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Northern Powergrid Appendix B for ENA Engineering Recommendation G81 - Part 4: Design and Planning

Framework for design and planning, materials specification, installation and record for industrial and commercial underground connected loads up to and including 11 kV

1. Purpose

This document forms Appendix A and B to Energy Networks Association (ENA) Engineering Recommendation (ER) G81 - Part 4: Design and Planning, "Framework for design and planning, of **industrial and commercial underground connected loads up to and including 11 kV**" and should be read in conjunction with that document.

This document contains a summary of the information contained in Northern Powergrid network design policies.

Please note that 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 Energy Networks Association).

If additional details are required, reference should be made to the individual policy documents cited in section 7.

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

Ref	Version	Title
G81 Part 4	1.1	Engineering Recommendation G81 - Part 4: Design and Planning

2. Scope

This document applies to the providers of network connections to the distribution network owned and operated by Northern Powergrid (Northeast) Ltd and Northern Powergrid (Yorkshire) plc

Northern Powergrid (Northeast) Ltd and Northern Powergrid (Yorkshire) plc are the Distribution Network Operators (DNOs) of Northern Powergrid.

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3. General Obligations

The main body of Engineering Recommendation G81 Part 4 draws the applicants' attention to the wide range of obligations to which system extensions must conform. The applicants' attention is drawn in particular to:

- The obligation under section 9 of the Electricity Act 1989 (as amended) to develop and maintain an efficient, co-ordinated and economical system of electricity distribution; and
- The obligations under the Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002, Regulation 3 that assets must:
 - o Individually be fit for purpose; and
 - o Be arranged so as to prevent danger or interruption of supply, so far as is reasonably practicable.

4. System Voltages

Applicants should note that the Northern Powergrid (Northeast) Ltd system includes large sections running at 'non-standard' pressures, specifically a set of systems operating at nominal pressures within the 5.25– 6.6 kV range, and an extensive system operating at 20 kV.

5. Design Information – Data Required from Applicant¹

The design information listed in section 5 should be provided by the applicant as part of the connection design process.

5.1. Feeder Information

For each feeder:

- Number of Customers and connections on each phase;
- Feeder rating and maximum feeder load: Amps;
- Fuse selected and minimum fusing current (phase to earth fault at remote end): Amps;
- Maximum voltage regulation at a cut-out position: +/- % on 230 V base;
- Maximum earth loop resistance: milli-ohms;
- Voltage fluctuations caused by industrial commercial and domestic equipment (e.g. for motors or sewage pumps) in accordance with ER P28; and
- Harmonic voltage distortion in accordance with ER G5/4.

5.2. Maximum Voltage Unbalance

Maximum voltage unbalance at any point: %.

¹ Section 5 relates to ENA ER G81 - Part 4: Appendix A

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5.3. Customer Demand

A listing of demand profile classes and annual energy consumption used for each category of service, together with the following information (as required in Distribution Code - DPC 5.2.1):

- Individual maximum power requirements: kVA or kW;
- Type and electrical loading of equipment to be connected, e.g. number and size of motors, cookers, showers, space and water heating arrangements, including details of equipment which is subject to switching by the Supplier; and
- Diversity: % of aggregate maximum power requirement.

5.4. Customer Information

For each Customer's connection:

- Maximum design Prospective Short Circuit Current (PSCC): kA; and
- Phase-neutral loop impedance and, if different, phase-earth loop impedance: milli-ohms.

5.5. Unmetered Supplies

Classes and max demands as per Balancing and Settlement Code Procedure (BSCP) 520.

6. Data Specific to Host DLH²

6.1. Substation Location and Network Layout

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

- Under section 9 of the Electricity Act 1989 (as amended) to develop and maintain an efficient, coordinated 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. All HV substations shall be looped in to the appropriate HV circuit.

All substation plant and cables shall be sized to take account of credible future developments.

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.

Interconnection shall be provided to support the LV network 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 should only be provided where it is opportune so to do, specifically where:

- Less than 50 metres of additional LV main is required; or
- The LV cable can be laid in a common trench with the HV cable.

² Section 6 relates to ENA ER G81 - Part 4: Appendix B

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Natural ventilation shall be provided in all parts of the substation buildings containing transformers. Where practicable, the design of the substation building shall provide the capacity to vent the products of any explosion to atmosphere away (preferably upwards) from the potential locations that staff or members of the public may be in the event of unforeseen failure of equipment.

All substations shall be placed and or designed to mitigate the risk from potential flood damage.

Where a new substation is to be installed as part of a customer’s development and it is at risk of flooding, the substation shall be designed to be protected against the potential flood depth. The developer shall be responsible for carrying out a flood risk assessment and it should be made available to the company along with the proposed flood mitigation measures for the development. All costs associated with compliance with this policy shall be met by the developer. Further guidance on flood risk assessment and mitigation measures can be found in the Northern Powergrid Code of Practice (IMP/001/012 – Code of Practice for Flood Mitigation at operational premises)

In general new substations shall not be located at the basement level of a proposed development unless the developer provides sufficient evidence that the potential flood risk has been mitigated and the substation does not create a confined space.

