The Distribution System Security and Planning Standards

(Demand customers only)

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Distribution System Operator
ESB Networks

Contents

1.0 Introduction

The Distribution System Operator (DSO) licence requires ESB as licensee to:

' operate and ensure the maintenance of and develop, as necessary, a safe, secure, reliable, economical and efficient electricity distribution system…'

To this end, condition 11 calls for DSO to prepare this document: "The Distribution System Security and Planning Standards". The Security and Planning Standards are prepared in adherence to the Distribution Code, which specifies the relationship between the Grid and Distribution Codes.

This document outlines the DSO's approach to the development of network. The document gives details of how we assess the connection of new loads and embedded generators to the Distribution System. It is intended as a guide to Users of the Distribution System and is referred to in the Distribution Code (Item 13). While this guide refers to customers' loads the same factors will apply, in general, to generators also. There are however, some specific requirements relating to generators and these are included under a separate heading. (Section 5)

1.1 Definitions

In general the terms used in this document have the meanings intended in the Distribution Code. As a brief guide, the terms used in this document are defined below:

Term	Definition
Connection Asset	The network erected to connect the connection point to the existing Distribution System. The connection asset forms part of the Distribution System and is not shared by other users.
Continuity or Continuity of Supply	This describes the quality of a supply as it relates to outages, whether caused by faults or planned work. A set of measures are required to describe continuity but, in general, the lower the incidence of outages and the shorter their duration, the higher the continuity.
Distribution System	The electric lines, plant and switch-gear used to convey electricity to final customers (excluding customers connected directly to the transmission system (grid)).
Disturbing Load	An electrical load that of its nature may affect the quality of electricity supply of other customers. Examples are welders, large electric motors etc. (See Appendix 1)

Term	Definition
Diversity	The ratio of actual peak loading in a customer's premises to the sum of all the individual load ratings connected within the premises.
Dual Radial Supply	A Dual Radial Supply is a supply method that can occasionally be used to supply loads of over 8MVA from a nearby 110/MV station. It consists of two MV circuits from opposite sides of the MV busbar in the 110/MV station to the customers CB's. The NO point is located on the customers MV busbar. ESB Metering and switchgear is situated in the ESB MV switchroom before the customers CB's.
Flicker	Voltage fluctuations, caused by a disturbing load (or rapid variations in generator output), the major effect of which is flickering of standard (incandescent) light bulbs.
Full Standby	Full standby is the standard of supply such that – for an outage of the normal Circuit to a customer – the full load can be fed from an alternative source at the same voltage. It does not take into account the level of standby available at higher voltage levels.
Looped Connection	A looped connection is one where there are two connections in to the customer from a main circuit which can be fed from either end. In the event of a fault on either connection the customer should only be without supply for the switching time necessary to restore supply. A looped connection may be from a main circuit which has either full or partial standby. In a non-looped supply a fault on the customer connection would result in loss of supply until the connection was repaired.
Losses	Electrical losses account for the difference between the power entering the distribution system and that delivered to customers. Losses can be regarded as the energy lost in the network due to the heating effect of the electricity passing through it.
Maximum Import Capacity	This is the maximum load which the customer has contracted with ESB. If the customer load exceeds their MIC then they are not guaranteed a supply within the quality of supply standards.
Normal Feeding	The network configuration under normal conditions and when all distribution plant is in service. The normal feeding arrangement is typically designed to provide best voltage performance, to minimise network losses and to make optimum use of the capacity of feeding substations is also a factor
Partial Standby	Partial standby is where standby may be available under certain fault conditions, but will not be available for all faults.

Term	Definition
Security of Connection	The expectation that the connection point will remain energised.
Short Circuit Level	The short circuit level is a measure of the 'strength' of the network i.e. the ability to limit the impact of disturbing loads and to maintain voltage stability. The size of the customer switched load relative to the short circuit level determines whether the voltage quality will be maintained within standard.
Short Circuit Rating	This refers to the Short Circuit Rating of the item of plant concerned.
Standby Feeding	The feeding arrangement when one or more items of network plant is out of service. The exact feeding arrangement will depends on which items are out of service. As standby feeding is a temporary arrangement, different standards of voltage apply.
Terminal Substation	A standard structure owned and operated by the DSO containing the distribution equipment necessary to connect a customer to the distribution system. Terminal substations are operated at the connection voltage of the customer i.e. transformation is not required.
Transformer Substation	A standard structure owned and operated by the DSO containing one or more transformers, to convert electricity at one standard distribution voltage to a lower standard voltage.

