IMP/001/916 - Appendices A and B for ENA Engineering Recommendation G81 - Part 1 and Part 4: Design and Planning

1. Purpose

This document forms the combined Northern Powergrid Appendix A and B to Energy Networks Association (ENA) Engineering Recommendation (EREC) G81 - Part 1: Design and Planning, “Framework for design and planning of low voltage housing development installations and associated new HV/LV distribution substations” and EREC G81 Part 4: Design and Planning, “Framework for design and planning of industrial and commercial underground connected loads up to and including HV”. This document should be read in conjunction with EREC G81.

This document contains a summary of the information contained in Northern Powergrid system design Code of Practice documents. If additional details are required, reference should be made to the individual Code of Practice documents cited in section 4.

Northern Powergrid is unable to provide copies of external documentation, standards and specifications referenced in this document, but copies may be obtained from the relevant issuing body (such as the British Standards Institution (BSI) or ENA). Copies of Northern Powergrid documents referred to in this document can be obtained from the Northern Powergrid website.[1]

This document supersedes the following document, all copies of which should be withdrawn from circulation:

Document Reference	Document Title	Version	Published Date
IMP/001/916	Appendices A and B for ENA Engineering Recommendation G81 - Part 1 and Part 4: Design and Planning	1.0	April 2017

2. Scope

This document applies to the providers of network assets that are intended to form part of the distribution system owned and operated by Northern Powergrid (Northeast) plc or Northern Powergrid (Yorkshire) plc, the licensed distributors of Northern Powergrid. Such asset providers are referred to as Independent Connection Providers (ICPs).

The Northern Powergrid Appendices A and B of EREC G81 - Part 1 and Part 4 have been combined to avoid extensive duplication and make the document easier to read. Where there are points relevant to only Part 1 or Part 4 of EREC G81 they have been highlighted.

This document should be read in conjunction with Code of Practice for the Economic Development of the LV System, IMP/001/911 and Code of Practice for the Economic Development of the HV System, IMP/001/912.

[1] Northern Powergrid documentation is available from https://www.northernpowergrid.com/document-library

2.1. Table of Contents

3. Process

3.1. General Obligations

The main body of Engineering Recommendation G81 Part 1 and Part 4 draws the Independent Connection Providers (ICPs) or Independent Distribution Network Operators (IDNOs) attention to the wide range of obligations to which system developments, including new connections, system reinforcements and asset replacement, must comply. The ICP's or IDNO's attention is drawn, in particular, to:

- The obligation under section 9(1) of the Electricity Act 1989 (as amended) on distribution network operators (DNOs) to develop and maintain an efficient, co-ordinated and economical system of electricity distribution; and facilitate competition in the supply and generation of electricity.
- The obligations under the Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002[2] (as amended), Regulation 3 (1) that assets must:
  a) individually be fit for purpose; and
  b) be arranged so as to prevent danger or interruption of supply, so far as is reasonably practicable.

3.2. Purpose

The purpose of this document is to present specified information contained in the Northern Powergrid Code of Practices in accordance with the requirements of the EREC G81 appendices; however, the ICP or the IDNO must comply with the requirements of all the relevant Northern Powergrid Codes of Practice cited in this document.

3.3. System Voltages

The ICP or IDNO should note that the Northern Powergrid Northeast system includes sections running at 'non-standard' voltages which should not be extended to provide new connections, specifically systems operating at nominal voltages within the 5.25-6.6kV range. Northern Powergrid Northeast also has an extensive system operating at 20kV which may be used to provide new connections.

Further information on the standard nominal voltages deployed in Northern Powergrid can be obtained from the Code of Practice for Distribution System Parameters, IMP/001/909.

Further information on the LV and HV voltage principles relating to system design can be obtained from the Code of Practice for Economic Development of the LV System, IMP/001/911 and the Code of Practice for Economic Development of the HV System, IMP/001/912.

3.4. Design Information – Data Required from the ICP or IDNO [3]

The design information listed in section 3.4 should be provided by the ICP or IDNO as part of the connection design process.

