Long Term Development Statement

October 2003

Foreword

Although every effort has been made to ensure the accuracy of the data provided in this statement, NEDL does not accept any liability for the accuracy of the information contained herein, and in particular neither NEDL nor its directors or its employees shall be under any liability for any misstatement or opinion on which the recipient of this statement relies or seeks to rely.

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Introduction

1 Purpose of Statement

This Long Term Development Statement has been compiled in accordance with Distribution Licence Condition 25, to assist existing and future users of NEDL's network in assessing opportunities available to them for making new or additional use of the network.

The aim of the Long Term Development Statement is to:

- Improve the availability of distribution network information
- Furnish developers with sufficient information to carry out initial assessments of network capability
- Inform users of distribution network development proposals
- Inform relevant people of the correct points of contact within distribution companies for specific enquiries

2 Content of Statement

The statement contains information regarding the 132kV, 66kV and 33kV systems and the transformation level to 20kV and 11kV that are owned and operated by NEDL. Whilst detailed network data is provided at these voltage levels, only generic statements on the design and operation of the 20kV, 11kV and LV networks are included. This approach has been taken in recognition of the volume of data associated with the 20kV, 11kV and LV networks and the speed with which it can become invalid. More detailed information and data on the 20kV, 11kV and LV systems is available on request.

The information in this statement is intended to present an overview of the distribution network and indicate the potential opportunities for users. It is recognised that more site-specific information will be required in order to develop a specific project and this additional information will be made available on request, in accordance with the Distribution Licence. In recognition of the bespoke nature of providing additional information, a separate charge will be made.

A price list for the provision of additional information and data is included as annex 1.

Information on the commercial terms for using our network is contained in our Licence Condition 4 statement, which is available from our website: www.nedl.co.uk. Technical requirements relating to connection and use of the distribution system are detailed in the Distribution Code and a number of other documents that are referenced in the Distribution Code. Details of how to obtain these documents and other useful contacts are shown in annex 2.

Information on the 400kV and 275kV transmission system can be found in the Seven Year Statement published by NGT and the Scottish transmission companies.

The Long Term Development Statement comprises three main parts:

Introduction

An overview of the Long Term Development Statement, intended to enable users and potential users of the network to understand the scope of the information provided and to assess if it would be of use to them.

Summary Information

A generic description of the design philosophies and practices appropriate to the whole of the distribution network.

Detailed Information

A series of tables, diagrams and narratives containing the following information:

- Schematic diagrams detailing the connectivity and normal operating configurations of the distribution network
- Geographic diagrams of the distribution network
- Circuit data
- Transformer data
- Load information
- Fault level information
- Distributed generation data
- An outline of authorised network development proposals.

3 Cost

The Introduction and Summary Information parts of the Long Term Development Statement are available free of charge on our website at www.nedl.co.uk. The complete Long Term Development Statement including the Detailed Information section is available in CD-ROM format at a cost of £50.

4 Contact details for further information

Requests for a copy of the full Long Term Development Statement should be made to:

General Services
YEDL
98 Aketon Road
Castleford
WF10 5DS

Telephone: 01977 605797

Requests for assistance in interpretation and clarification of the information contained in the Long Term Development Statement should be made to:

Strategy and Investment Director
YEDL
98 Aketon Road
Castleford
WF10 5DS

Enquiries concerning new or modified connections should be addressed to:

Integrated Utility Services Ltd.
Cargo Fleet Lane
Middlesborough
Cleveland
TS3 8DG

There maybe development projects that you wish to discuss directly with NEDL, in this instance enquiries should be addressed to:

Connection Policy Manager
YEDL
98 Aketon Road
Castleford
WF10 5DS

Summary Information

5 Design philosophies and practices

5.1 Background

NEDL has a functional philosophy that underlies the development of the distribution system at all voltages. This ensures that the whole distribution system satisfies the following fundamental design criteria throughout the planning period:

- compliance with all legal and statutory requirements,
- compliance with all regulatory requirements, including the Grid Code and the Distribution Code,
- compliance with all relevant national and international standards,
- ability to meet the demands placed upon it in terms of customer requirements, supply performance (availability and reliability) and supply quality (voltage and waveform quality).

The distribution system must also be capable of being operated, maintained, repaired, extended and replaced as necessary during its life, without exceeding design levels of risk to the customers it serves.

5.2 Operational environment

The distribution system has to be designed such that it is capable of continuous operation under the range of climatic conditions that can be reasonably expected in the geographic region covered by NEDL's distribution system.

5.3 Technical characteristics of the distribution system

The distribution system and the electricity supplies derived from it will have the technical characteristics detailed below in order to fulfil the requirements set out above.

5.3.1 Frequency

The Distribution Code requires that the system be designed to enable the normal operating frequency supplied to customers to comply with the Electricity Safety, Quality and Continuity Regulations 2002. The Regulations require us to declare a frequency of 50Hz for our supplies, and allow a variation not exceeding one per cent above or below the declared frequency. Currently distribution networks are reliant on NGT-connected generators to maintain frequency in accordance with the Grid Code, which requires the frequency of the transmission system to be controlled within the limits of 49.5 – 50.5Hz unless exceptional circumstances prevail. Additional performance requirements of users are given in section CC6.1.3 of the Grid Code.