1.2 Aim of Planning

The aim of planning is to ensure that the Distribution System is developed in an orderly and cost effective manner.It is necessary to ensure that there is capacity available to meet new loads as they arise, and to meet ongoing growth requirements. It is also necessary to ensure that new connections are made:

- in an economic fashion
- with a view to the possible future needs of the customer and the network
- in a way that is technically acceptable.

In general the MV and HV three phase backbone networks are planned to a single contingency standard. This means that the system is designed to withstand a single contingency, and any outages experienced for this single contingency are only for such time as is required to transfer load from faulted plant. In summary, ESB will provide customer connections, which will deliver the required capacity to an acceptable standard as detailed in the Distribution Code and will comply with the Grid Code at all points of connection to the Transmission System A higher standard of installation or a higher security of connection arrangement can be provided at the customer's request, however the full additional costs will be attributed to the customer.

2.0 Distribution System

The standard configuration of the Distribution System is illustrated schematically in Figure 1 below.

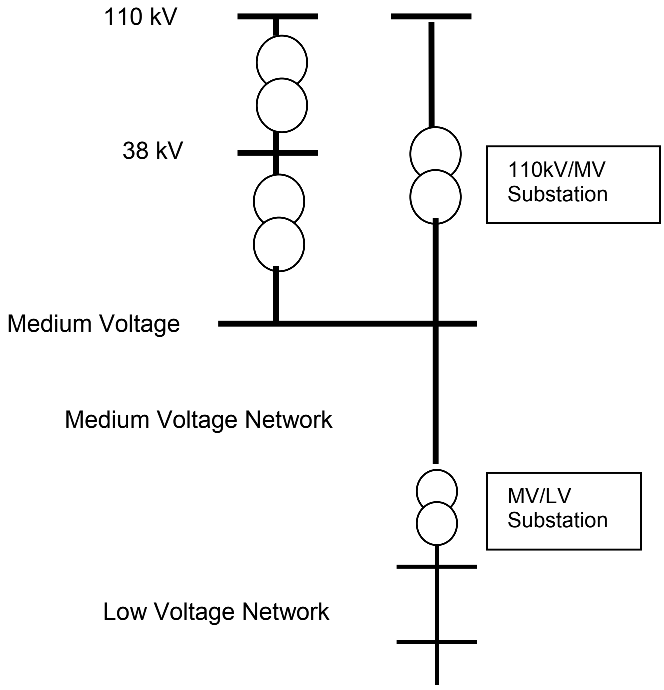

Figure 1. Representation of the Distribution System

2.1 Voltage Levels

There are a number of standard voltages in use on the Distribution System and customers will be connected at one of these levels. Voltage Levels at which a connection can be provided are as follows:

Voltage Level	Nominal Voltage
Low Voltage (LV)	230V (single phase)
	400V (3 phase)
Medium Voltage (MV)	10kV
	20kV
High Voltage (HV)	38kV
	110kV[1]

Table 1

[1] While certain 110kV stations and lines (mainly in the Dublin Region) are part of the Distribution System, the 110kV system is primarily a Transmission voltage and connections at this voltage level will normally be dealt with by the Transmission System Operator (TSO). Tailed 110kV substations are deemed to be sub-transmission. However it is likely that – in time – such stations will be looped and typically become part of the Transmission network. Where this is the case, network will be developed in accordance with Transmission Standards, or developed in such a way as to allow these standards to be easily met in the future.

ESB is currently in the process of upgrading its medium voltage Distribution networks. This involves converting the more heavily loaded rural overhead 10kV networks to 20kV operation and feeding directly from the 110kV networks i.e. 110kV/MV stations. Thus future developments are likely to be 110kV/MV rather than 38kV/MV. This will provide improved voltage performance and greater voltage stability. While large customers may be offered a 38kV connection depending on location and other factors the trend will be towards connection at MV voltage ranges where there is a concentration of small to medium sized load close to a 110/MV station e.g. in a business park in a large city.

Generally the voltage level at which customer connection will be made is dependent on the load range. The typical voltage level for various load ranges is shown below.

Load Range	Typical Voltage Level
Up to 200kVA	LV
Up to 500kVA	LV[2], MV
500kVA to 5MVA	MV[3],
5MVA – 15MVA	MV[3], 38kV[4], 110kV[5]
>15MVA	110kV

Table 2

2.2 Effects of Disturbing Loads

Certain types of equipment such as motors and welders may cause fluctuations in the supply voltage, which cause disturbances to the connection of other customers. Where customers intend to install any equipment likely to cause supply disturbances, this equipment must be evaluated to assess the likely impact. The limits imposed on disturbing loads are specified in the Distribution Code. It may be necessary, depending on the characteristics of the equipment, for a customer connection to be made using a different network configuration via a higher voltage, a dedicated substation or other method.

