1 Scope

This appendix to ENA ER G81 Part 4 covers the design and planning of new low voltage services and mains and associated high voltage to low voltage substations for the purpose of connecting industrial and commercial customers to the electricity distribution network of Electricity North West Limited (Electricity North West). (This Part 4 of ES281 provides the information, specific to Electricity North West, required by Appendix B of Part 4 of ENA ER G81.)

2 Design and Planning of New Connections for Industrial and Commercial Customers

2.1 General

The design of all new works to be adopted by Electricity North West shall comply with EPD279 and the associated policy for each voltage level, specifically:

- EPD282 for new HV networks, and;
- EPD283 for new LV networks.

All these EPDs shall be read in conjunction with each other and designers should be aware of the details, some of which are described in this document.

2.2 Connections Design

The design of third party connections for new housing developments is also governed by ES210 and the following associated specifications.

- ES211 for the provision of connections for street electrical fixtures.
- ES212 for the provision of service connections of up to 60kVA rating.
- ES214 for the provision of LV connections up to 300kVA.
- ES215 for the provision of connections up to 1500kVA.
- ES216 for the provision of 11kV Connections up to 15MVA.

The above specifications provide design guidance for new connections, which compliments this document.

2.3 Security of Supply

All networks and parts of networks, to be adopted by Electricity North West, shall comply with ENA ER P2/6. This requirement is imposed by a condition of Electricity North West's Distribution Licence.

© Electricity North West Limited 2021

2.4 HV Network

The design fault level for HV networks shall be 250MVA. This is equivalent to 13.1kA at 11kV or 21.9kA at 6.6kV.

The two sizes of HV aluminium core triplex cable, permitted by the materials specification ES281 Part 4, are described in Table 1.

Table 1 – 11kV Single Core, Solid Aluminium Conductor, Polymeric Insulation, Copper Screen and Laid in Triplex Formation

11KV ALUMINIUM TRIPLEX CABLE CROSS-SECTION (MM^2)	MAXIMUM CONTINUOUS RATING (A)		
	LAID DIRECT, UNGROUPED CABLE $G = 1.2KMW^{-1}$ $T_G = 15°C$	IN DUCTS, ONE CABLE PER DUCT, UNGROUPED CABLE, $G = 1.2KMW^{-1}$ $T_G = 15°C$	IN AIR & SHADE, AMBIENT TEMPERATURE 25°C
95	245	214	285
300	461	403	580

Aluminium cored cable, having a cross-section of $95mm^2$, may be used for any of the following:

(a) a new connection to or from an overhead line, or where an overhead line forms part of the circuit, between points of isolation, provided that the current rating of the cable does not limit the rating of the circuit; or

(b) a new connection between a transformer and its local switchgear.

However, all other new cables shall have a cross-section of $300mm^2$ aluminium.

Most HV circuits within Electricity North West's network operate radially with one or more open points, which provide alternative means of connection. New substations may be tee-connected to underground circuits, provided that:

(a) no such tee is connected between a primary substation and the first downstream switching point;

(b) the underground circuit has a maximum of four interconnected ends;

(c) the point of connection for a new substation to the existing Network, measured along the proposed cable route, exceeds 250m; and

(d) the number of customers, at repair-time risk, is not expected to exceed 200 (transformers connected between points of isolation shall be limited to a maximum of five transformers).

© Electricity North West Limited 2021

Where the extension to the HV network includes new protective devices, e.g. additional circuit breakers at a primary substation or to protect a customer's installation, the design of the protection and its settings shall be co-ordinated with the protection of Electricity North West's network. In such cases, Electricity North West' Engineer shall be consulted at an early stage in the design.

2.5 Distribution Substations

Distribution Substations shall be designed in accordance with ES352.

Distribution Substations shall normally be housed in a GRP enclosure, meeting the requirements of ES301. Alternatively, enclosed brick-built substations are acceptable.

Distribution Substations shall be sited in accordance with ES352 and CP226 and shall normally be located near the centre of the load group they are intended to connect. Electricity North West may require an alternative location for a substation, in order to enable its use for other purposes. Designers are, therefore, advised to consult the Engineer at an early stage, when locating substations. Any additional cabling costs incurred by such a change in location will be borne by Electricity North West.