Under the terms of the Grid Code, NGT may require us to reduce demand by automatic load shedding of discrete blocks of load if the system frequency falls below certain threshold points.

5.3.2 Voltage levels and control

The distribution system will operate at the following nominal voltages: 132kV, 66V, 33kV, 20kV, 11kV, 6.6kV and 400/230V. 6.6kV is a non-preferred legacy voltage.

The Distribution Code requires that the distribution system, and any user connections to it, be designed to enable the voltages supplied to customers to comply with statutory regulations. The regulations require us to declare the voltage at which the supply is delivered to connected customers, and set limits for that voltage of +10%/-6% at low voltage, ±6% at high voltage (above 1kV but below 132kV), and ±10% at 132kV or above. The distribution system will be designed such that the voltage at all points where customers are connected lies within statutory limits.

The distribution system will also be designed to enable the limiting voltage conditions at lower voltage levels to be maintained in accordance with Engineering Recommendation P10 for the specified operating scenarios.

The voltage at the source substation 132kV, 66kV, 33kV, 20kV and 11kV busbars will normally be held sensibly constant by means of Automatic Voltage Regulator (AVR) relays (or an Automatic Voltage Regulator System provided by NGT) controlling the tapchangers of the transformers feeding that busbar. Voltage control systems at the different transformation levels will be time-graded to minimise the number of tap changer operations.

Line Drop Compensation is installed at substations with 20kV or 11kV as the lower voltage, but it is generally not operational.

Tap changing facilities at 20/0.433kV and 11/0.433kV transformers will only be suitable for off-load operation.

Under the terms of the Grid Code, NGT may under certain circumstances instruct us to reduce demand on the distribution system; this is normally achieved by blanket voltage reductions applied remotely to the 20kV and 11kV distribution systems.

5.3.3 Voltage and waveform quality

The distribution system will be designed such that voltage disturbances due to the effect of abnormal loads are within the limits set out in the following Engineering Recommendations: -

- P28 – Planning Limits for Voltage Fluctuations Caused by Industrial, Commercial and Domestic Equipment in the United Kingdom
- P29 – Planning Limits for Voltage Unbalance in the United Kingdom
- G5/4 – Planning Levels for Harmonic Voltage Distortion and the Connection of Non-linear Loads to Transmission Systems and Public Electricity Supply Systems in the United Kingdom

Single-phase distribution transformers and loaded spurs will be connected to the 20kV and 11kV network so that the load on the main line is equally distributed (balanced) across all three phases. This will minimise voltage imbalance and reduce losses.

5.3.4 Electromagnetic compatibility

Satisfactory operation of the distribution system and users' equipment is only obtained where electromagnetic compatibility (EMC) exists between them.

Appropriate component parts of the distribution system must conform to the Electromagnetic Compatibility Regulations (SI 1992/2372). These Regulations, which implement the EU EMC Directive in the UK, seek to limit the disturbances present in the distribution system to levels below the immunity levels at which equipment function and performance are likely to be impaired.

Engineering Recommendation G5/4 helps to fulfil the objective of the EMC Regulations by limiting the harmonic emissions of customers' non-linear loads and generating plant.

Whilst there are likely to be parts of the distribution network where harmonic levels, particularly 5th harmonics, are approaching the limits specified in the planning standard, we are not aware of any locations where the level of harmonics exceed these limits.

5.3.5 Neutral earthing

The Distribution Code requires that the arrangements for connecting the distribution system with earth be designed to comply with the requirements of the Electricity Safety, Quality and Continuity Regulations and relevant European and British Standards.

The 132kV system will be multiple-earthed at both source and at transformation points to lower voltages. Each 400/132kV and 275/132kV autotransformer at a GSP substation will be normally solidly earthed at the star point of its 132kV winding. There may, however, be situations at sites where existing substations are being refurbished or at sites with four transformers where measures such as the introduction of neutral earthing resistors are required to keep short circuit levels within the rating of existing plant (such as cable sheaths). In addition every 132kV/lower-voltage transformer will be solidly earthed at the star point of the 132kV winding.

The star point of each 33kV and 66kV system will be earthed at its source only, where earthing transformers will be used to earth the lower-voltage delta windings of each 400, 275 or 132/33kV or 66kV transformer. The characteristics of the earthing transformers will ensure that the earth fault current does not exceed the full load current of the associated 400, 275 or 132/lower voltage transformer. In consequence the short circuit rating of equipment on the 33kV and 66kV system need only take account of the maximum short circuit phase-to-phase fault current.

20kV and 11kV system neutrals will be earthed at source only (that is, at the starpoint of the lower voltage winding on 66/20kV, 132, 66 or 33/11kV transformers). Earthing will be either direct or via a neutral earthing impedance, which may take the form of an Arc Suppression Coil.

Protective Multiple Earthing (PME) or Protection Neutral Bonding (PNB) will normally be applied to all low voltage distribution systems. Existing systems using Separate Neutral/Earth (SNE) cables may continue to be earthed at a single point (that is, at the LV neutral terminal of the 20kV/LV or 11kV/LV transformer).