[2] In some cases an LV MIC increase >500kVA and <900kVA may be possible.
[3] At MV the capacity available from an existing 38kV station will generally be limited by the 38kV circuit capacity on standby and by capacity available following outage of one transformer in the station, allowing for planned requirements. so that at best no more than 5MVA would typically be available. In 110/MV stations capacity available is again determined by 110kV circuit capacity, by capacity available following a transformer outage and by planned capacity requirements. Feeding higher loads at MV assumes a 110/MV station nearby, typically in a business park. No single MV customer should exceed 12MVA.
Individual customer loads not in the vicinity of a 110/MV station would be fed at 38kV or 110kV
[4] If this is the most technically feasible solution e.g if redundancy or over-capacity exists, or if the 38kV network can be more appropriately developed to feed the load. Usually feeding high loads at 38kV requires that the load is close to a 110/38kV station and can be fed from a dedicated feeder or looped into a 40MVA circuit which has adequate spare capacity.
[5] If this is the most technically feasible solution e.g if redundancy or over-capacity exists, or if the 110kV network can be more appropriately developed to feed the load.

3.0 Assessment of New Load

The assessment of the connection for a new load requires details of the load. The details should be provided by completing an application form as in ESB Guide to the Process for Connection to ESB's Distribution System (see www.esb.ie)

3.1 Information Required from Customers

Details of the information required from demand customers and generators seeking connections or extensions to the Distribution System are provided in the Distribution Code. Application forms for connection are available from ESB offices, and are on the ESB website. Specifically the following information may be requested, depending on the nature of the load.

3.1.1 Geographical location

Site location maps and site layout plans in order to determine the location of the proposed load in relation to the existing network.

3.1.2 Maximum Import Capacity (MIC)

Maximum Import Capacity (MIC) required, the size and nature of the load, diversity of the load and proposed phasing of the development i.e. the pace at which the load is expected to ramp up to full demand.

3.1.3 Disturbing Loads

Details of any disturbing elements of the load are required such as:

- Large motors - details of starting arrangements for all large motor.
- Disturbing Loads i.e. electric welding, and details of the nature and usage pattern of the disturbing load.
- Harmonics - details of any non-linear equipment likely to produce harmonics on our system and any filtering arrangements which the customer may have already in place. The customer should also provide details of compensation or balancing equipment connected.
- Unbalanced Loads – Where a customer has a three phase supply, load should be balanced as evenly as possible over the three phases.

  The above is an example of the information which may be requested. Depending of the size and complexity of the load, additional information may also be requested.

- Power Factor – The power factor of the customers load as seen by the network should be between 0.95 and unity.

Examples of disturbing loads are given in Appendix 1.

3.1.4 Multiple customer development versus Single Load

Whether the application is for infrastructure to facilitate connections to multiple end customers within a development or is for connection of a single customer.

3.1.5 Specific Requirements

Details of any specific customer requirements for connection of the load.

3.1.6 Diversity

Customers should note when assessing the Capacity requirements that not all of the equipment will be operating at full load at the same time. The customer should apply a diversity factor to each component of the load, as well as to the overall load in order to assess the capacity required. Diversity factors will vary depending on the nature of the load.

3.1.7 Domestic Customers

With regard to Domestic customers we typically plan for a load of 12kVA. Domestic customers can be part of a housing scheme, or can be non-scheme. A housing scheme is defined in ' ***Charges for the Connection to the Distribution System'.***

3.2 Requirements for a Terminal Station Building

A Customer or Developer should check at the earliest stage of project design regarding a requirement for the provision of a Terminal Station Building / Site for the development.

Please refer to ESB Guide to the Process for Connection to ESB's Distribution System for contact details.

3.2.1 Requirement for a HV Terminal Station.

Where the connection voltage is determined to be at 38kV or 110kV then a HV Terminal Station to comply with the appropriate standard ESB Substation Building Specification for 38kV or 110kV supply is required in all cases. The terminal station may be either indoor or outdoor based on the least cost technically acceptable solution. Typically substations being developed in urban areas and town centres will be indoor, whereas those in more rural locations will be outdoor.

3.2.2 Requirements for a HV/MV Transformer Station

In some cases where a customer is supplied at MV, but this load cannot be met by the existing MV network, a HV/MV terminal station may be required. The general guidelines and site requirements for a Terminal Station Building under these circumstances are shown on Table 3.