3.4.1. Feeder Information

For each feeder:

- Number of customers and connections on each phase;
- Feeder rating and maximum feeder load: Amps;

[2] This includes The ESQC (Amendment) Regulations 2006 (No. 1521, 1st October 2006) and The ESQC (Amendment) Regulations 2009 (No. 639, 6th April 2009).
[3] Section 3.4 relates to ENA EREC G81 - Part 1 Appendix A and Part 4 Appendix A.

- Fuse selected and maximum clearance time (phase to earth fault at remote end): Amps and seconds;
- Maximum voltage regulation at a cut-out position: +/- % on 230V base; and
- Maximum earth loop impedance: milli-ohms.

3.4.2. Maximum Voltage Unbalance

Maximum voltage unbalance at any point: %.

3.4.3. Customer Demand and Generation

A list of demand profile classes & annual energy consumption or ADMD used for each category of service connection shall be provided, together with the following information (as required in Distribution Code - DPC 5.2.1):

- Individual maximum power requirements: kVA or kW;[4]
- Type and electrical loading of equipment to be connected, e.g. number and size of motors, cookers, showers, space and water heating arrangements, electric vehicle charging facilities, heat pumps and other low carbon technologies[5] including details of equipment which is subject to switching by the Supplier;
- Diversity: design demand at the Point of Connection/aggregate maximum power requirement, expressed as a percentage;
- Details of connected motor loads/disturbing loads; and
- Details of distributed generation connected at each installation.[6]

In addition to the information listed above the following shall be provided by the ICP or IDNO applying under EREC G81 Part 4:

- Voltage fluctuations caused by industrial commercial and domestic equipment (e.g. for motors or sewage pumps) in accordance with EREC P28; and
- Harmonic voltage distortion in accordance with EREC G5.

3.4.4. Prospective Short Circuit Current (PSCC)

For each customer's connection:

- Maximum design prospective short circuit current (PSCC) at connection of service to main:
  a) 1ph 230V: kA;
  b) 3ph 230/400V: kA;
  c) 2ph 230/460V: kA;
- Design PSCC at LV busbars of HV/LV transformer: kA; and

[4] Customers should take reasonable steps to operate at a power factor of between 0.95 lagging and unity at the Point of Supply in order to contribute to maintaining an efficient electrical distribution network as required by the DCUSA.
[5] Information relating to low carbon technologies is not explicitly required in accordance with EREC G81; but this information is becoming increasingly important for the design of HV and LV distribution systems.
[6] The information shall be sufficient for the DNO/IDNO to comply with their DCUSA obligations to publish an Embedded Capacity Register and Grid Code Week 24 obligations.

- Phase-neutral loop impedance and, if different, phase-earth loop impedance: milli-ohms.

3.4.5. Unmetered Supplies

A list of classes and maximum demands in accordance with the Balancing and Settlement Code Procedure (BSCP) 520.

3.4.6. Underground Cables

A list of cable types, sizes and ratings employed. Cables deployed shall comply with requirements of the Code of Practice for Underground Cable Ratings and Parameters, IMP/001/013.

3.5. Data specific to host Distribution Network Operator (DNO) [7] [8]

3.5.1. Substation Location and Network Layout

These requirements are intended to ensure that the design complies with the following obligations:

- Under section 9 (1) of the Electricity Act 1989 (as amended), to develop and maintain an efficient, co-ordinated and economical system of electricity distribution;
- Under the Health and Safety at Work Act 1974 and the Construction (Design and Management) Regulations 1994, to design safety into our system from the outset; and
- Under the Environmental Protection Act 1990, to avoid statutory nuisance.

When establishing a new substation a risk assessment in accordance with the Code of Practice for the Risk Assessment of Ground Mounted substations, MNT/006/001 should be carried out.

All substations shall be placed as near as practicable to the load centre, taking account of credible future developments; this will require a dialogue between Northern Powergrid and the developer.