5.3.6 System phasing and vector groups

Vector groups of transformers and phase connections at each voltage level will be in accordance with NEDL's Standard for System Phasing to ensure that operational parallels can be made between different parts of the network that operate at the same voltage.

The red phase vector on the 132kV system is the reference vector for phasing on the distribution system, and is in phase with the red phase vector on the 400kV, and 275kV systems, all of which are taken to be at 0º. Standard 132/66kV transformers will be of vector group Yd0, resulting in the red phase vector on the 66kV busbar being in phase with respect to the reference.

Standard 132/33kV transformers will be of vector group Yd1, resulting in the red phase vector on the 33kV busbar being at -30° with respect to the reference.

Standard 66/20kV transformers will be of vector group Yy0, resulting in the red phase vector on the 20kV busbar being in phase with respect to the reference.

Standard 66/11kV transformers will be of vector group Dy11, and standard 33/11kV transformers will be of vector group Yy6 (connected Yy10) resulting in the red phase vector on the 11kV busbar being at +30° with respect to the reference EXCEPT in the City of York where standard 33/11kV transformers will be of vector group Dy11 resulting in the red phase vector on the 11kV busbar being at +120° with respect to the reference. IN ADDITION, phase sequence within the City of York is represented vectorially by R-Y-B <u>clockwise</u> rotation.

Standard 20/0.433kV and 11/0.433kV distribution transformers will be of vector group Dy11, resulting in the red phase vector on the 0.433kV busbar being at +30° when supplied from standard 20kV systems, +60° when supplied from standard 11kV systems and +90° when supplied from the City of York 11kV system.

5.3.7 Current ratings

Current ratings of plant will normally be co-ordinated, using switchgear and busbar current ratings selected from preferred IEC values. These requirements will usually be satisfied when standard plant and components are used. Standard current ratings of equipment are given in the relevant section of this document.

5.3.8 Short circuit levels

NEDL design policies are based on the use of two standard impedance transformers operating in parallel at 132kV, 66kV and 33kV/lower voltage substations. The resulting short circuit levels are summarised below. New plant for use on the distribution system generally has ratings in excess of these values

Voltage Level	Short Circuit level (MVA)
132kV	3500
66kV	2500
33kV	1000
20kV	350
11kV	250
LV	18.75

When designing any modification to the network, including the provision of new or modified customer connections, the calculated fault levels are assessed against a design fault rating, which is the network fault capability.

Engineering Recommendations P25/1 (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) and P26 (The estimation of maximum prospective short-circuit current for three-phase 415V Supplies) provide more detailed guidance on the likely maximum fault levels at specific customers' LV exit points.

In addition the LV distribution system will be designed such that the typical maximum fault loop impedance is no greater than the value set out in Engineering Recommendation P23/1 – Customers' earth fault protection for compliance with the IEE wiring regulations for electrical installations.

5.4 System design criteria

5.4.1 System voltage, configuration and topology

The choice of system voltages, system configuration and system topology are governed by a variety of factors. These include the required levels of security, interconnection and supply performance, voltage profile and waveform quality, load density and growth rate, the rating and short circuit capability of plant.

In general LV, 11kV, 20kV, 33kV and 132kV systems are normally based on radial circuits, often with tapered conductor sizes, whereas 66kV systems are either radial or based on closed rings. Limited interconnection will be provided at all voltage levels to meet required levels of security and supply performance. Interconnection at LV, 11kV and 20kV will be supplemented where necessary by providing facilities for connecting mobile generators during system outages.

5.4.2 Security of supply

Both our Distribution Licence and the Distribution Code require us to plan and develop our distribution system to a standard not less than that set out in Engineering Recommendation P2/5 – Security of Supply (October 1978 revision).

Where customer connection arrangements make use of non-firm system capacity in excess of the firm capacity available, an alarm/trip load management scheme will be applied at the customer's premises in order to prevent overload of the distribution system under outage conditions. The details of such scheme will be recorded in the customer's Connection Agreement.

5.4.3 Interfaces with connected parties

Arrangements at interfaces with NGT, other network operators and with customers will comply with the relevant obligations of the Grid Code and Distribution Code respectively.

Customer connections to the high voltage network will include a ground-mounted isolatable metering circuit breaker.

5.5 Plant requirements

5.5.1 General requirements

All plant used on the distribution system must be capable of safe operation under all anticipated operating conditions and duties within the expected range of climatic conditions and within the distribution system parameters set out in the table below.

