Design and Planning

Framework for underground networks in UK Power Networks

Appendices for ENA/OFGEM Engineering Recommendation G81 Generic Documents:

Part 1:
Framework for design and planning for low voltage housing estate installations and associated, new, HV/LV distribution substations.

Part 4:
Framework for design and planning of industrial and commercial underground connected loads up to and including 11kV.

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Review Date:	31/12/2014		

This document forms part of the Company's Integrated Business System and its requirements are mandatory throughout UK Power Networks. If you have any queries about this document please contact the originator of the current issue.

Version	Date	Details	Originator
1.0	17/12/2004	Three area documents combined and revised	Paul Abreu
1a	24/02/2005	Minor corrections.	Paul Abreu
2.0	02/01/2008	More guidance on HV design & minor alterations	Hilary Grinter
2.1	11/08/2009	More guidance on HV design issues	Dave Croucher
3.0	25/10/2010	New company information	Toni Calder
4.0	11/02/2011	General update	Dave Croucher
5.0	04/07/2011	Improve clarity following feedback from an ICP	Karolina Kujawska

CONTENTS

Introduction

For all four of UK Power Networks distribution networks the design of the 11/6.6kV (HV) and low voltage (LV) network extension downstream of the declared point of connection is contestable.

If an Independent Connection Provider (ICP) wishes to undertake the design of a connection installation the following requirements must be complied with:

- The principles of any design are to be agreed with UK Power Networks at the outset of the design process and should comply with Part A of this document 'UK Power Networks Design Information'.

- Details of the proposed design are to be submitted to UK Power Networks for approval and should contain the information detailed in Part B of this document 'Design Information to be Provided by Third Party Connection Providers'.

Where UK Power Networks requirements are not specified in this document ICPs should plan to undertake any design work in accordance with best industry practice, complying with all appropriate legislation, including those referred to in the ENA G81 suite of documents. If an ICP chooses to use a design specification that is not included within this document, the ICP should liaise with UK Power Networks for confirmation that the proposals are in keeping with UK Power Networks design methodology. ICPs are also required to obtain design approval from UK Power Networks prior to implementation.

If you need further information about the design process please contact UK Power Networks Competition in Connections Solutions Department on CiCGateway.Connections@ukpowernetworks.co.uk

References

- ENA Engineering Recommendation (ER) P2/6, "Security of Supply".
- EI 08-0105 – Diversity of Secondary Switchgear.
- ENA Engineering Recommendation P28
- ENA Engineering Recommendation G5/4
- ENA Engineering Recommendation P29
- EB 08-0004 Guidance on Fire Fighting Supplies

Part A - Design Information

1.0 Introduction

This document provides guidance to ICPs that wish to undertake the design of distribution networks that are to be adopted by UK Power Networks. If an ICP chooses to use a design specification that is not included within this document, the ICP should seek confirmation that the proposals are in keeping with UK Power Networks design methodology. **Prior to the implementation of any design ICPs are required to obtain approval for such designs from UK Power Networks.**

2.0 SECURITY OF SUPPLY

HV networks shall, as a minimum, be designed to comply with the security of supply standards set out in Engineering Recommendation (ER) P2/6, "Security of Supply".
The following extract from ER P2/6 sets out the levels of security required for demands normally encountered on the distribution network.

		Minimum demand to be met	
Class of Supply	Range of Group Demand	After First Circuit Outage	After Second Circuit Outage
A	Up to 1 MW	In repair time: Group Demand	Nil
B	Over 1 MW to 12 MW	(a) Within 3 hrs: Group Demand minus 1MW (b) In repair time: Group Demand	Nil

Note: The requirements of P 2/6 do not apply to a single customer taking a load excess of 1 MW. The security level of an individual customer's supply would normally be agreed with that customer and written into the supply agreement.

3.0 SYSTEM SHORT-CIRCUIT VALUES

All electrical equipment connected to the network must be able to withstand, without failure or damage, the maximum short-circuit conditions that it may be subjected to at the point where it is connected.

Additionally, for overhead line networks consideration has to be given to the short-circuit ratings to ensure that conductor failure or excessive sagging of conductors does not occur during fault conditions. Similarly with underground networks, the short circuit ratings of cables, both new and existing, must also be considered. When networks are reinforced, fault levels increase and existing cables may need to be replaced or protection settings altered avoid damage under fault conditions.

4.0 VOLTAGE REGULATION

Voltage regulation policies vary across the four licence areas and these policies are the subject of review. In all licence areas, low-voltage limits within the declared range of 230 volts +10% and –6% are to be maintained both during normal running conditions and outage conditions. 11/6.6kV supplies are to be maintained at nominal voltage +6% or –6%.

5.0 HV NETWORK CONFIGURATION

A simple network is a safe network. In designing any additions or alterations every endeavour should be made not to make the network more complicated.

The principles set out below should be applied when additions or alterations are made to the network.

5.1 The normal method of 11/6.6 kV distribution is by way of open ring circuits feeding from the primary substation to normal open points that provide

interconnection with adjacent feeders. The load on any teed section or group of teed substations between switching points shall be restricted to 1MVA. Additional connections should continue this philosophy. In this context, "load" refers to an estimate of the maximum demand on connected substations (not the aggregate transformer capacity), based on current load, plus a reasonable allowance for any anticipated load growth over the following 10 years.

5.2 For large sites where the network is to be extended in phases over a prolonged period, the network shall be designed to ensure that the requirements of ER P2/6 are met at the completion of each phase. At the design stage ICPs must consult with UK Power Networks to agree timescales and security of supply risks associated with each phase of the development.