New distribution substation buildings shall be designed to conform to the current version of The Building Regulations and reflect any additional local planning authority requirements. New distribution substations forming part of a new housing development may be of prefabricated construction in accordance with the Northern Powergrid specification (Technical Specification for Distribution Substation Enclosures, NPS/006/002) or a masonry construction to match that development. The substation building shall be free of any footholds or climbing aids to minimise the risk of unauthorised access to the substation roof. All substations shall be provided with security measures appropriate to the risk of unauthorised access.

Ground-mounted substations shall be enclosed in accordance with the Policy for the Enclosure of Ground Mounted Distribution Substations, IMP/009, and precautions taken against the risk of flood, fire and explosion in accordance with the Code of Practice for Flood Risk Mitigation at Substation Sites, IMP/001/012 and the Policy for Fire Mitigation at Operational Premises, IMP/011 (which includes criteria for the use of fixed CO_2 installations).

For the safety and convenience of staff accessing the substation, the housing and access shall be located at ground level with direct 24-hour unrestricted access from the public highway. The creation of a confined space is not permitted, and there must be free natural ventilation of the site, which will generally preclude basement substations.

Substations that are detached from any other buildings are preferred. If an integral substation cannot be avoided, refer to the Code of Practice for Economic Development of the LV System, IMP/001/911.

[7] Section 3.5 relates to ENA EREC G81 - Part 1 Appendix B and Part4: Appendix B.
[8] EREC G81 refers to Host Distribution Licence Holder (Host DLH). DNO used to maintain consistency in this document.

For further information on HV/LV substations and system layout refer to the Code of Practice for Economic Development of the HV System, IMP/001/912.

Interconnection shall be provided to support the LV system of a substation supplied from an HV tee, or of existing substations that require regular dead-tank maintenance, if it can be achieved economically from a LV network with an independent HV source. Otherwise, interconnection shall be provided where it is opportune so to do, specifically where:

- Less than 500 metres of additional LV main is required; or
- The LV cable can be laid in a common trench with the HV cable.

For further information on LV interconnection refer to the Code of Practice for Economic Development of LV Systems, IMP/001/911.

3.5.2. Cable Location

LV and HV cables should generally be installed in footpaths. In footpaths, LV cables shall be buried at a minimum depth of 450mm and have a 150mm tile tape laid directly above. HV cables shall be buried at a minimum depth of 600mm and have a 200mm wide tile tape laid directly above. Road crossings shall be ducted, with spare ducts provided, at a depth below the road construction and not less than 750mm. HV and LV cables shall be separated so far as is reasonably practicable and spaced at no less than 300mm between centres, to prevent danger and to facilitate future works.

Cables and cable ducts shall be installed as close as practicable to the minimum depth described to avoid future operational access issues, safety issues, reduce de-rating effects and additional expenditure in accordance with Northern Powergrid Policy for the Installation of Distribution Power Cables, NSP/002.

For further information on routing of LV and HV circuits, refer to the Code of Practice for Economic Development of LV system, IMP/001/911 and the Code of Practice for Economic Development of HV system, IMP/001/912.

3.5.3. HV to LV Transformers

Ground mounted HV to LV substations and HV substations in urban systems (predominantly comprising underground cable) shall be looped into the HV circuits supplying them.[9]

When establishing the rating of a transformer the following factors shall be taken into account:

- the developer's estimate of demand (where appropriate);
- diversity between customers and feeders;
- credible future development, i.e. DFES scenarios;[10]
- the cost of losses, in particular compliance with the Standard Conditions of the Electricity Distribution Licence, Condition 49: Electricity Distribution Losses Management; and
- its cyclic capability and the impact of enclosure in accordance with Power Transformers: Loading guide for oil immersed power transformers, BS IEC 60076-7: 2005.

To comply with these requirements, where a new HV to LV transformer is to be installed its rating should be selected based on the maximum economic initial loading guidance in the Code of Practice for the Economic Development of the LV System, IMP/001/911.

Transformers up to and including 1,600kVA may be used to supply individual customers from dedicated substations. Permissible cyclic ratings can be calculated in accordance with BS IEC 60076-7:2005 (taking

[9] This is in line with IMP/001/912 - Code of Practice for the Economic Development of the HV System.
[10] Distribution Future Energy Scenarios - https://odileeds.github.io/northern-powergrid/.

into account load curves forecast by the ICP or IDNO and the effects of enclosure and ambient temperature).

