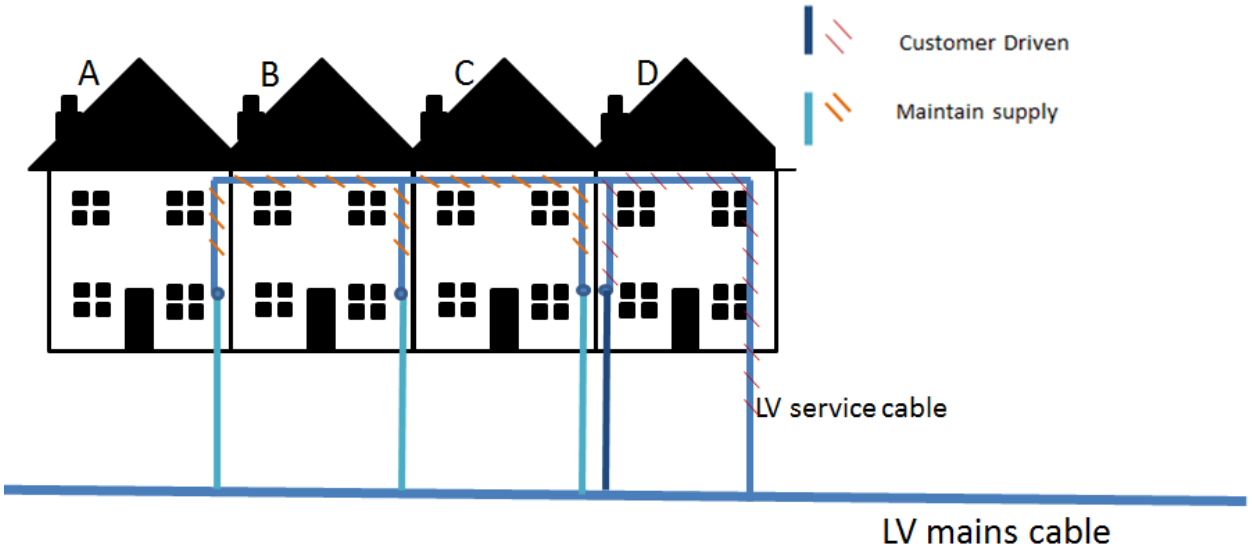
Service size inadequate – Quotation at customers cost required to provide direct underground supply. The cost for the disconnection and removal of the span for house B will also need to be included. In this scenario houses C & D remain unaffected. Direct supply required for House A under work programme number and the disconnection and removal of the existing span to this property.

Service size adequate – If the service cable is rated above the maximum demand the customer is requesting but still requires de-looping a direct supply should be provided to houses A & B utilising a work programme number and associated disconnections and span removals.

House C

Service size inadequate – Quotation at customers cost required to provide direct underground supply. The cost for the disconnection and removal of the span for house C will also need to be included. In this scenario only house D remains unaffected. Direct supply required for House A & B under work programme number and the disconnection and removal of existing spans to house A & B

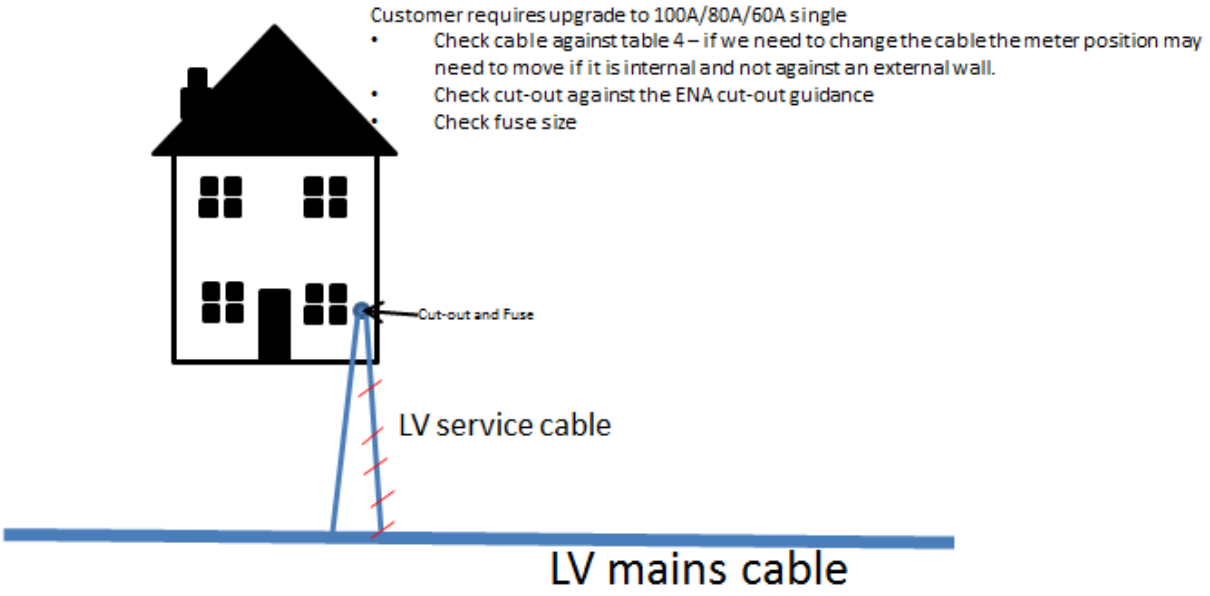
Service size adequate – If the service cable is rated above the maximum demand the customer is requesting but still requires de-looping a direct supply should be provided to houses A, B and C utilising a work programme number and the disconnection and removal of existing spans to houses A, B and C



House D

Service size inadequate – Quotation at customers cost required to provide direct underground supply. In this case house A-C are affected. All will require re-servicing under a work programme number and the disconnection and removal of redundant spans to these properties

Service size adequate – If the service cable is rated above the maximum demand the customer is requesting but still requires de-looping a direct supply should be provided utilising the work programme number for all properties and associated disconnections and span removals



In a direct feed the customer will always be responsible for the cost if an upgrade is required. The assessment will be on what part of their equipment, if any, an upgrade needs to take place.

Appendix 6 – Earthing

NPg's underground cable network employs two different types of earthing systems, these are

- A Separate Neutral and Earth system (SNE)
- A Combined Neutral and Earth system (CNE) which employs PME earthing.

When providing any new connections from an existing network the earth provided to the customer must be appropriate for the network providing the supply to the connections.
In general this means that;

- Connections provided from CNE system, or a SNE system converted to PME, must be provided with a CNE/PMEearth.
- Connections provided from SNE systems that have not been converted to PME must be provided with a SNEEarth.

Where it is not clear what earthing system is applicable a referral to a higher level designer will be required.

In addition to the above, Code of Practice for Earthing LV Networks and HV Distribution Substations IMP/010/011 provides a list of situations that need special consideration. Where any supplies are provided to any of the following sitesreferral to a higher level design will be required to decide on whether an earth can be provided or not. Where an earth can be provided they will have to specify the type of earth to be used.

- Construction Sites and Quarries
- Farms, Milking Parlours, Pig Sty's etc.
- Swimming Pools and Sports Pavilions
- Petrol Filling Areas
- Caravans, Mobile Homes, Temporary Site Offices, Boat Installations etc.
- Fairgrounds and Showgrounds
- Roadside and other Housings Accessible to the public.
- Railway Service Areas
- Multiple supplies to Steel Framed Buildings.