5.3 The section of cable between the primary circuit breaker and the first ring main unit shall be free of:

- teed transformer connections; and
- teed connections that do not interconnect with another 11kV/6.6kV network. No additional connection, including those interconnecting with another 11/6.6 kV network, shall be connected to the first leg out.

5.4 Circuits from a primary substation that provide mutual support shall where practicable be connected to separate sections of the primary busbars, to provide security in the event of a busbar fault.

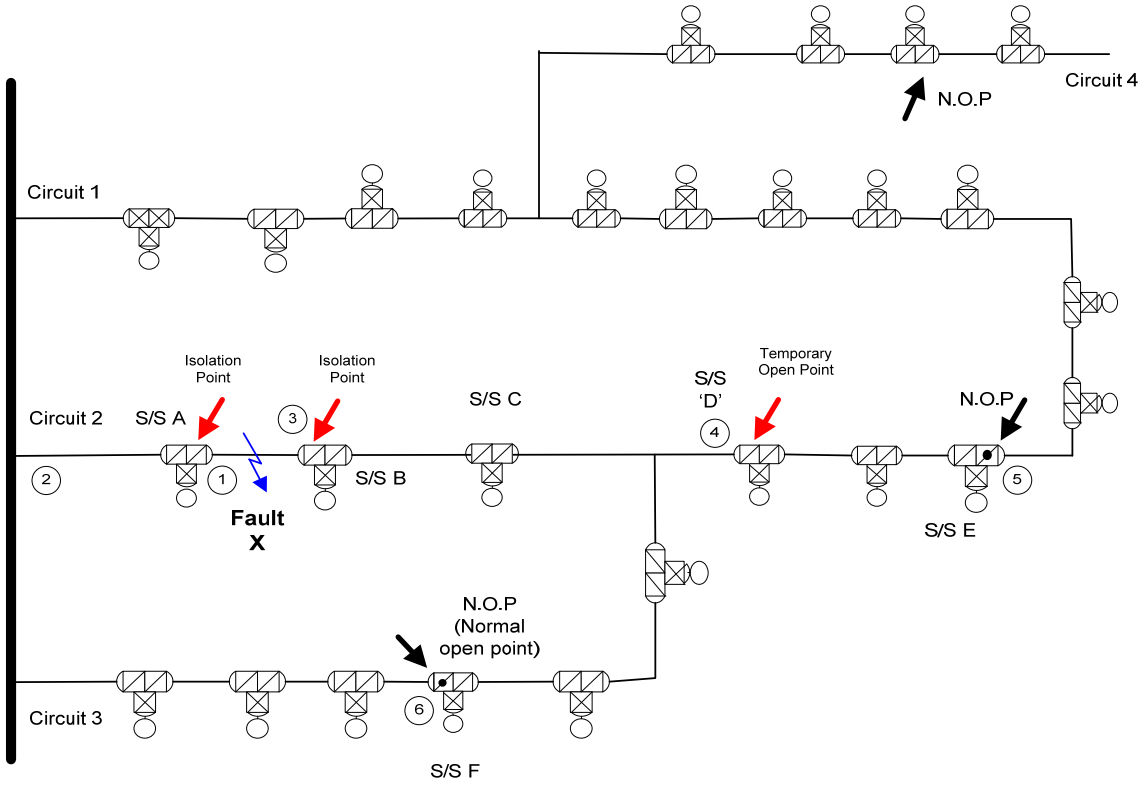
5.5 Care must be taken to ensure that any interconnection across two circuits includes at least two ring main units (this ensures that only one circuit is affected by the failure of one of the RMUs).

5.6 The conductor size of additional cables shall be at least 185mm^2 Al when directly laid or 300mm^2 Al when ducted. The rating of the new cable must at least match the rating of the circuit. In high load zones in city centres 300mm^2 copper cables, should be installed as a minimum. All HV cables on the London network are to be ducted.

5.7 300mm^2 copper cables shall be laid for the first drum length from a Primary substation in the London network because of de-rating due to the grouping of cables in the vicinity of the substation.

5.8 To avoid serious operational difficulties if an operational restriction needs to be applied to a particular type of switchgear following the discovery of a potentially dangerous defect UK Power Networks operate a switchgear diversity policy, EI 08-0105.

5.9 For a first fault outage, alternative supplies shall normally be restored to the healthy sections of network by a single load transfer plus restoration from the source circuit breaker (4 switching operations). This may not be possible in established networks with small section cables when no more than two load transfers plus restoration from the source circuit breaker (6 switching operations) are acceptable. Figure 1 shows this.



For a fault at 'X'

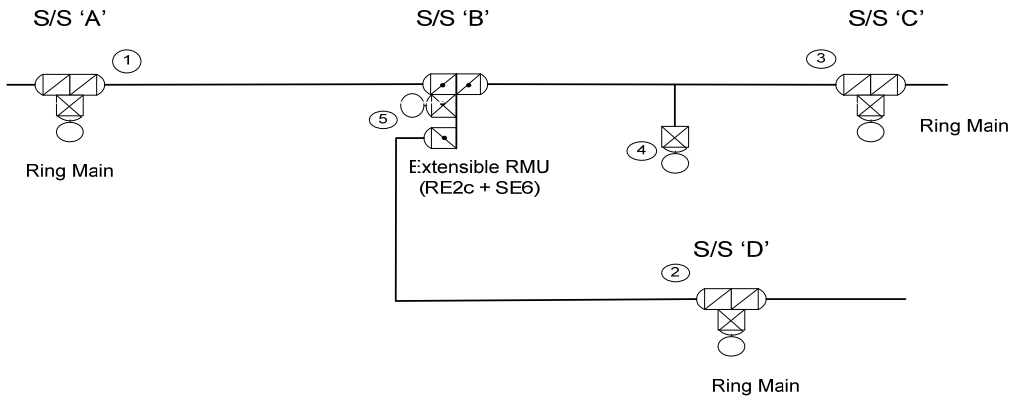
Following trip of feeder circuit breaker and confirmation that the fault is between substations A & B it should only be necessary to carry out a maximum of six switching operations to restore customer supplies

1. At substation A -.Open substation B Gas switch
2. At primary substation - Close circuit 2 circuit breaker.
3. At substation B – Open S/S A Gas Switch
4. At substation D - Open S/S C and Tee Gas Switch } Additional Load Transfer
5. At substation E - Close N. O. P.
6. At substation F – Close N. O. P.