Maximum Import Capacity (MIC)	Customer requirement for the provision of a Substation Building
> (Greater than or equal to)5MVA	HV/MV Terminal Station will probably be required for loads greater than this level.
<5MVA	A HV/MV Transformer Station may be required where this is the least cost technically acceptable solution based on : • The MIC (MVA) of the proposed load. • Disturbing elements of customer load • The distance from the existing substations to the proposed load. • Any spare capacity above planned requirements available on existing substations and on the local MV network. • The Customer's future expansion plans

Table 3

3.2.3 Requirements for a MV Terminal Station.

MV connected customers are required to provide an MV Terminal Station Building to comply with the standard ESB NETWORKS' *Substation Building Specification* in all cases.

3.2.4 Requirements for a MV/LV Transformer Station.

The general guidelines for a Transformer Station Building requirements when a customer connected at LV needs a new MV/LV Transformer Station are shown on the attached table.

Maximum Import Capacity (MIC)	Customer requirement for the provision of a Transformer Station Building
> (Greater than or equal to) 200kVA	Customer / Developer to provide a Transformer Station Building free of charge to ESB in all cases. See section 5.2.3 of the "Charges for Connection to the Distribution System".
Urban Areas <200kVA	In certain cases for loads less than 200kVAin Urban Areas a Transformer Station building is required where this is the least cost technically acceptable solution based on: • The MIC (kVA) of the proposed load. • The distance from existing substations to the proposed load. • Any spare capacity above planned requirements available on existing substations and on the local LV networks. • The Customer's future expansion plans.
Rural Areas <200kVA	Supply from a pole mounted transformer (up to 200kVA) is the norm. Where future expansion is envisaged that would raise the proposed MIC above 200kVA a Transformer Station building will be required.

Table 4

4.0 Determining the Least cost Technically Acceptable Solution.

The Least Cost Technically Acceptable Solution is defined as the solution which is technically acceptable and which results in the least cost being incurred by the DSO in implementing the solution and which facilitates the long term development of the electricity network in the area. The following factors are used by ESB Networks to determine the method of connection and the Least Cost Technically Acceptable Solution for any particular case. Any costs incurred by the ESB Networks in providing a connection or installing infrastructure which are deemed by ESB Networks to be over and above the Least Cost Technically Acceptable solution are borne in full by the customer or developer.

The following factors are taken into account when determining the method of connection and the Least Cost Technically Acceptable solution in the context of the development of the area.

4.1 Location of Optimal Substation site

Selection of a suitable site for the substation to be developed by DSO, will depend on the location of the load to be fed, the location of the network to be used to feed the station, and other geographical factors.

The following items might typically be considered when assessing a site:

1. Will the station be accessible for potential future connections?
2. Where possible, avoid the need for road/water crossings to feed load
3. Stations located at site boundaries are generally more suitable
4. Typically site locations close to a public road, which limit the need for excessive intrusion on customer or third party land, would be best
5. Station should be at ground level with good access for equipment and personnel, should have suitable routes in the ground for cable entries and should not be liable to flooding. Access for communications cables should also to be catered for.
6. Finally the structural finish required on the station must take account of the area in which the station is being built. For examples, a higher standard would typically be required in a residential/commercial area rather than an industrial estate.

The above give some guidelines which may be used in selecting the best site for a station. However each situation must be assessed individually before choosing the best site location.

The specific criteria, which are used to determine the Least Cost Technically Acceptable Solution in the context of a Business Park or Town Centre, are outlined in Appendix 2.

4.2 Location of Load

The position of the load relative to a **suitable** network will be a significant factor in determining the connection method. The load may be close to the network but this does not necessarily mean that a connection can be made at this point. Connections can only be made from that part of the network which has adequate capacity to feed the new load, taking into account the impact of existing and other proposed loads.

In general the least cost technically acceptable method of connection is to the adjoining network but there are several factors, which may necessitate an alternative connection e.g.

- The adjoining network may not be at the appropriate voltage level or it may not have the necessary capacity.
- System requirements for the adjoining network may mean there is not sufficient spare capacity to feed the new load.
- The capacity of the networks at the same voltage may vary considerably from one location to another. In urban areas, for example, it may be possible to connect a load at a lower voltage than would be the case in rural areas.

4.3 Network Examination

On deciding on the method of connection it must first be established that the existing network has adequate capacity to feed the additional load. If this is not the case then it is necessary to upgrade the network or construct additional network to connect the load.

Networks are assessed to determine:

- Voltage levels
- Line/cable loading under normal feeding and standby feeding conditions.
- Station loading under normal and standby feeding conditions
- Short circuit capacities on the networks in question

Expected circuit loading is calculated for both Winter and Summer loading conditions. The network capacity limits are specified for two conditions of ambient temperature[6] to correspond to Winter and Summer conditions. In addition, any new load in excess of a given threshold[7]must be assessed by the TSO to determine the impact on the Transmission System.