For further information on transformer initial loadings and sizing when installing new transformers on the system refer to the Code of Practice for Economic Development of LV system, IMP/001/911.

For further information on use of pad mount transformers refer to the Code of Practice for the Economic Development of the LV System, IMP/001/911 and the Code of Practice for Economic Development of HV system, IMP/001/912.

Transformers deployed shall be in accordance with Northern Powergrid Technical Specification for Ground-Mounted Distribution Transformers up to and including 20kV, NPS/003/011.

3.5.4. Voltage Regulation

The Electricity Safety, Quality and Continuity Regulations 2002 (including amendments) require that the voltage at LV customers supply terminals is 230/400V +10%/-6%. As the voltage on the LV system is managed by design, rather than being explicitly controlled, there are coordinated design principles which allocate the permitted voltage regulation on the HV and LV system. Further guidance can be found in the Code of Practice for Managing Voltages on the Distribution System, IMP/001/915.

3.5.4.1. HV Voltage Regulation

The voltage at the LV terminals of the HV to LV transformer under HV first circuit outage conditions should be a minimum of 230.0V. This is equivalent to a 4.5% voltage drop on a HV feeder under first circuit outage conditions.

Where the HV voltage drop under first circuit outage conditions is more than 4.5%, this may be acceptable provided that the LV systems supplied from the HV system has a suitably small voltage drop.

3.5.4.2. LV Voltage Regulation

The design voltage at the LV terminals of the HV to LV transformer should be a minimum of 230.0V.

The lowest permitted voltage is 216.2V i.e. max voltage drop of 13.8V (6% of 230.0V).

The highest permitted voltage is 253.0V i.e. max voltage rise of 23.0V (10% of 230.0V).

The maximum calculated voltage drop on the LV system (i.e. on the main as well as the service) should not exceed 6%. Typically, the voltage drop on a service would be no more than 0.3% (based on a typical 20m service and 4.6kW demand) and in many cases can be ignored.

Longer services (ideally no longer than 40m) are acceptable provided that the overall voltage drop on the LV system remains less than 6% and the earth loop impedance is acceptable. Typically, these services would be to:

- unmetered supplies, for example street lighting and telecoms supplies;
- metered/unmetered low capacity EVCPs[11;]
- supplies from pole mounted equipment; or
- supplies to premises remote from an LV main where a mains extension would not be an economic and efficient development of the LV system.

[11] Although they are referred to as unmetered connections, public unmetered EVCPs utilise portable meters as opposed to a fixed meter installed adjacent to the Point of Supply. Elexon publishes a list of approved Measured Central Management Systems (MCMS) on their website, including portable meters to be used for unmetered connections.

For further information on application of the above detailed design voltage principles refer to the Code of Practice for Economic Development of LV system, IMP/001/911 and the Code of Practice for Economic Development of HV system, IMP/001/912.

3.5.5. Maximum Service Volt Drop

There is no maximum service volt drop, between LV main and service cut-out, provided that the voltage at the service cut-out complies with the requirements of section 3.5.4.2.

3.5.6. Maximum Loop Impedance

The phase to neutral loop impedance on new systems shall not exceed 250mΩ including the transformer, main and service, in accordance with EREC P5. To provide for the loop impedance of a typical 20m service, which is between 30 and 50mΩ, LV mains cables laid in advance of providing services should be designed to a maximum of 200mΩ through the transformer and main. Table 1 shows the maximum loop impedance values for connections from new and existing circuits.

Table 1 – Maximum loop impedance values for connections from new and existing circuits

Service type	Connection to new circuits[12]	Connections to existing circuits[13]
CNE service: Phase-neutral and phase-earth loop impedance	250mΩ	400mΩ
SNE service: Phase-neutral loop impedance	-	400mΩ
SNE service: Phase-earth loop impedance	-	800mΩ

For further information on allowed loop impedances values for LV system design refer to the Code of Practice for Economic Development of LV system, IMP/001/911.