Figure 1

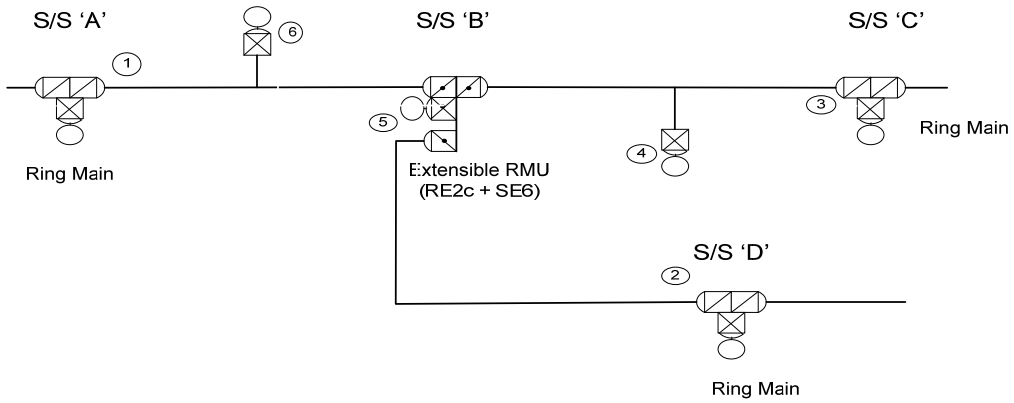
5.10 To avoid the creation of complex networks the number of points of isolation to any switchboard should be limited to five. (The local transformer switch fuse / C.B. is to be included as a point of isolation), as shown in figure 2. In some cases it may be necessary to fit switchgear instead of creating a Tee joint. In London this has traditionally utilised a Ring Main Unit with a fully rated circuit breaker operating as a switch with its protection disabled. This unit has been known as a Trunk Feeder Unit (TFU).

1)



Failure of the switchgear at S/S B requires 5 points of isolation to isolate network between S/S 'A' S/S 'C' and S/S 'D' - **ACCEPTABLE**

2)



Failure of the switchgear at S/S B requires 6 points of isolation to isolate network between S/S 'A' S/S 'C' and S/S 'D' - **NOT ACCEPTABLE**

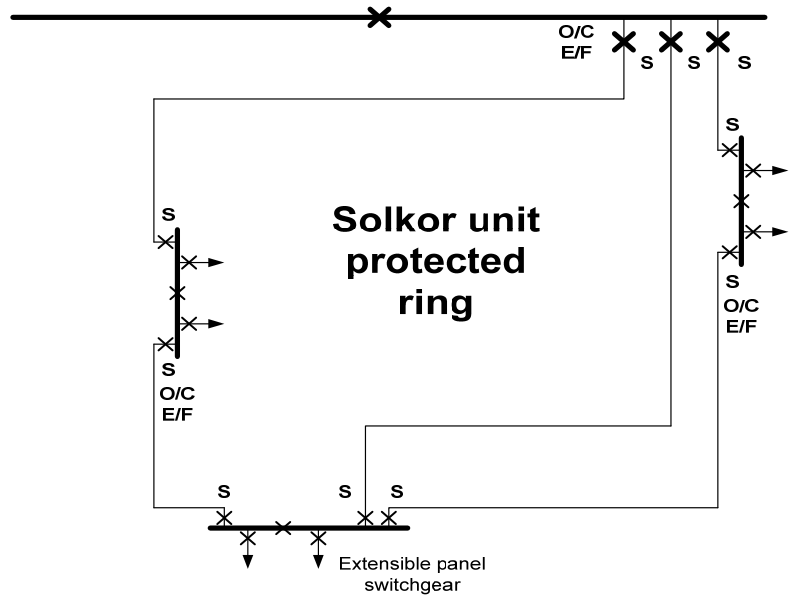
Figure 2

5.11 All new substations within 100 metres of an existing 11/6.6 kV ring circuit to which the connection is to be made shall be ringed. Where a new substation is within 100 metres of a ring circuit, but the nearest connection point is to an 11/6.6 kV spur, this existing spur shall be reinforced to form part of the ring network.

5.12 In town centres and shopping areas, distribution substations shall be ring connected i.e. by the installation of ring main unit switchgear within the radial network.

5.13 All new substations to be situated further than 100 metres from an existing 11kV/6.6kV ring shall be ringed where this is a requirement of P 2/6 or the five isolation point rule.

5.14 An alternative method of distribution, primarily for 11/6.6 kV customers or larger dedicated loads, is by means of closed ring circuits operating in a mesh. Each section of cable is protected by a unit protection scheme usually referred to by the manufacturer's brand name, e.g. SOLKOR or TRANSLAY. Panel switchgear is required at each secondary substation with circuit breakers controlling each cable. In the event of a cable fault, the faulty section between circuit breakers will be isolated maintaining supply to the rest of the mesh. Sectionalising OC/EF protection will be fitted at strategic points to limit the loss of supply in the event of a fault not within the protected zone, e.g. on switchgear. A typical unit protected mesh network is shown below.