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. So far as is reasonably practicable, the substation building shall be of a visual construction appropriate to the surrounding development. Substation buildings with flat roof constructions are prohibited.

New distribution substations forming part of a new housing development may be of prefabricated construction in accordance with the Northern Powergrid specification (NPS/006/002 – Technical Specification for Prefabricated Distribution Substation Enclosures) or a masonry construction to match that development. In such cases, the materials will usually be provided by the developer as part of the overall site development.

The foundation of the substation shall be of a concrete plinth or foundation block construction with appropriate provision for cabling and other services. The substation doors shall be provided with stays that enable the door to be fixed in an open position at 110 degrees to the substation front face. The substation should be designed so that, where possible, the majority of materials are maintenance free for the nominal life of the substation.

All earthing and bonding at new distribution substations shall be compliant with the Northern Powergrid Code of practice (IMP/010/011 – Codes of practice for Earthing LV Networks and HV Distribution Substations).

The substation building shall be free of any footholds or climbing aids in order 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, specifically:

- For sites that are classified as high or medium risk (in accordance with the guidance notes to the Electricity Safety, Quality and Continuity Regulations 2002), the substation shall be certified to Building Research Establishment Loss Prevention Standard LPS 1175 – security rating classification 4. The standard of locking arrangement shall provide security against unauthorised access commensurate with that provided by the enclosure; or
- The construction of substations at sites classified as low or negligible risk (in accordance with the guidance notes to the Electricity Safety, Quality and Continuity Regulations 2002) shall be certified to Building Research Establishment Loss Prevention Standard LPS 1175 – security rating classification 2. The standard of locking arrangement shall provide security against unauthorised access commensurate with that provided by the enclosure.

Substations that are detached from any other buildings are preferred. If an integral substation cannot be avoided, the following precautions must be undertaken at the developer’s expense:

- For the safety and convenience of staff accessing the substation:
 - o Substations shall be at ground level with direct 24 hour unrestricted access from the public highway; and

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- Substations shall not create a confined space and there must be free natural ventilation of the site.
- To minimise statutory nuisance:
 - The substation chamber shall be of dimensions that attenuate, rather than amplify, transformer noise;
 - Low noise transformers shall be used;
 - The transformer shall be mounted on anti-vibration pads so as to damp vibration;
 - Ventilation shall be arranged so as to direct noise away from customers' premises;
 - A minimum of 3m shall be provided between all conductors and any chamber likely to be used by the Customer for electronic equipment; and
 - All chambers immediately adjoining the substation chamber, including those directly above and below shall not be such that they will, or might credibly at some time in the future, be used as dwellings. For example, in blocks of flats, only communal areas are permitted adjacent to the substation chamber.

6.2. Cable Location

LV and HV cables should generally be installed in footpaths. In footpaths, LV cables shall be buried at a depth of 450mm and have a 150mm tile tape laid directly above. HV cables shall be buried at a depth of 600mm and have a 200mm tile tape laid directly above.

Road crossings shall be ducted, with spare ducts provided, below the road construction and in any case at a depth of not less than 750mm. HV and LV cables shall be separated so far as is reasonably practicable, and in any case spaced at no less than between 300mm centres, to prevent danger and to facilitate future works.

Cables shall be located in accordance with Northern Powergrid Network Service Procedure NSP/002 – Policy for the Installation of Distribution Power Cables.

6.3. HV to LV Transformers

Standard sizes in accordance with materials specifications, maximum 1000 kVA for a network substation and 1600 kVA for an individual customer connected at LV should be used with the choice being determined by assessed load, including growth rates for current development and provision for credible future development. Permissible cyclic ratings can be calculated in accordance with BSI BS IEC 60076-7:2005 (taking into account load curves forecast by the applicant and the effects of enclosure).

Transformers shall be in accordance with Northern Powergrid Network Product Specification NPS/003/011 – Technical Specification for 11 and 20kV Distribution Transformers.

6.4. Maximum HV Volt Drop

Under normal feeding arrangements and under all planned and fault outage scenarios involving a single event on a given part of the system, all customers should receive a supply within statutory voltage limits. This shall be achieved by ensuring that the voltage on the HV system does not fall below the nominal voltage less 6%. This should leave sufficient margin for LV voltage drop to ensure that customers connected to the LV system receive a voltage within the statutory voltage limits, i.e. 230V +10%/-6%.

6.5. Maximum Voltage Regulation from LV Busbars of HV/LV Substation

To remote end of service

Urban network 7% on 230V

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Rural network 5% on 230V

To end of main, where no service exists

Urban network 6% on 230V

Rural network 4% on 230V

Here 'rural' networks are defined as those more than 15 km³ from the nearest primary substation. The location of primary substations is given in the published Long-Term Development Statement.

6.6. Maximum Service Volt Drop

The maximum Service volt drop between LV main and service cut-out is 1%.

6.7. Maximum Voltage Unbalance

Maximum voltage unbalance, at any point, should not to exceed 10%.

6.8. Maximum Earth Loop Resistance

- To end of service 250 milli-ohms.

- To end of main, where no service exists, 200 milli-ohms.