3.5.7. Phase to Neutral Fault Clearance Time

LV mains shall be fused at the source to clear faults at the end of services within 60s.

3.5.8. Prospective Short Circuit Current (PSCC)

3.5.8.1. On the HV System[14]

The legacy design PSCC values on the HV system are 13.1kA at 11kV and 10.1kA at 20kV. However, there might be instances where the PSCC is greater than these values. For further information on PSCC on HV system and ratings of equipment refer to the Code of Practice for Economic Development of HV system, IMP/001/912.

3.5.8.2. At LV Busbars of HV to LV Substation

The design PSCC on the LV system is 35.5kA. However typical PSCC values are 26kA. For further information on LV PSCC refer to the Code of Practice for Economic Development of LV system, IMP/001/911.

[12] Including extensions of existing systems designed to the current 250mΩ standard.
[13] These values are intended to be applied primarily to modifications of existing systems designed to the former 400mΩ phase-neutral loop impedance. They should not be applied to modifications to systems designed to the current 250mΩ phase-neutral loop impedance, i.e. they should not be seen as a relaxation permitting the impedance on main and services to be extended beyond the 250mΩ limit.
[14] These values are the break ratings of the HV equipment, the make values shall be higher but for a shorter time of 10ms.

3.5.8.3. At a LV Cut-Out

The design PSCC at a LV cut-out is 16kA for single-phase connections up to 100A in accordance with BS 7657.

3.5.9. Losses Optimisation

For most routine design work on the LV and HV system, the use of minimum circuit conductor sizes will be sufficient to demonstrate compliance with the Northern Powergrid licence obligation relating to losses. These minimum conductor sizes are stated in the Code of Practice for Economic Development of LV system, IMP/001/911 and the Code of Practise for Economic Development of the HV system, IMP/001/912.

The selection of transformers based on the economic loading, set out in the Code of Practice for the Economic Development of the LV System, IMP/001/911, will be sufficient to demonstrate compliance with the Northern Powergrid licence obligation relating to losses.

3.5.10. ADMD Information

The Northern Powergrid ADMD values and growth allowances for domestic load and emerging low carbon technologies (LCTs) e.g. heat pumps, electric vehicles and Photovoltaic generation are provided in the Code of Practice for Economic Development of LV system, IMP/001/911. This Code of Practice also provides guidance for assessing the design demand associated with multiple industrial and commercial design customers.[15]

Alternatively, the ICP or IDNO may use and provide their own ADMD values.[16]

3.5.11. Maximum Number of Services per Joint

A maximum of four single-phase service cables may be terminated per cable joint; or

A maximum of two three-phase service cables may be terminated per cable joint.

3.5.12. Looped Services

New looped or branched services are not permitted; dedicated underground services shall be provided even when they are connected to LV overhead lines.

3.5.13. Service Entry Requirements

3.5.13.1. LV Housing Developments (EREC G81-Part 1)

Each property shall be provided with an individual service via a duct for direct connection to the LV main.

On new housing developments the service entry to a customer's electrical installation shall be in ducting either up the external wall or internally within the wall cavity to an outdoor meter cabinet, complying with:

- NJUG 2; and
- ENATS 12-24

[15] An ADMD based design demand calculator which has been developed in Excel to assess multiple types of demand. This is available on the Northern Powergrid website http://www.northernpowergrid.com/information-for-icps .This is based on principles to assess demand set out in in the Code of Practice for Economic Development of LV System, IMP/001/911.

[16] ICPs may use larger ADMDs than the Northern Powergrid values if required. Smaller ADMDs than those provided in IMP/001/911 Code of Practice for Economic Development of LV System, shall not be used. IDNOs should provide the required design demand based on their own ADMD values.

Where an internal position is agreed, the service termination must be mounted on class 'O' fire retardant chipboard to BS 476, Part 6.

New service cables shall be 35 mm^2 Al concentric.