5.15 11/6.6 kV underground cable networks should, where practical, be designed such that the primary method of alternative supply is via another 11/6.6 kV feed. Where LV is used as the alternative, the level of LV interconnection provided in these circumstances should ensure that no more than two generators will be required to maintain supplies for a cable or network distribution switchgear outage.

5.16 Any additions to 11/6.6kV circuits should be assessed in terms of Quality of Supply using the approved network modelling tool. Where alterations or additions to the network will potentially increase CI or CML indices, remote control and/or automation should be considered as a way of mitigation.

5.17 Any proposals to make permanent alterations to the 11/6.6kV distribution network may have a potential impact upon the operation of network remote control or automation schemes. The integrity of automation schemes must be maintained.

5.18 Self resetting fault-passage indicators are to be fitted to the outgoing switches at all ground mounted distribution substations.

5.19 Remote operation/automation equipment will be fitted to one switch of all RMUs in EPN and SPN and on both switches in LPN.

5.20 Overhead line circuits are designed as three-phase open rings with interconnection from adjacent circuits. The load on any teed section or group of teed substations between switching points is restricted to 1MVA. Additional connections should continue this philosophy.

Three-phase distribution transformers supplying three-phase low-voltage networks, is the normal method of distribution. In many areas single-phase 2-wire spurs are teed from the three-phase network to provide supply to small communities or individual customers via single-phase transformers. In these situations transformers are connected for 2-wire (240V) or 3-wire (240/480V) low-voltage working.

5.21 11kV overhead line network extensions and reinforcement will be made three-phase to reduce losses and maintain voltage limits.

5.22 Some areas of the London network utilise multiple feeders connected to feed load blocks which can result in seemingly unusual connection configurations. These networks are referred to as "Interconnected" LV networks and are mainly found in the central London area. Their operation depends on both the HV and the LV networks being configured in specific ways and both must be considered together when designing alterations or load additions. The HV feeders will normally be open rings with all of the feeders supplying an interconnected LV load block being fed from a common busbar at the Main Sub Station.

Large point loads and HV supplies should not, ideally, be connected to HV feeders supplying interconnected LV load blocks. If it is necessary to do so, then additional protection in the form of a Parasitic Load Trip Unit (PLTU) will be required to disconnect the point load under certain HV fault conditions to ensure network stability.

More details are discussed in section 7. The ICP should discuss these configurations with the UK Power Networks CiC designer.

5.23 Certain areas of London operate a distribution network at voltages higher than 11kV e.g. 22kV and 33kV.

6.0 LOADS CAUSING DISTORTION OF THE SUPPLY VOLTAGE

Excessive distortion of the system voltage waveform, caused by certain types of load, may result in annoyance to users of the distribution system or damage to connected apparatus. UK Power Networks use national and international recommendations in regards to the maximum level of distortion which may be accepted on the distribution system:

- **Engineering Recommendation P28**

This recommendation introduces the concept of the Flicker Severity Value, which is based on visual perception of the fluctuating luminance of tungsten lighting caused by voltage changes.

- **Engineering Recommendation G5/4**

This recommendation sets the planning levels for harmonic distortion to be used in the process for the connection of non-linear equipment. A process for establishing individual customer emission limits based on these planning levels is described. The Distribution Code requires that these levels should not be exceeded when considering the connection of non-linear loads.

- **Engineering Recommendation P29**

This Engineering Recommendation provides limits for voltage unbalance in distribution networks, to be used in the technical evaluation of proposed new loads which may give rise to voltage unbalance. The limits relate specifically to the voltage unbalance attributable to the proposed new load and are not intended to be applied as generalised network limits. In assessing requirements for the connection of the load, account will be taken of significant sources of unbalance already known to be connected in order to maintain an acceptable quality of supply.

Single phase overhead line networks may cause voltage unbalance which is to be kept to a minimum to reduce losses and maintain voltage limits. Hence, network extensions and reinforcement, including reconductoring, will be made three-phase

7.0 LV NETWORK DESIGN

LV networks will normally be designed as radial, fed from the secondary substation via fuses to open points in network link boxes. There are exceptions to this, particularly in central London where historically there has been a high load density in the area of the West End to the City which is known as the Central High Load Density Zone (CHLDZ). In this area the LV network is electrically connected together via fuses across HV feeders to achieve two main results; 1. to support the high LV load density by providing multiple infeeds; 2. to support and maintain supply to LV loads in the event of an HV fault. Although mainly in the CHLDZ, this type of network can be found in other areas of London.

Supplies to loads of less than 800kVA will generally be made at LV. For all three UK Power Networks network areas LV networks should be designed using the WINDEBUT program. This software is a design tool which uses predefined daily demand profiles for different types of customers to propose minimum cable sizing requirements for LV networks.

7.1 Calculation of Demand

Calculation of demand data for calculation of demand is determined by WINDEBUT and is dependant upon the number of connections and the designer's estimate of annual unit consumption. The table below indicates the classifications of properties and typical unit consumptions used by UK Power Networks.