	Parameter	LV	11kV	20kV	33kV	66kV	132kV	Units
1	Design voltage	0.23/0.4	11	20	33	66	132	kV rms
2	Power frequency withstand to earth	3	28	50	70	140	275	kV rms
3	Lightning impulse withstand to earth	-	95	125	170	325	650	kV peak
4	Rated frequency	50	50	50	50	50	50	Hz
5	Current rating of plant	Range of ratings						A
6	Short circuit levels	Range of ratings						kA
7	Neutral earthing point	Multiple	source	source	source	source	all ends	-
8	Earth fault factor	1.73	1.73	1.73	1.73	1.73	1.40	-
9	Rated voltage of plant	0.25/0.433	12	24	36	72.5	145	kV rms

5.5.2 Auto-switching of plant

Single-shot delayed auto-reclosing facilities should be provided on all 132kV, 66kV and 33kV circuits containing overhead lines. The switching sequences and corresponding timings are determined on an individual basis depending upon the network configuration and protection arrangements. Generally the delayed auto-reclose sequences will be complete within 60 seconds. Where practicable and of benefit to customers for quality of supply purposes, auto-isolation of faulty equipment (for example transformers) will be implemented as part of an integrated scheme to restore supplies to healthy plant by auto-reclosure. Primary substations having only a single 66/20kV, 66/11kV or 33/11kV transformer will be equipped with an alternative connection from the 20kV or 11kV network, with remote or auto switching to restore supplies.

All 20kV and 11kV circuit breakers controlling 1km or more of overhead line will be capable of multi-shot auto-reclose operation and will be fitted with delayed auto-reclose features. The standard auto-reclose sequence is 2 instantaneous trips plus one IDMT trip with a dead time of 10 seconds and a reclaim time of 5 seconds except where sequencing is employed and the standard is 2 instantaneous trips and 2 IDMT trips . Circuit breaker maintenance lock-out facilities will be provided. The last trip before maintenance lock-out will be an IDMT trip. Excess fault frequency inhibit logic will be provided to reduce circuit breaker wear during excessive lightning storms.

5.5.3 Remote control of plant

At all substations where there is equipment operating at system voltages of 33kV and above, all circuit breakers and other plant capable of remote control and/or monitoring will be provided with SCADA facilities.

NEDL is currently implementing remote control facilities on the rural 20kV and 11kV network. This involves providing remote control and indication facilities at pole mounted reclosers controlling sections of main line. The implementation commenced during 2002.

5.5.4 Earthing and bonding

Substation earthing systems will be designed such that touch and step potentials within and adjacent to the substation are maintained within safe limits and, where practicable, such that the substation is classified as ’cold’.

Earthing and bonding of insulated sheath cables (and where necessary the application of sheath voltage limiters) will be in accordance with Engineering Recommendation C55/4 – Insulated Sheath Power Cable Systems.

5.6 Protection and control

NEDL’s overall philosophy for protection and control is to ensure that there are sufficient automatic and manual switching points to minimise disruption to the distribution system when clearing a fault, (i.e. the protection should disconnect the minimum amount of healthy equipment) and to restore supplies following disconnection of the faulty equipment. The correct operation of protection and control systems, is particularly dependent upon the integrity of the battery system. Hence, where it is necessary for protection and control systems associated with customer connections to be extend beyond the boundary of the YEDL substation, this is achieved by the use of voltage free contacts to interface with the customers independent battery system. An overview of the protection system at each voltage level is given in the relevant section of this document.

5.7 Transient Stability

The distribution system should remain in a stable condition following a major disturbance (for example a severe fault or loss of a generating set), with all connected generation remaining in synchronism, and with the disturbance quickly removed by means of appropriate protective gear with suitable settings.

Engineering Recommendation G75/1 states that the design of the distribution system should seek to maintain system stability and prevent the loss of synchronism of generating plant under all normal operating conditions. It also recommends that, if studies detect a risk of instability, suitable protection should be provided to detect the condition, trip the generating plant and protect the system.

6 132kV System

6.1 System configuration

The 132kV system in NEDL serves in a distribution role between the NGT system (at 400kV or 275kV) and the 33kV and 66kV systems. Exceptionally, direct 132/11kV transformation may be economically justified.

The preferred circuit arrangement will be radial circuits from the nearest Grid Supply Point (GSP) substation feeding individual 132/66kV or 132/33kV transformers. However, depending on the particular circumstances, more complex interconnected circuit arrangements may be adopted subject to compliance with Engineering Recommendation P18 (Complexity of 132kV Circuits), which sets out the normal limits of complexity of 132kV circuits.

The design of the 132kV system will comply with the general principles of Engineering Recommendation P19 (Procedure for the planning and design of 132kV systems).

6.2 System Security

In order to comply with Engineering Recommendation P2/5, substation arrangements will normally enable two 132/33 or 132/66kV transformers to be operated in parallel with protection designed to provide a continuous firm supply to the lower voltage busbar. In some high load density areas the parallel operation of three 132/33 or 132/66kV transformers will facilitate the economical provision of capacity and security. It will normally be necessary for some 33kV and 66kV circuits to be arranged as interconnectors between 132/33kV and/or 132/66kV substations, with appropriate normal open points. Such circuits will be provided where convenient and economic in order to comply with the requirements of Engineering Recommendation P2/5 (Security of supply) for minimum supply to be met after first circuit and second circuit outages.

6.3 Selection and application of plant

6.3.1 Transformers

Transformers to BS EN 60076 (IEC 60076) with nominal ratings as stated below will be the normal standard.

- 75/150MVA ONAN/OFAF for 132/66kV
- 45/90 MVA ONAN/OFAF for 132/33kV and
- 15/30 MVA ONAN/OFAF for 132/11kV

It is important that, where there is export from a site, the continuous site export should not exceed the capability of a transformer without any cooling fans and oil circulating pumps operating, as transformers are not generally designed for such auxiliary equipment to operate on a continuous basis.