Service cables shall be terminated onto an insulated cut-out with combined neutral and earth terminals rated at 100 amps, which shall comply with the requirements of BS 7654, and equipped with 80 Amp fuses to BS 88.

3.5.13.2. Small Industrial/Commercial Developments (EREC G81-Part 4)

For small industrial/commercial premises with a connection capacity of up to 100 amps per phase, service entry to a customer's electrical installation shall be in ducting either up the external wall or internally within the wall cavity to an outdoor meter cabinet, complying with:

- NJUG 2; and
- ENATS 12-24

Where an internal position is agreed, the service termination must be mounted on class 'O' fire retardant chipboard to BS 476, Part 6.

Each property shall be provided with an individual service for direct connection to the main.

For service terminations associated with supplies up to 100 amps per phase, cables shall be terminated onto an insulated cut-out with combined neutral and earth terminals, rated at 100 amps, which shall comply with the requirements of BS 7654, and equipped with 80 amp fuses to BS 88.

Connections up to 276kVA may be provided from the LV system via a fused cut-out; connections up to 1,600kVA may be provided at LV from a substation on the customer's premises via a circuit breaker. In either case, metering shall be provided at the Point of Supply.

Connections up to 160 amps at 11kV may be provided from a Northern Powergrid Ring Main Unit, with metering VTs and CTs on the outgoing side; connections up to 630 amps will require the use of extensible switchgear.

Further guidance on customer connection arrangements is provided in the Code of Practice for Standard Arrangements for Customer Connections, IMP/001/010.

The customer need not install their own protection in series with Northern Powergrid's protection. This is permitted under BS 7671 regulation 473-02-02. Northern Powergrid's protection may be used to protect customer's equipment, provided the customer grants an indemnity for use of the Northern Powergrid protection equipment and for the adequacy of the Northern Powergrid protection scheme to protect their equipment. Where the customer considers that the Northern Powergrid protection scheme does not adequately protect their assets, or where the customer does not provide adequate indemnity, they shall install their own protection and control equipment. This equipment shall be located as close as is reasonably practicable to the Northern Powergrid metering circuit breaker in order to minimise the extent of network between the supply terminals and the customer's network. The preferred arrangement is a cable connection from the supply terminals to the customer's network.

3.5.14. Earthing

All new systems and customers' connections shall be to Protective Multiple Earth (PME) standards in accordance with EREC G12, unless for individual installations where PME would be unsafe (e.g. petrol stations).

All earthing and bonding shall be compliant with the Code of Practice for Earthing LV Networks and HV Distribution Substations, IMP/010/011.

Customer connections from the Low Voltage side of a dedicated transformer shall be arranged to provide a customer earth terminal from the solidly earthed neutral point of the transformer. The earth electrodes at the substation shall be designed, installed, and used in such a manner so as to prevent danger occurring in any LV system as a result of any fault in the high voltage network.

The customer's main earthing lead minimum cross-sectional area shall comprise 16 mm^2 copper conductor.

3.5.15. Underground Cable Ratings – Criteria for HV and LV Cables

Cables that comply with the materials specification (Technical Specification for 11 & 22kV power cables, NPS/002/020 and Technical Specifications for LV Distribution and Service Cables, NPS/002/019) shall be used. When assessing the rating of such cables, the following factors should be applied:

- Continuous ratings in accordance with ENATS or manufacturers' specifications;
- Soil thermal resistivity g = 1.2°C metres per watt;
- Ground ambient temperatures 15°C; and
- Maximum conductor temperatures in accordance with the relevant ENA Technical Specification or manufacturers' specifications.

For cables laid directly in the ground, where the route contains a continuous ducted section of less than 15m in length, the effect of cable de-ratings due to the ducting can be ignored.

The definition of continuous and cyclic ratings set out in the Code of Practice for Guidance on the Selection of Underground Cable Ratings, IMP/001/013 shall be used.

The LV system shall be designed using 3c 300 mm^2 Al waveform cables, however for short tail-end spurs carrying less than 120 A per phase (e.g. cul-de-sacs), 3c 95 mm^2 Al waveform cable may be used. Under exceptional cases 4c cables may be used in accordance with the Code of Practice for Earthing LV Networks and HV Distribution Substations, IMP/010/011. These cable sizes have been chosen to ensure compliance with the Code of Practice for Methodology of Assessing Losses, IMP/001/103.