	ADMDs (kW)		DEBUT curve / units		
Type	**Day**	**Night**	**Curve**	**Day**	**Night**
1/2 Bed Gas C/h	1.2	0.3	URLC	3500	0
3 Bed Gas C/h	1.5	0.3	URLC	4400	0
4 Bed Gas C/h	1.8	0.5	URMC	5800	0
5+ Bed Gas C/h	2.4	0.5	URHC	7500	0
1/2 Bed Other C/h	1.5	2	ESEVEN	3500	2000
3 Bed Other C/h	1.9	2.5	ESEVEN	4400	2500
4 Bed Other C/h	2.1	3	ESEVEN	5800	3000
5+ Bed Other C/h	3.1	3.5	ESEVEN	7500	3500
E7 1 Heater / W/h	2.2	5.13	ESEVEN	5500	5000
E7 2 Heater / W/h	2.5	7.56	ESEVEN	5700	7500
E7 3 Heater / W/h	2.8	9.99	ESEVEN	6000	10000
E7 4 Heater / W/h	3.4	12.42	ESEVEN	7500	12000
15kW Boiler	4.5	16.2	ESEVEN	10300	16000
19kW Boiler	5.7	19.8	ESEVEN	12000	18800

7.2 Voltage Regulation

At LV, the supply voltage must remain within the declared voltage range of 230 volts +10% and – 6 % during normal running and outage conditions.

Maximum Voltage at the distribution system Exit Point shall **not** exceed 253V;

- Minimum Voltage at the distribution system Exit Point shall **not** be less than 216V;
- Maximum voltage regulation from LV busbars of HV/LV substation to the end of each main shall not exceed 5%;
- Maximum voltage regulation in any service shall not exceed 2%.

7.3 Voltage Flicker

The use of high load instantaneous shower units (unity power factor load) can cause voltage flicker problems, particularly where ADMDs are low. To avoid these problems, the network should be designed such that the cable circuit resistance (phase/neutral loop) from the substation to any consumer's terminals combined with the substation transformer resistance does not exceed 250 milliohms. This will ensure that a start load of 20A (4.8kW) will cause no more than 2% voltage dips, or 30A (7.2kW) no more than 3% dips, which will generally be acceptable at the sort of frequencies associated with instantaneous shower units.

7.4 Maximum Earth Loop Impedance

For LV mains controlled by 315A fuses the maximum phase-neutral loop impedance must not exceed 280 milliohms to the end of the main. The phase-neutral loop impedance at the service position must not exceed 350 milliohms.

The maximum allowable cumulative impedance for circuits controlled by 400A fuses shall be reduced to 153 milliohms for circuits containing 95mm^2 cables.

Some of UK Power Networks LV networks are controlled by 500A fuses. In these circumstances the maximum loop impedance shall not exceed 100 milliohms to end of LV main.

7.5 Interconnected LV networks in LPN

There are various network configurations of interconnected LV networks in the LPN area. The earliest was a single load block on each HV feeder with fringe fuses between the blocks. This design developed into having a number of load blocks on each feeder and latterly have some interleaving as well. Other networks were developed as fully interleaved. The early designs were based on a solidly linked LV network, although all networks are now fused with specific rules on the number of fuses feeding together. The size of the load block is different for the different types of network and the networks in London are now likely to be a combination of previous designs.

There are some fundamental principles that need to be considered if adding new load to an LV interconnected network.

- Transformers must be loaded no more than 80% of nameplate to provide support during HV faults,
- Transformers must be to LPN specification to allow 160% loading during HV fault restoration,
- Adequate LV connections must be provided to the existing LV network,
- Fault level needs to be controlled and may require less than obvious connection points,
- Off site network reinforcement or rearrangement may be required to maintain the size of the load blocks within limits.
- HV feeders may need to be reinforced or rearranged or open points moved.

The minimum scheme for a new connection may therefore require the considerations mentioned above and the ICP should make allowance for this when discussing these configurations with the UK Power Networks CiC designer

7.6 Prospective Short Circuit Current in LPN

The network configuration in the LPN area may result in higher fault levels than in other parts of UK Power Networks where the Prospective Short Circuit Current (PSCC) at the LV busbar of any distribution substation is 25kA.

The information below sets out the maximum fault levels that can be expected. ER P25/1 and P26 give figures for the maximum design values of PSCC at the point of connection of the service line to the PES main LV distributor. However, P25/1 and P26 contain caveats for the LPN area. P25/1 recommends that the single phase figure

quoted (section 9.32) be applied to the cut-out rather than the point of connection of the service line to the main LV distributor. P26 states that the three-phase value quoted is not applicable to the LPN area.

LPN Transformer Size	LPN Normal Range	LPN Maximum
1000 kVA	20 – 46 kA	46 kA
800 kVA	16 – 46 kA	46 kA
500 kVA	10 – 46 kA	46 kA

Note that the LPN 46kA figure relates to permanently interconnected LV networks. The other figures are for single transformer operation.

7.7 Fire Fighting Supplies

UK Power Networks policy is covered in EB 08-0004 Guidance on Fire Fighting Supplies

8.0 TRANSFORMERS

Only UK Power Networks approved transformer designs can be connected to distribution networks to be adopted. Details of all approved transformers are contained in the Materials Specification document. Transformers shall ideally be of the unit type, directly coupled to the ring main unit. Low-voltage take off chambers directly connected to distribution transformers will be the normal arrangement.

The standard sizes of distribution transformer for underground networks are 315/500/800/1000kVA. The smallest transformer approved for connection to UK Power Networks LPN network and for town centre loads on all networks is 500kVA.

All LPN transformers must also be built to withstand 160% overload. In EPN and SPN the smallest transformer approved for use in new housing estates is rated at 315kVA which are rated for a cyclic overloading of 110% for indoor transformers.

Freestanding pole-mounted transformers shall not be used in new networks. Pad mount/micro transformers shall not be connected on a permanent basis to urban MV networks. They may however be used as temporary supplies for construction works or in some circumstances (subject to the approval of UK Power Networks) as an interim measure during the development of a site, prior to the installation of permanent network.