6.3.2 Switchgear

Single 132kV busbars will be the normal standard. However, double 132kV busbars (main and reserve in two sections) will normally be provided at substations which accommodate, or are likely to be extended to accommodate, more than two grid transformer or generation infeeds. Double busbar arrangements may also be adopted where the additional cost can be justified by the resulting improved system reliability, security of supply and maintainability.

Outdoor-type air-insulated substations equipped with non-oil type circuit breakers will be the normal standard, although, where space is restricted or the layout of existing or proposed circuits would result in a more economical arrangement, metal-clad indoor or outdoor designs may be considered.

The normal current rating of 132kV switchgear will be 2,000A in accordance with EATS 41-10 and British Standard BS 5311.

6.3.3 Overhead lines

The normal standard for 132kV overhead lines is double circuit 3-phase lines on steel towers to EATS 43-7 – 132kV Steel Tower Transmission Lines: Specification L4(M) – 1978, equipped with 175mm^2 ACSR (Lynx) conductor. Where single-circuit lines are required or tower lines cannot easily be accommodated, designs using wood pole or tubular steel supports will be considered.

6.3.4 Underground cables

New 132kV underground circuits will comprise three single-core XLPE insulated cables per circuit, with conductor sizes chosen to achieve ratings to match either the rating of the associated overhead line or the total connected transformer rating.

6.3.5 Short circuit levels

The range of 132kV switchgear normally obtainable has a maximum short circuit rating of 20kA 3-phase, 25kA phase to earth. This rating is needed at GSP substations where there may be four 400 or 275/132kV transformers installed and will permit three transformers to be operated in parallel to meet the required security standard. Historically, where there were only two 400 or 275/132kV transformers at a GSP substation (and this was considered the ultimate development), 132kV switchgear rated at 15kA 3-phase, 18kA phase to earth was specified. However, with rising short circuit levels on the system and infeeds from generation likely to rise further, a rating of 20/25kA is the minimum that will be specified for all new 132kV equipment.

6.3.6 Protection

All items of plant will be covered by systems of main protection and back-up protection.

The main protection will be fully discriminative i.e. cover all types of phase and earth faults whilst disconnecting only the faulted system elements. Fault detection will occur in less than 50ms with total fault clearance achieved in 100ms to 200ms. This fault clearance time will be irrespective of the number of circuit ends. This specification for fault clearance times may need to be shortened where necessary to ensure stability of distributed generation.

The back-up protection will be arranged to limit the disruption of supplies in the event of failure of the main protection or the associated circuit breaker.

7 66kV and 33kV System

7.1 System configuration

The 33kV and 66kV systems in NEDL serve in a secondary distribution role between the 132kV and 20kV or 11kV systems, since direct 132/11kV transformation is only economically justified in special cases. There are a small number of industrial loads that it is appropriate to supply at 33 (or 66) kV. In addition these systems generally provide additional security by interconnection between 132/33 (or 66) kV substation lower voltage busbars to allow for double 132/33 (and 66) kV outage conditions.

Historically, the 66kV systems, which are mainly overhead with outdoor-type substations, developed in rural areas between the large urban conurbations. 33kV systems developed in urban areas as they were more economic for underground cable installation and indoor metal-clad substations.

The preferred arrangement is for a matched pair of 33/11kV, 66/11kV or 66/20kV transformers at a primary substation to be operated in parallel to provide a continuous firm supply to the 11kV or 20kV busbar. Wherever possible, symmetrical feeding arrangements will be used for the two transformers as this will generally minimise losses and circulating currents and will help to avoid voltage control problems when generation is connected.

In localities with low load density requiring an injection point to the 20kV or 11kV system to provide adequate voltage support, a single-transformer primary substation may be installed to supply demands of less than 12MW. Single-transformer primary substations may also be used to supply abnormal loads or to meet the specific requirements of customers.

Radial transformer feeder circuits from the nearest 400, 275 or 132/33kV or 66kV substation will be the preferred circuit arrangement. On overhead circuits, particularly in rural areas, it will often be economic and practicable to connect two transformers to a single overhead line. In urban areas where underground circuits are required, individual consideration will be given to the possible connection of second transformers, dependent upon loads and circuit capacities.

Where larger-size cables are already installed, but are feeding only one transformer, these will be used to connect an additional transformer in appropriate cases. In such cases, outage conditions will be carefully considered to ensure, for example, that the four transformers at two substations are not supplied from only two cables.

Extensions to the 66kV system will normally maintain the same network configuration as the existing system, i.e. radial or closed ring.

7.2 System security

At primary substations, two 33/11, 66/11kV or 66/20kV transformers operating in parallel, with appropriate protection to provide continuous firm supply to the 11kV or 20kV busbar, will be the normal arrangement to meet the standard economically. Single-transformer primary substations may be installed in rural areas to supply demands of less than 12MW, with a switched firm 11kV or 20kV supply provided by means of an auto-closing arrangement (using SCADA facilities where appropriate), the alternative feeds being provided by 11kV and 20kV interconnection.