A number of different phasing connections are employed within Electricity North West's networks. Transformer windings and HV and LV busbars shall be connected in accordance with local conventions and requirements. Where a new substation is to feed LV network, phasing shall match that of the surrounding network, even if no interconnection facility is to be installed initially.

Distribution transformers shall comply with ES322.

The ratings of transformers, to be adopted by Electricity North West, shall be selected from the standard ratings allowed by the latest issue of ENA TS 35-1 Part 1, and shall be such that the initial utilisation factors are not less than 0.6. The transformer shall be sized to match the calculated demand, or to achieve other requirements such as voltage regulation. The maximum transformer size to be adopted shall not exceed 1000kVA.

Any new Distribution Substation shall have facilities for the connection of a mobile generator to the LV distribution board.

Remote Control (RC) functionality, e.g. actuators for feeder switches, shall be considered for new Distribution Stations, in accordance with EPD282.

2.6 Prospective Short-Circuit Current

For a network fed by a single 1000kVA transformer the maximum PSCC, at the customer's terminals, is not expected to exceed the following values:

- Three phase = 27kA;
- Single phase = 16kA.

Fault contribution from distributed generation on the LV Network should be taken into account.

Further guidance on the determination of PSCC can be obtained from ENA ER P25 for single phase and ENA ER P26 for three phase.

© Electricity North West Limited 2021

2.7 Protection of LV Networks and Distribution Transformers

LV networks and transformers shall be protected in accordance with CP331. In particular, the following points shall be satisfied.

- Designs shall ensure that all LV mains are protected by fuses such that a single-phase to earth or neutral fault will be disconnected in 100s in an underground cable or 10s on an overhead line.
- Designs for new distributors shall not include any additional fuses downstream of the substation, e.g. in a link-box.

In principle, LV fuse-links shall be selected so as to comply with each of the following.

(a) Distributors shall be protected such that faults will be cleared within the stated times;

(b) Discrimination with HV protection shall be achieved; and

(c) Fuse-ratings shall be sufficient to cater for loads up to the thermal ratings of the distributors, which they protect.

The maximum LV fuse-link ratings for which discrimination is maintained across the associated distribution transformer, are shown in Table 2.

Table 2 – Distribution Transformer Maximum LV Fuse-Link

DISTRIBUTION TRANSFORMER RATING (kVA)	PHASE	MAXIMUM ASSOCIATED LV FUSE-LINK RATING (A)
200	3	200
300/315	3	315
500	3	400
750/800/1000	3	630

2.8 Earthing Arrangement

The earthing arrangements for the network shall be configured as follows.

- 11/6.6kV Network – Resistance Earth (maximum current 2200A).
- LV Network – Solid Earth (PME).

© Electricity North West Limited 2021

Further requirements for the earthing of distribution substations and equipment are described in EPD333, which shall be complied with by the application of the associated code of practice, CP333. In particular, the HV and LV earthing systems shall not be combined unless the combined resistance to earth is less than 1Ω.

Detailed engineering requirements for the provision of LV PME connections are described in CP332.

2.9 Earth-Loop Impedance

The earth-loop impedance, as measured at any exit point, shall not exceed the values stated in ENA ER P23/1.

2.10 Losses

The length of new HV connections to the existing Electricity North West network shall be kept to a minimum, so far as is reasonably practicable.

Distribution transformers shall comply with ES322, in particular, shall be of low-loss design.

LV networks designed in accordance with the requirements of this ES, in particular Section 2.9 and 2.11 can be expected to operate with an acceptable level of loss. However, the length of the LV network shall be kept to a minimum, so far as is reasonably practicable.

2.11 Loading of LV Networks

The three sizes of LV cable, permitted by the materials specification ES281 Part 4, are described in Table 3.

Table 3 – Solid Aluminium Cored, Polymeric Insulated, Combined Neutral/Earth (CNE) Waveform Cable

ALUMINIUM CORED, WAVEFORM CABLE CROSS - section (mm^2)	MAXIMUM CONTINUOUS RATING (A)		
	LAID DIRECT, UNGROUPED CABLE $g = 1.2KmW^{-1}$ $T_g = 15°C$	IN DUCTS, ONE CABLE PER DUCT, UNGROUPED CABLE, $g = 1.2KmW^{-1}$ $T_g = 15°C$	IN AIR & SHADE, AMBIENT TEMPERATURE 25°C
95	235	190	230
185	335	275	350
300	435	360	475

The maximum voltage regulation from the LV busbars of a Distribution Substation to any exit point shall not exceed 7%, of which no more than 2% shall be in the service connection.