The UK Power Networks distribution networks contain a number of local variations for cable to transformer winding connections. This can affect both the HV and LV transformer connections and it will be necessary to replicate the local arrangement on all new installations in order for the new LV network to “phase-in” with the existing LV network. At the design stage ICPs will need to liaise with UK Power Networks to establish the correct phasing required for each of their projects.

9.0 CABLE POSITIONING & LAYING REQUIREMENTS.

Cables should be located and installed in accordance with the National Joint Utility Group publication NJUG 7 and our Installation and Record Appendix. Mains cables should not pass under buildings and should be laid in ground to be adopted by the local Authority. Where this is not practical an ‘Easement’ (NOT a Wayleave) will be required for any such cable routes. Where cables cross or run beneath carriageways they should be installed in ducts. Cable joints should be located beneath the footpath (not beneath carriageway).

Where ducts are to be installed in concrete, prior agreement must be obtained from UK Power Networks and the use of steel pipes will be required. Steel pipes to be medium quality, screwed, complying with BS1387:1985.
The minimum cable bending radii are set out in the 'Installation and Records Specification'.

On new housing developments the preferred location of service termination is in an external meter cabinet. Service entry should be in accordance with NJUG 6. Ducts and/or service cable route from the service termination to the mains cable should be via the shortest practical route and should not cross third party property. Each property should be separately serviced from the distribution main, looped service arrangements will not be accepted..

Multiple service jointing arrangements may only be employed where such techniques are not to the detriment of load balancing across phases. In addition, the maximum number of services per joint will depend on the size of the mains cable but should never exceed 4.

10.0 UNDERGROUND CABLE RATINGS

The following cables and ratings are used on UK Power Networks three distribution systems. The cable ratings have been derived from the following criteria:

	Summer	Winter
Soil Thermal Resistance	= 1.2 °C m/W	=0.9°C m/W
Ground ambient temperatures	=15 °C	=10 °C
Air ambient temperature	= 25 °C	= 25 °C
Maximum conductor temperatures	= 80°C	= 80°C

10.1. 600/1000V Polymeric insulated, Combined Neutral and Earth (CNE) cables (Waveform) with copper neutral conductor.

Conductor Area mm^2	Maximum Continuous Rating – Amps		
	Laid Direct	In Ducts	In Air
95	235	181	263
185	339	264	404
300	442	345	549

The above direct and ducted ratings are based on a single circuit installed at depth of 450mm
'In Duct' cable rating should be used where duct lengths exceed 10m. Diversity factors should NOT be applied to cables supplying off peak load.

10.2 600/1000V Polymeric Insulated Concentric Service Cable, Copper and Aluminium Conductors.

Conductor Area mm^2	Insulation (Max Temp ^{0}C)	Max Continuous Rating (Amps)		
		Laid Direct	In Duct	In Air
1 P 4Cu (PLs only)	PVC (70)	53	44	42
1 P 35 Al	XLPE (90)	150	125	130
3 P 35 Al	XLPE (90)	130	105	110

Services should be sized to meet the maximum continuous 'In Duct' cable rating required to supply the load to be connected. Diversity factors should NOT be applied to off-peak load when determining service cable rating.

10.3 600/1000V Stranded conductor XLPE Insulated Sheathed to IEC502.

Conductor Area mm^2	Maximum Continuous Rating in Amps		
	Laid Direct	In Duct	In Air
300 Al	460	460	500
400 Al	530	530	595

The ratings apply to services taken directly from the distribution board or the transformer in a sub-station.

10.4 6350/11000v Triplex XLPE Cable

Single phase Conductor Area mm^2	Insulation (Max Temperature ^0C)	Distribution Current Rating/Conductor 600mm depth of cover, g = 0.9°C m/watt, Ground / Air temp = 10°	
		Laid Direct	Laid in duct
95Al	XLPE (90)	360	238
185Al	XLPE (90)	523	354
300Al	XLPE (90)	688	463
300Cu	XLPE (90)	866	581

The conductor size of additional cables shall be at least 185mm^2 Al when directly laid or 300mm^2 Al when ducted and the rating of the new cable must match the rating of the circuit, as a minimum. 300mm^2 copper cable, as a minimum, should be laid in high load zones in city centres.

11.0 SUBSTATIONS

Substations must be sited as closely as practical to the major load centre(s) and must allow 24 hour unimpeded access. Designs incorporating substations in sub-optimal locations give rise to increased system losses for the DNO in perpetuity and will NOT be approved.
Substations in areas below ground will not generally be accepted.
UK Power Networks will require a lease or the freehold for every substation.

The choice of enclosure will be influenced by an assessment of the likely risks to arise from interference, vandalism or unauthorised access. Other security measures may also be required (E.g. choice of doors and locks). Regulations 3 and 11 of 'The Electricity Safety, Quality and Continuity Regulations 2002' refers. To avoid abortive design work and costs no work should be commenced without first carrying out a risk assessment and obtaining a detailed specification of UK Power Networks requirements.

The minimum requirement is for a GRP enclosure. Approved enclosures suppliers are listed in the Materials Specification. Enclosed brick built sub-stations are acceptable and specification will be provided on request. Fire regulations in the London area require a concrete roof construction.

11.1 EARTHING

The guidelines set out in EATS 41-24 shall be followed for all new substation sites. The HV and LV earthing systems must be designed to ensure that the maximum 'rise of potential' does not exceed 430 volts for an HV earth fault.