7.3 Selection and application of plant

7.3.1 Transformers

Transformers to BS EN 60076-1 and EATS 35-2 with a nominal 12/24MVA continuous emergency rating (CER) at 5°C and impedance of 80% on 100MVA will be the normal standard for 33/11kV and 66/11kV substations with 20/40MVA units being the standard at 66/20kV. However, there are situations where other transformers can be used. For example, in high-density city centre areas where future substation sites are likely to be unavailable, 16/32MVA and 20/40MVA CER transformers may be used to supply 11kV busbars. 10MVA CMR transformers may be used for single-transformer primary substations in rural locations supplying a demand of less than 12MW where this is more economical than using 12/24MVA CER transformers.

It is important that where there is export from a site, the site export should not exceed the capability of a transformer without any cooling fans and oil circulating pumps operating, as transformers are not generally designed for such auxiliary equipment to operate on a continuous basis.

7.3.2 Switchgear

Single-busbar non-oil type metal-clad switchgear will be the normal standard at 33kV, and outdoor single-busbar non-oil type switchgear at 66kV. The following minimum current ratings will be specified:

Rating	11kV at primary substations	20kV at primary substations	33kV	66kV
Busbar & bus-section	2000A *	1250A	2000A	2000A
Transformer	2000A *	1250A	2000A	2000A
Feeder	630A	630A	800A	800A

* Where there is no likelihood of the ultimate load on the substation exceeding 24MVA (for example at primary substations initially equipped with a single transformer), the use of 1250A rated busbars, bus-section and transformer circuit breakers is acceptable.

7.3.3 Overhead lines

Overhead lines will meet the appropriate plant specification. 175mm2 AAAC conductors will be the normal standard at 33kV and 175mm2 ACSR (Lynx) conductors will be the normal standard at 66kV.

7.3.4 Underground cables

New 66kV and 33kV underground circuits will comprise three single-core XLPE insulated cables per circuit, with conductor sizes chosen to achieve ratings to match either the rating of the associated overhead line, the total connected transformer rating or to maintain the rating of the closed ring.

7.3.5 Short circuit levels

In order to facilitate future uprating of the short circuit capability of the distribution system, for example to permit connection of additional generation, all new switchgear installed on the 33kV and 66kV distribution systems will be specified with a three-phase symmetrical short circuit breaking rating of 25kA. As higher-rated plant (31.5kA or 40kA) becomes available on the market, then this will be specified where economic. It should be noted, however, that existing circuits are likely to impose a constraint on the maximum short circuit capability of the distribution system as a whole.

7.3.6 Protection

All items of plant will be covered by systems of main protection and back-up protection.

The main protection will be discriminative i.e. disconnect only the faulted system elements for all likely faults on the protected plant. Fault detection will occur in less than 50ms with total fault clearance achieved in 100ms to 200ms. This complete fault clearance time will be longer when fault-throwing switches, LV directional overcurrent, or neutral displacement protection are necessarily employed as a means of, or substitute for, intertripping. Clearance times exceeding 200ms will also occur on feeders protected by zone 2 distance and directional earth fault protection. However, the total clearance time for any of these situations will not exceed 1 second. This specification for fault clearance times may need to be shortened where necessary to ensure stability of distributed generation.

The back-up protection will be arranged to limit the disruption of supplies in the event of failure of the main protection or the associated circuit breaker

8 20kV, 11kV and 6.6kV Systems

8.1 System configuration

The main purpose of the 20kV and 11kV systems is to distribute electricity into and around local urban and rural areas in an economic, efficient, safe and secure manner whilst meeting the needs of customers. There is a limited amount of 6.6kV infrastructure which tends to be limited to older industrial (e.g. riverside) networks. It is envisaged that, over time, the 6.6kV network will be uprated to 11kV and the 6.6kV networks will not be developed.

The general design principle for configuring the distribution system is based on primary substations with duplicate transformers and 20kV or 11kV busbars, providing a continuous firm 20kV or 11kV supply. In low load-density localities, a single-transformer primary substation supplying demands of less than 12MW may be installed with a switched firm supply, the alternative being provided by 20kV or 11kV interconnection.

The 20kV and 11kV feeders radiating from primary substations will either form interconnectors with other primary substations, or rings connected to the busbar on either side of the bus section at duplicate transformer substations. Sections of non-interconnected 20kV and 11kV feeder, and the development of rings on rings and cable cross-ties which produce an excess of under-utilised cable capacity, will be avoided wherever possible. Figure 1 illustrates examples of these.