HV distribution system feeders shall be designed using 300mm^2 and 185mm^2 Al triplex cables at 11kV and 20kV respectively. High capacity 11kV and 20kV feeders especially dedicated customer feeders can be designed using larger cables than 300mm^2 and 185mm^2 Al triplex respectively.

For further information on standard ratings and sizes of LV and HV underground cables that shall be used refer to the Code of Practice for Economic Development of LV system, IMP/001/911 and the Code of Practice for Economic Development of HV system, IMP/001/912.

3.5.16. HV Network Configuration

The Code of Practice for the Economic Development of the EHV System, IMP/001/913 sets out the requirements to design an EHV system that establishes EHV to HV substations generally equipped with duplicate EHV to HV transformers and HV busbars. This is the preferred arrangement, which enables supplies up to the defined firm capacity of the EHV to HV substation to be maintained for a single circuit outage of either of the incoming EHV feeders, either of the EHV to HV transformers or either of the transformer HV circuit breakers. In this case the HV system is not required to ensure Engineering Recommendation P2/8 compliance of the demand group supplied by the EHV to HV substation. In rural areas, an EHV to HV substation equipped with a single transformer may suffice, however in this case the HV system will need to have sufficient interconnection with other EHV to HV substations to maintain supplies normally supplied from the substation in order to ensure compliance with Engineering Recommendation P2/8.

For further information on the HV network configuration and the fault restoration/passage indicator, remote operation and automation requirements refer to the Code of Practice for Economic Development of HV system, IMP/001/912.

3.5.17. Protection

Effective utilisation of cables and transformers requires that 400A LV fuses be used in the majority of situations, leading to a standard of clearing faults at the end of services in 60s or, if systems are laid out in the absence of detailed knowledge of services, clearing faults at the end of the main in 30s. This requirement can be achieved by using the fuse values shown in Table 2 below:

Table 2 – LV Fuse rating and demand capacity

Fuse Rating (A)	Loop impedance to end of service (mΩ)	Loop impedance to end of main (mΩ)	Capacity (kVA)[17]
315	290	250	217
400	230	200	276
500	180	160	330

Protection of the HV systems shall be in accordance with the Policy for the Protection of Distribution Networks (TS1), IMP/001/014.

For further information on protection scheme designs and locations of HV protections equipment refer to the Code of Practice for Economic Development of HV system, IMP/001/912.

[17] Taken as 3 x 230V x fuse rating (or, in the case of 500A fuses, the capability of a 300mm^2 waveform limits the capacity to 330A instead of 345A).

4. References

4.1. External Documentation

Reference	Title	Version and Date
BS 476: Part 6	Fire Tests on building materials and structures	C1: 2014
BS 7654	Specification for single phase street lighting cut-out assemblies for low voltage public electricity distribution systems. 25A rating for highway power supplies and street furniture.	3: 2010
BS 7657	Specification for Cut-Out Assemblies up to 100 A rating, for Power Supply to Buildings	1: 2010
BS 7671	British Standard Requirements for Electrical Installations (The 18th Edition of the IET Wiring Regulations)	1: 2008
BS 88	Low-Voltage fuses	3: 2007
BS IEC 60076-7 (IEC 354)	Guide to Loading of Oil-Immersed Power Transformers	5: 2005
BSCP 520	Balancing and Settlement Code Procedure 520	25: 2016
Electricity Regulations	The Electricity at Work Regulations 1989	Statutory Instrument 1989 No. 635
ENATS 12-24	Plastic ducts for buried electric cables	3: 2014
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	5: 2020
Engineering Recommendation G12	Requirements for The Application of Protective Multiple Earthing to Low Voltage Networks	4: 2022
Engineering Recommendation G81:Part 1	Framework for new low voltage housing development installations	3: 2016
Engineering Recommendation G81:Part 4	Framework for new industrial and commercial underground connections	3: 2016
Engineering Recommendation P5	Design of Low Voltage Underground Networks for Housing Estates	6: 2017
Engineering Recommendation P2/8	Security of Supply	8: 2023
Engineering Recommendation P28	Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom	2: 2019
Engineering Recommendation P29	Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom	2: 2019