HV and LV earths shall not be combined unless

- The combined resistance to earth does not exceed 1 Ohm

- The normal HV supply to the site is via a continuous underground cable circuit back to the primary substation
- For primary substations designated as 'Hot' – the proposed substation is outside of the 'Hot' zone.
- The rise of potential of the earthing system as a result of an HV earth fault is likely to exceed 430 volts.

UK Power Networks will provide guidance on whether earths should be combined or separate. Special safety signs are required to be installed if earths are separate.

12.0 MULTI-OCCUPANCY DWELLINGS

For Maisonette Type Domestic Buildings – A duct must be installed and terminated into a meter cabinet at ground floor level, as described in the Installation and Records Appendix. Cabinets are to be sited so that the top of the cabinet is not more than 1.8m from the ground and the bottom of the cabinet is not less than 450m from the ground. A single-phase service is to be installed in each cabinet. Each cabinet should be sized to accommodate both a meter and time switch. The minimum space requirement is 350mm wide by 320mm high. A PME Earth terminal is to be provided with each service.

For Multiple Storey Domestic Buildings – A buried 125mm Rigi-duct is to be installed terminating in a full height cupboard with a full height door in a common access area on the ground floor of the building The cupboard will accommodate a three phase service cable terminated in a multi-way service head or a three phase service head with an approved distribution board. A PME Earth terminal is to be provided with the service. If supplying more than 4 customers the earth terminal must be connected to an earth pin. For larger buildings a central internal rising sub-main to distribution boards on each floor with Lateral connections to each dwelling may be employed.

12.1 Internal Rising and Lateral Connections

For the UK Power Networks LPN network internal Rising and Lateral Connections do not form part of the distribution network and will remain in the ownership of the property owner (UK Power Networks will not adopt).

In order for Rising and Lateral connection installations to be accepted for connection to the distribution network which is to be adopted by UK Power Networks, a safe and proper system is required. The notes below provide guidance of UK Power Networks requirements for such a system.

12.2 General Design Requirements

These general requirements are applicable to all to systems whether to be owned, operated or repaired and maintained by UK Power Networks or the property owner.

a) The main electrical intake position within the building must be sited so that the incoming underground service cable is terminated as close as possible to its entry point to the building.
b) The intake position must be in a communal part of the building exclusively set aside for the purpose and NOT in a store or bin area
c) The electrical intake position must be segregated from the gas intake and water pipes.
d) The rising and lateral connection system design and installations must be fully compliant with the requirements of both UK Power Networks and BS 7671 (the IEE Wiring Regulations).

e) Rising chases where used should be constructed of non combustible material, have an internal depth of at least 200mm, have removable covers and a fire barrier must be installed between each storey of the building.
f) Each Customer must be fed from a separate fuse. These fuses to be housed in the cut-out of the service termination or in an approved distribution board with fuseways complying with BS 1361. All fuses shall be of HRC type to BS 1361.
g) Space to be provided for both a meter and a time switch for each customer (minimum space requirement meter & time switch 350mm w x 320mm h).
h) The maximum height of any meter should be 1.8m from floor / ground level and the minimum height should be 450mm.
i) Meter tails should be less than 1m in length unless enclosed in galvanised steel trunking, high impact PVC trunking or hard drawn galvanised steel conduit.
j) Connections between distribution boards and individual domestic dwellings should have a minimum installed rating of 60 amps.
k) Both service and sub-main cables are to be of Low Smoke and Fume specification.
l) Cables can be installed in a duct, conduit, trunking or clipped to the surface at high level or in a rising chase or clipped to a cable tray. Mechanical protection and measures to prevent interference by third parties must be provided.
m) Steel Wire Armoured and MIMS connections cannot be terminated directly into the meter and should terminate in sealable connector blocks immediately adjacent to the meter. 16mm² or 25mm² copper stranded double thermoplastic insulated single core meter tails to be provided for final connection into the meter.
n) The installation should be designed to be "withdrawable" so as to facilitate repair and replacement at a later date. Cables should not be cast directly into building slab or plastered into wall screed. When cables are clipped to the surface, all clips should be positioned to be accessible at a later date. If cables are to be positioned behind false ceilings they should be accessible through removable panels.
o) All equipment is only to be installed in communal areas.
p) The minimum size for service cables is $35mm^2$.
q) Multi-way service heads are to have individual fuses labelled with each flat number (not plot numbers).
r) In the UK Power Networks LPN area Rising and Lateral connections and internal rising sub-mains must be SNE systems. Meters should be grouped at the common access intake position or installed in a suitable meter cabinet at each dwelling. However, the position of meter may limit the tariffs which can be offered to customers (pre-payment meters should be sited within the dwelling). In the LPN area cables used for unmetered rising and lateral connections must be either:-
    - Thermoplastic insulated cables run in hard drawn screwed galvanised steel or high impact PVC conduit,
    - Steel Wire Armoured cables, or
    - MIMS cables.
s) Loading on Rising and Lateral connections and internal rising sub-mains should be determined using calculations of demand determined by DEBUT. The loading is dependant upon the number of connections and the designer's estimate of annual unit consumption. Typical examples are shown in the 'Calculation of Demand section above.

12.3 Volt Drop

For electrical design purposes Internal Rising Sub-Mains will be treated as if they form part of the LV distribution network and the voltage drop from substation to any dwelling, as calculated by accepted methods, should not exceed 6%.

12.4 R&L Earthing

12.4.1 PME and Metal Conduit

Where a PME supply is provided to a building, any metal conduit or trunking forming rising or lateral accommodation shall be bonded to the building main earth terminal.

The Developer must provide bonding between the earth terminal of the incoming service cable and the water and gas mains at their points of entry into the building both at the intake position and within the individual premises. Note the position of this connection in relation to any insulated inserts in non-electric mains.