6.9. LV Phase to Neutral Fault Clearance Time

Not more than 60s for a fault at the end of the service. Not more than 30s for a fault at the end of the main, where no service exists.

6.10. Prospective Short Circuit Current (PSCC) on the HV System

Typical maximum 13 kA.

All equipment to be capable of withstanding 20 kA for 3 seconds.

6.11. Prospective Short Circuit Current (PSCC) at LV busbars of HV/LV Substation

Typical maximum 25 kA.

All equipment to be capable of withstanding 36 kA.

6.12. Prospective Short Circuit Current (PSCC) at the Cut-Out

Design values to be established by applicant.

All equipment to capable of withstanding 16 kA for single-phase connections up to 100 A.

6.13. Loss Evaluation Criteria Employed: Economic Ratings

Schemes shall be evaluated assuming a capitalised cost of losses of £200 per MWh of average annual losses. For example, a design that would incur 100 MWh per year of losses (aggregate of fixed and variable) would have attributed to it a capitalised cost of losses of £200 * 100 = £20,000.

³ 30km where the HV network operates at 20kV

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6.14. ADMD Information

To be provided by applicant. An allowance of 1% per annum for each of twenty years from commissioning shall be made for growth of unrestricted or day units. Zero growth allowance shall be made for night (restricted hour) demand.

6.15. Maximum Number of Services per Joint

Four single-phase service cables (making a connection to only two of the three phases) to be terminated per cable joint;

or

Two three-phase service cables to be terminated per cable joint.

6.16. Service Entry Requirements

For small industrial/commercial premises with a connection capacity of up to 100 Amps per phase, the preferred method of service entry to a customer's each electrical installation is via a duct (with draw-wire) connected onto a 38mm service tube (hockey Stick) installed up the external wall to an outdoor meter cabinet, complying with Northern Powergrid Specification (NPS/002/007 – Technical Specification for meter Boards and Outdoor meter Cabinets).

Where an internal position is agreed, the service termination MUST be mounted on 12mm thick class 'O', non-combustible, resin-bonded particle board of minimum density 600kg/m³ and conforming to any of type P2 to P7 as detailed in BS EN 312.

Each property is to be provided with an individual service for direct connection to the main. Branched service arrangements will NOT be allowed.

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 7657, and be equipped with 80 Amp fuses to BS HD 60269-3:2010, BS 88-3:2010.

Connections up to 330 kVA may be provided from the general Low Voltage network via a fused cut-out; connections up to 1600 kVA may be provided at Low Voltage from a substation on the Customer's premises via a circuit breaker. In either case, metering shall be provided at the point of isolation.

Connections up to 300 Amps at High Voltage 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.

The Customer need not install their own protection in series with Northern Powergrid's protection, if they accept that the equipment and scheme used to protect the Northern Powergrid system will also protect his system. 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 protection equipment and for the adequacy of the 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.

6.17. Earthing

All new networks, including customers' connections, at Low Voltage will be to Protective Multiple Earth (PME) standards as laid out in ER G12/3, save for individual installations where PME would be unsafe (e.g. filling stations).

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All earthing and bonding shall be compliant with the Northern Powergrid Code of practise (IMP/010/011 - Codes of practice for Earthing LV Networks and HV Distribution Substations).

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 low voltage network as a result of any fault in the high voltage network.

6.18. Underground Cable Ratings - Criteria for HV and LV Cables

Cables as laid out in the materials specification only to be used, applying the following factors:

- Continuous ratings in accordance with ENATS or manufacturers’ specifications.
- Soil thermal resistivity $g = 1.2^{\circ}\text{C metres per watt}$.
- Ground ambient temperatures 15°C .
- Maximum conductor temperatures in accordance with ENATS or manufacturers’ specifications.
- Definition of cyclic ratings in accordance with IEC 853: group de-rating factors in accordance with ERA 69-30.
- Ducts – maximum lengths without de-rating 20m.

Applying the loss evaluation criteria laid out above means that the use of 185 mm^2 LV cable shall be restricted to industrial and commercial services only. LV networks shall be designed using 300 mm^2 cables other than for short tail-end spurs carrying less than 120 A per phase (e.g. cul-de-sacs), where 95 mm^2 cable shall be used.

High capacity 11kV feeders shall be designed using 300mm^2 triplex cables. Low capacity 11kV feeders shall be designed using 300mm^2 triplex cables for the first section from primary substation with 185mm^2 triplex for the remainder.

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7. References

7.1. Internal Documentation

This document contains information extracted from the following key Northern Powergrid policies, which are available upon request.

Reference	Title
IMP/001/909	Code of Practice for Distribution System Parameters
IMP/001/911	Code of Practice for the Economic Development of Low Voltage Networks
IMP/001/012	Code of Practice for Flood Mitigation at Operational Premises
IMP/001/912	Code of Practice for the Economic Development of the HV System
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
IMP/003/001	Code of Practice for the Construction and Building Design of Ground Mounted Secondary Substations
NPS/002/007	Technical Specification for Meter Boards and Outdoor Meter Cabinets
NPS/006/002	Technical Specification for Prefabricated Distribution Substation Enclosures