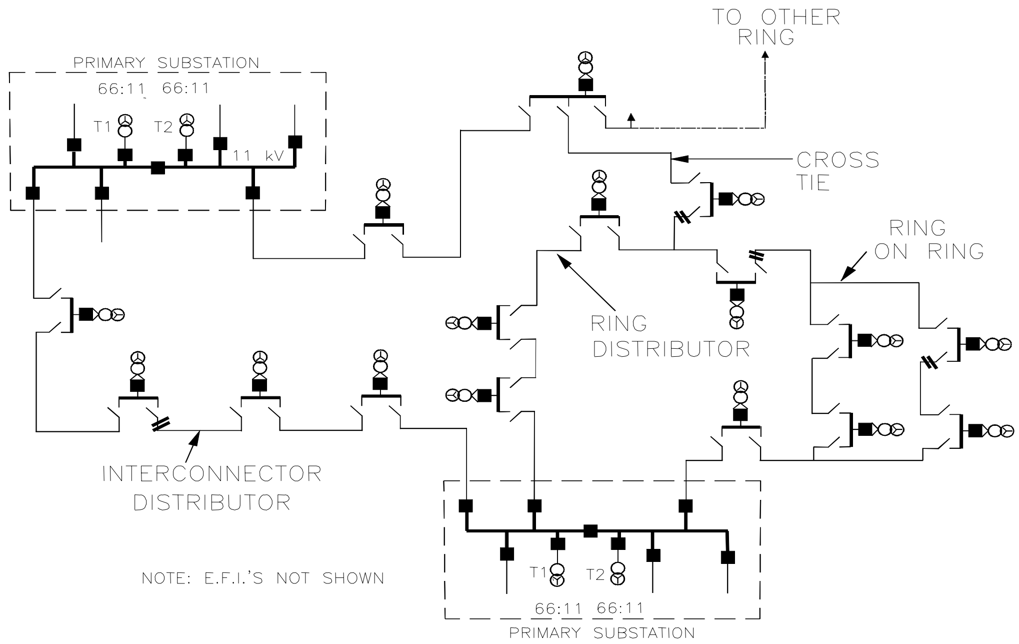

Figure 1 : concepts of interconnector and ring distributors, cross-ties and rings on rings.

Distributors will normally be operated as radial feeders, with the open point selected for ease of operational access to minimise customer minutes lost, whilst taking account of the need to meet security requirements and minimise system losses and voltage drops.

Urban networks will normally comprise underground cables with distribution substations looped-in en route. In order to preserve the quality of supplies to customers afforded by the existing network topology, teed connections to 20kV and 11kV underground cables are not acceptable other than in exceptional circumstances, e.g. where the tee provides the dedicated main or alternative connection to a 20kV or 11kV customer.

In order to maintain quality of supply standards there should be no more than two tees made to any one electrical section of an underground cable system.

Rural overhead networks will be developed to follow the same basic system configuration as shown in Figure 1, comprising mainly interconnectors between Primary Substations. These will normally be supported by strategically-placed cross-ties between adjacent interconnectors in order to provide alternative means of securing and restoring supplies in the event of a fault. Tee-connected pole-mounted transformers will normally be used to connect individual point loads along the route of the line, with teed spurs added as necessary between switching points to supply loads remote from the main line.

8.2 System security

In order to meet the expectations of customers, the 20kV and 11kV network is generally designed in excess of the minimum requirements specified in Engineering Recommendation P2/5 – Security of Supply. Ideally, particularly in cable networks, it should be possible to restore supplies to all customers by 20kV or 11kV switching of the demand onto an alternative feeder.

The first-choice alternative feeder in a 20kV or 11kV distributor ring or interconnector should be capable of picking up the full load of the circuit after fault, without the need for initial 'off-loading'. The design will ensure that initial restoration of all feeder load will be possible with a single switching operation on either side of an isolated faulty section, based on cyclic cable ratings and/or winter overhead line ratings. Subsequent switching operations may be necessary to redistribute feeder loads and restore voltage conditions.

Interconnection at low voltage will be provided, where economic and practicable, between adjacent Distribution Substations to facilitate substation maintenance and in the case of tee substations provide a limited level of transfer capability for high voltage faults. The level of interconnection capacity will be dependant upon the substation demand profile, but for LV networks supplying domestic customers it will generally be equivalent to 30% of the transformer winter maximum demand.

8.3 Selection and application of plant

8.3.1 Distribution substations

New ground-mounted distribution substations will be selected from the approved range of standard transformer ratings. They will normally be looped-in to the existing underground or overhead distribution system and free-standing 20kV or 11kV indoor metal-clad non-oil type switchgear of 630A rating will be used. The use of Unit Distribution Equipment (UDE) is restricted to housing estates.

New distribution substations will normally be equipped with a single 20/0.433kV or 11/0.433kV ground-mounted transformer of vector group Dy11, with a rating of up to 1000kVA and fitted with an off-load tapchanger having a range of ±5% in 2.5% steps. In situations where a single commercial or industrial connection is provided the use of 1250kVA and 1600kVA transformers is permitted.

16kVA pole transformers will be the minimum size used for connection to overhead networks.

8.3.2 Overhead lines

Bare wire 20kV and 11kV overhead lines forming part of a main line or interconnector spur will be constructed using 175mm² Aluminium Alloy conductor. Other 20kV and 11kV spur lines and tees will be constructed using 50mm² Aluminium Alloy.

8.3.3 Underground cables

All new 20kV and 11kV underground cables will utilise three XLPE insulated single core cables per circuit of 185mm2 Al or 300mm2 Al conductor. In exceptional circumstances, teed substations may be supplied via 95mm2 Al cable.