12.4.2 Earth Rods

An earth electrode system (rod or rods) should be provided for all Rising and Lateral systems where the number of customers connected to the system exceeds 4 (for the purposes of this calculation a landlord supply should be treated as a customer)

12.4.3 Lightning Conductor

A lightning conductor system for a building will be electrically isolated from all other metalwork connected to the Company's earthing terminal unless the conductor is attached to a metallic structure on top of the building on which there is electrical equipment e.g. lights, etc. in which case an earth bond will be permitted, providing that the lightning protection system has its own independent earth electrode.

Part B - Design Information to be Provided by Independent Connection Providers

The following information must be provided by ICPs for UK Power Networks to assess and agree any proposed network designs.

1.0 General Information

Site name with full postal address and postcode.
A site location map, with grid reference, outlining the site in relation to at least two streets or roads.
Site load.
Completed network, civil and electrical designs:

- Design to show cable size, cable depths and cross section along the cable routes;
- Construction drawings where a substation is required, including plant layout, earthing and the small power and lighting;
- Works being carried out by contractors for the ICP.

List of materials to be used including the UK Power Networks SAP Code.

Health and Safety Plan including the CDMC.

Legal Details.

Programme of Works

2.0 Loading Information

For all sites
Overall site Maximum Power Requirement _____ kVA

Start current of the largest lift or other motors including starter type and frequency of start & frequencies and magnitudes of the harmonic rejection currents (Thyristor soft start only). The impact of any harmonics or generation on UK Power Networks' local network.

For sites to be adopted by UK Power Networks
Detail of type and electrical loading of equipment to be connected, eg number and size of motors, cookers, showers, space and water heating arrangements including details of equipment which is subject to switching by the Supplier.

Data for calculation of demand should be determined by DEBUT program and is dependant upon the number of connections and the designer's estimate of annual unit consumption. The table below should be completed showing number of connections and estimated demand.

Type	Curve	Number of Connections	Estimated Demand
1/2 Bed Gas C/h	URLC		
3 Bed Gas C/h	URLC		
4 Bed Gas C/h	URMC		
5+ Bed Gas C/h	URHC		
1/2 Bed Other C/h	ESEVEN		

3 Bed Other C/h	ESEVEN		
4 Bed Other C/h	ESEVEN		
5+ Bed Other C/h	ESEVEN		
E7 1 Heater / W/h	ESEVEN		
E7 2 Heater / W/h	ESEVEN		
E7 3 Heater / W/h	ESEVEN		
E7 4 Heater / W/h	ESEVEN		
15kW Boiler	ESEVEN		
19kW Boiler	ESEVEN		
Retail/Office/Industrial/Other Commercial			
Totals			

For each distribution transformer –

Capacity	Number of customers connected	Estimated MD

For each LV distribution cable – Number of Customers and connections on each phase

Phase	R	Y	B
No. Customers	___	___	___
No. Connections	___	___	___

Maximum feeder load per phase in Amps ____ Amps

Generation (where applicable), for each LV distribution cable
Number of generators connected _____
Export capacity per generator _____
Starting characteristics _____
Contribution to LV fault level per generator _____

3.0 Voltage Regulation (For sites to be adopted by UK Power Networks)
For each LV distribution cable –
Maximum voltage regulation from LV busbars of HV/LV s/s to end of main ___ %

4.0 Maximum Earth Loop Resistance (For sites to be adopted by UK Power Networks)
For each service/feeder -
Maximum earth loop resistance at cutout position/feeder end ___ Ohms

5.0 Fuse Selection/Clearance Time (For sites to be adopted by UK Power Networks)
For each LV distribution cable with phase to earth fault at the remote end –
Maximum clearance time ___ Sec
For each LV distribution cable with phase to phase fault at the remote end –
Maximum clearance time ___ Sec

Fuse size selected ___ Amps

6.0 Earthing, Fuse selection & Prospective Short Circuit Current (For sites to be adopted by UK Power Networks)

For each service –

Cutout fuse size selected	___ Amps
Service earthing (PME, SNE)	___
Maximum design PSCCs at connection of service to main	
1ph 230v	___ kA
3ph 230/400v	___ kA
2ph 230/460v	___ kA

Design PSCC at LV busbars of HV/LV transformer ___ kA

7.0 Substations

7.1 A substation construction drawing showing detail of transformer plinth, foundation, duct entry, ventilation, earthing, power and lighting and access arrangements.
Plant with manufacturer and SAP code

8.0 Cable layout and Information

A 1:500 site layout overlaid with the proposed main and service cable design. The drawing should indicate cable size and type of main and service cable, and the location and size/type of ducts to be used, location and rating of substations and location of link boxes. In addition highway/footway to be adopted by local authority should also be clearly indicated.

A single line operational diagram.

9.0 Rising and Lateral Mains Systems (For sites to be adopted by UK Power Networks)

R&L systems will not be adopted by LPN. Where LPN agrees a contract to operate and maintain R&L systems additional information about loading, voltage regulation, fuse size/clearance times, earth lop impedance and cable type/specification for the R&L system will be required in similar format to the above.

10.0 Quality of supply implications of the network extension

Detail of overall impact on the quality of supply.

11.0 Legal Agreements

Name and contact details of the land owner
Local authority area
Name and contact details of the Solicitor or agent acting for the land owner.
Rights to be granted
Legal Drawings and Draft Legal Agreements – Substation Lease, Cable Easement drawings and draft legal agreements

12.0 Unmetered Supplies (For sites to be adopted by UK Power Networks)

Classes and max demands per BSCP 520.