Reference	Title	Version and Date
ESQC regulations	The Electricity Supply, Quality and Continuity Regulations 2002	Statutory Instrument 2002 No. 2665 including amendment regulations in 2006 (SI 2006 No. 1521) and 2009 (SI 2009 No. 639)
HASAWA 74	The Health and Safety at Work etc. Act 1974	
NJUG Volume 2	NJUG guidelines on the positioning of Underground Utilities Apparatus for New Development Sites	4: 2013
The Act	The Electricity Act 1989 (as amended by the Utilities Act 2000, Energy Act 2004)	

4.2. Internal Documentation

This document contains information extracted from the following key Northern Powergrid policies, which are available to download from Northern Powergrid website.

Reference	Title
IMP/001/010	Code Of Practice for Standard Arrangements for Customer Connections
IMP/001/010/001	ICP Self-Select Point of Connection Limits, Design Considerations and ICP Design Approval Requirements
IMP/001/011	Code of Practice for the Guidance on the Selection of Overhead Line Ratings and Parameters
IMP/001/012	Code of Practice for Flood Risk Mitigation at Substation Sites
IMP/001/013	Code of Practice for Underground Cable Ratings and Parameters
IMP/001/014	Policy for Protection of Distribution Networks
IMP/001/103	Code of Practice for Methodology of Assessing Losses
IMP/001/206	Code of Practice for Guidance for Assessing Security of Supply in accordance with engineering Recommendation P2/7
IMP/001/909	Code of Practice for Distribution System Parameters
IMP/001/911	Code of Practice for the Economic Development of the LV system
IMP/001/912	Code of Practice for the Economic Development of the HV system
IMP/001/913	Code of Practice for the Economic Development of the EHV system
IMP/009	Policy for the Enclosure of Ground Mounted Distribution Substations
IMP/010/011	Code of Practice for Earthing LV Networks and HV Distribution Substations
IMP/011	Policy for Fire Mitigation at Operational Premises
MNT/006/001	Code of Practice for the Risk Assessment of Ground Mounted Substations
NPS/002/019	Technical Specifications for LV Distribution and Service cables
NPS/002/020	Technical Specifications for 11 & 20kV Power Cables
NPS/003/011	Technical Specifications for 11kV and 20kV Ground-Mounted Distribution Transformers
NPS/006/002	Technical Specification for Distribution Substation Enclosures
NSP/002	Policy for Installation of Distribution Power Cables

4.3. Amendments from Previous Version

Reference	Description
Whole document	Minor editorial changes across the document
3.5.1	Selection criteria for transformers added
3.5.9	Losses assessment details updated to bring in line with IMP/001/103 - Code of Practice for Methodology of Assessing Losses

5. Definitions

Term	Definition
ADMD	After Diversity Maximum Demand is the maximum demand to be catered for at a point in the system after taking into consideration the diversified (coincident peaks) demand which is aggregated over a large number of customers.
HV	Means voltages greater than 1kV and less than 33kV.
ICP	Independent Connections Provider is an accredited company that can build electricity networks to agreed standards and quality required for them to be owned by either a Distribution Network Operator such as Northern Powergrid or an Independent Distribution Network Operator.
LV	Low Voltage (less than 1,000 Volts).

6. Authority for Issue

6.1. CDS Assurance

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

		Date
Liz Beat	Governance Administrator	13/12/2023

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for 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:	Reason:	
Should this document be displayed on the Northern Powergrid external website?			Yes
			Date
Chris Artist	Manager - Design Team		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 authorisation.

		Date
Alan Creighton	Senior Smart Grid Development Engineer	13/07/2023
Phil Jagger	Head of Network Planning & Design	24/07/2023

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Mark Callum	Smart Grid Development Manager	03/07/2023