8.3.4 Short circuit levels

Historically the 11kV network has been constructed with equipment rated at 250MVA. Although new ground mounted switchgear will be specified with a rating of 16kA, due to the extent of the 11kV infrastructure the network will continue to be designed based on a short circuit level of 250MVA (13.1kA). Similarly the 20kV network has been constructed with equipment rated at 350MVA. The minimum rating of new switchgear will be 12.5kA but the network will continue to be designed based on a short circuit level of 350MVA (10.1kA).

8.3.5 Protection

All plant will be protected against phase and earth faults. In general the protection will be time graded and arranged to limit the disruption of supplies in the event of a system fault. Systems that are required to run interconnected will be equipped with discriminative protection that will disconnect only faulty system elements for all likely faults. The exceptions are sections of busbars and small zones at primary substations.

If second stage protection is applied to a feeder, then the feeder will be checked for generation and intertripping provided if necessary for an island situation.

9 Low Voltage System

9.1 System configuration

The main purpose of the LV distribution system is to distribute electricity in local urban or rural areas and to deliver it to customers' LV exit points in an economic, efficient, safe and secure manner.

The LV system will normally be developed as a network of tapered radial mains supplied from a distribution substation placed near to the load centre. At least one of the LV mains from each substation will act as an interconnector to an adjacent substation. Interconnectors will not be tapered.

LV mains not forming or likely to form interconnectors will be tapered to meet the requirements of load, terminal voltage and loop impedance, but we shall not use conductors of less than $70mm^2$ aluminium cable or $95mm^2$ aluminium ABC overhead line (or their equivalents). In high load-density areas such as city centres and retail/industrial parks, tapering is normally not appropriate.

9.2 System security

The security requirements specified in Engineering Recommendation P2/5 for demand supported by LV networks are minimal. However, in order to deliver expected customer service, interconnection of up to 30% of the substation demand will normally be provided for domestic/general LV networks. Where this is not practical or economic, connection facilities for mobile generators will be provided.

For interconnection design purposes, the cyclic rating of LV interconnecting cables and short-term overload rating of transformers will normally be used, unless the interconnected load is known to have an essentially flat load curve at peak times, in which case continuous ratings will be appropriate.

9.3 Selection and application of plant

9.3.1 Distribution substations

Where economic and practicable, new ground-mounted distribution substations will be selected from the approved range of standard transformer ratings. They will normally be looped-in to the existing underground or overhead distribution system and free-standing 20kV or 11kV indoor metal-clad non-oil type switchgear of 630A rating will be used. The use of Unit Distribution Equipment (UDE) is restricted to housing estates.

New distribution substations will normally be equipped with a single 20/0.433kV or 11/0.433kV ground-mounted transformer of vector group Dy11, with a rating of up to 1000kVA and fitted with an off-load tapchanger having a range of ±5% in 2.5% steps. In situations where a single commercial or industrial connection is provided the use of 1250kVA and 1600kVA transformers is permitted.

16kVA pole transformers will be the minimum size used for connection to overhead networks.

9.3.2 Overhead lines

New overhead mains will only be installed where underground mains are either not economic or not practical. This will normally be limited to the extension of existing overhead mains at the extremities of rural village networks.

Where LV overhead mains are to be installed, approved 4-core ABC conductor will be used, with conductors having a cross-sectional area not less than $95mm^2$ Al.

9.3.3 Underground cables

LV underground mains will be selected from approved three-phase CNE cables having a cross-sectional area not less than $70mm^2$ aluminium (or equivalent).

9.3.4 Protection

All plant will be protected against phase and earth faults. In general the protection will be time-graded and arranged to limit the disruption of supplies in the event of a system fault.

10 Operating Voltage

The following tables indicate the target voltages employed within the NEDL region. These are generic and local conditions may dictate that different target voltage is adopted.

Voltage Level	Target Voltage	Comments
132kV	134kV	
66kV	66kV	Bandwidth: +/- 1.5%
33kV	33kV	Bandwidth: +/- 1.5%
20kV	20.4kV	Bandwidth: +/- 1.5%
11kV	11.3kV	Bandwidth: +/- 1.5%

11 Load management areas

There are no areas of the NEDL distribution network affected by a general load management scheme. Load management schemes will be employed on an individual customer basis to provide connections that meet the security requirements of the customer. Apart from these individual load management schemes, there are no areas where operational constraints or restrictions are used to maximise network utilisation.

12 Other Interconnected networks

The main interconnection with other networks is with the National Grid Transco transmission system via grid supply point substations. There are also a number of customers who are connected directly to NGT's network and have interconnections with the NEDL network to provide alternative supplies. Further information can be obtained from:

National Grid Transco
NGT House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

There are a number of other interconnections and these are detailed below:

Part of the NEDL network in North Yorkshire is currently supplied via three 132kV circuits from Ferrybridge B GSP within YEDL's distribution area.

Part of the NEDL network in Northumberland is currently supplied via two 20kV circuits connected to Spadeadam Substation within United Utilities' distribution area.

Further information can be obtained from:

Strategy and Investment Director
YEDL
98 Aketon Road
Castleford
WF10 5DS