2.12 Disturbing Loads

Where it is known that equipment liable to cause disturbing voltage flicker is to be installed (e.g. welding equipment), distributors shall be designed such that the limits specified in ENA ER P28 are not exceeded.

© Electricity North West Limited 2021

2.13 Cable Layout

As far as is reasonably practicable, mains cables shall be laid in land adopted or to be adopted by the local authority under the New Roads and Street Works Act (NRSWA); cables shall be positioned in accordance with National Joint Utilities Group (NJUG) Guideline publications, Volume 1 and Volume 2.

All other routes for mains cables shall be secured by means of easements.

Mains cables shall not be laid nor left in position under any building.

Cables laid under carriageways shall be installed in continuous ducts.

As far as is reasonably practicable, mains cables to be adopted by Electricity North West shall be separated from those of other network operators, e.g. IDNOs. Where, however, it is expedient for Electricity North West's cables and other electricity cables to share the same route, Electricity North West's cables shall not be placed either above or below the other cables, except where cables need to cross each other.

2.14 Multiple Occupancy Buildings

Connection arrangements for multiple occupancy buildings (flats, office blocks, industrial units etc) shall be in accordance with ES287, which describes the application of ENA ER G87 within the Electricity North West network.

3 Documents Referenced

DOCUMENTS REFERENCED	
Legislation and Guidance	
NRSWA	New Roads and Street Works Act 1991
NJUG Guidelines Volume 1	Positioning and Colour Coding of Underground Utilities' Apparatus
NJUG Guidelines Volume 2	Positioning of Underground Utilities Apparatus for New Development Sites
Energy Networks Association engineering documents	
ER G81 Part 4	Framework for new industrial and commercial underground connections. Part 4 Design and planning
ER G87	Guidelines for the provision of low voltage connections to multiple occupancy buildings.

© Electricity North West Limited 2021

ER P2/6	Security of Supply
ER P23/1	Customers' Earth Fault Protection for Compliance with the IEE Wiring Regulations for Electrical Installations
EP P25	The Short-Circuit Characteristics of Public Electricity Suppliers' Low Voltage Distribution Networks and the Co-ordination of Overcurrent Protective Devices on 230V Single-Phase Supplies up to 100A
ER P26	The Estimation of the Maximum Prospective Short-Circuit Current for Three-Phase 415V Supplies
ER P28	Planning Limits for Voltage Fluctuations Caused by Industrial, Commercial and Domestic Equipment in the United Kingdom
TS 35-1 Part 1	Distribution transformers - Part 1 Common clauses
Note: Electricity North West is unable to supply copies of any of the above documents, but copies may be obtained from the Energy Networks Association.	
Electricity North West documents	
EPD279	Distribution System Design - General Requirements
EPD282	Distribution System Design - HV Network
EPD283	Distribution System Design - Low Voltage Network
EPD333	Supply System Earthing
CP226	Low Voltage Network Design
CP331	Protection of LV Underground and Overhead Distributors and HV Protection of Distribution Transformers
CP332	LV Service Connections and Application of PME

© Electricity North West Limited 2021

CP333	Earthing Design for 11/6.6kV Distribution Substations and Equipment
ES210	General Specification for Third-Party Constructed New Connections, Extensions and Alterations
ES211	Third-Party Provided New Connections of Street Electrical Fixtures
ES212	New whole-Current-Metered Connections up to 60kVA
ES214	New LV Connections of up to 300kVA Capacity
ES215	New Connections of up to 1,500kVA Capacity
ES216	11/6.6kV Connections of up to 9MVA (6.6kV) or 15MVA (11kV) Capacity
ES287	Connections to Multiple Occupancy Buildings
ES301	Distribution Substation Housings; Replacement Roofs and Doors
ES322	Ground Mounted Distribution Transformers
ES352	Design of Distribution Substations

4 Keywords

ADMD; connection; design; domestic; ICP; P2/6; service.

© Electricity North West Limited 2021