The planning and design of the network does not allow any plant and network to loaded beyond its normal rating, as specified by the manufacturer, except in emergency situations designated by the DSO.

4.4 Short Circuit Capacity

[6] Weather conditions are: ambient temperature 5°or 25°, 2MPH cross wind, full sun radiation.

[7] The threshold at present is 4MVA unless otherwise requested by the TSO for specific locations.

The design short circuit capacities for various connection voltages are provided in section DCC6.5.1 of the Distribution Code.

The short circuit rating of Customers' equipment should not be less than the design capacities given in section DCC6.5.1 of the Distribution Code. It should be noted however, that the actual short circuit level at the connection point may differ from the design level.

4.5 Voltage Drop

One of the factors limiting the connection of new load to a network is the level of voltage drop incurred in carrying the current from the substation to the customer's premises. This is particularly true of rural networks where the length of network involved is often large. Section DPC4.2.2 of the Distribution Code outlines ESB's responsibilities in relation to voltage ranges and the international standard EN50160.

The voltage ranges at the ESB Networks' Substation busbars using these design standards will be as follows:

Voltage at Busbar.					
	LV	10kV	20kV	38kV	110kV[8]
Normal Feed	207V to 244V single phase; 360V to 424V Three phase.	=<10.75kV	=<21.50kV	=<41.35kV	=<120kV

Table 6

The above voltages are part of the criteria to which the network is planned. Operational conditions may mean that the voltage varies from these values.

If the voltage drop is outside standard then:

- an alternative method of connection will be required; or
- a voltage injection from a new substation should be considered; or
- a voltage regulator may be used to boost the voltage (at 38kV or MV) when high loads cause excessive voltage drop on a feeder.

4.6 Substation Capacity

Having established that the capacity of the network is sufficient the capacity of the substation feeding this network must be considered. Where the substation capacity is not adequate to take the additional load either it must be upgraded, an alternative substation must be used or a new one constructed.

4.7 Other Reinforcements

[8] 110kV mentioned excludes 110kV network under TSO control.

The addition of a new load at one voltage may result in reinforcement being carried out at the voltage level above. This could occur, for example, where a line or substation is nearing its capacity and the addition of the new load requires this to be increased. In some cases the reinforcement may not be required immediately but may have to be done sooner than previously planned as a result on the new load being connected.

For larger loads [7] Transmission Reinforcement may also be required and this would be specified by the TSO.

4.8 Network Configuration (how the load is connected)

Major loads are connected to the system through ESB Networks substations on the customers' premises.

- The connection may be looped in which case two connecting lines/cables (normal and standby) are provided at the same voltage from a main circuit which can be fed from either end. The main circuit is operated normally open at a suitable point on the circuit or in the case of some 38kV network the loop may be operated normally closed.
- For loads of more than 8MVA fed at MV from a nearby 110/MV station a Dual Radial connection may be used if appropriate to the network configuration..
- The connection may be tail fed from a cubicle in a distribution station or
- The connection may be teed from the distribution network. In the case of teed connections the following criteria are used:
    - At 110kV no tees are allowed and connection is either by a tail feed from an existing station, a looped feed from the 110kV line or from a new 110kV switching station at the branch point.
    - At 38kV a tee is allowed on the circuit between two protected 38kV outlets provided that
    - (a) it is the only tee on the circuit
    - (b) the teed connection point is more than 2km from the adjoining 38kV station
    - (c) the load/generator being connected is not closer to the adjoining 38kV station than to the 38kV line
    - (d)protection is not compromised and the operational flexibility of the 38kV network can be preserved through additional measures which are economic and technically acceptable e.g. the installation of upgraded protection.

In cases where a teed connection is permitted the tee point shall be equipped with switches on each line segment.

In all other cases connection will be by a tail feed from the adjoining 38kV station or a looped connection from the 38kV circuit.

Except in exceptional circumstances, point loads greater than 1MVA will be looped and the main circuit designed to provide full standby. (See below re Security of Connection.)

There is no standby connection for Tail and Teed arrangements. They may be used in cases where it is uneconomic to provide a looped connection but continuity limitations must be quantified by ESB Networks and accepted in writing by the customer.

4.9 Treatment of Electrical Losses.

Electrical losses on the network impose a significant cost – both financial and environmental - and must be managed. Therefore losses are taken into account in determining the optimum connection method. For MV and HV circuits losses are calculated for three phase only as single phase losses are small in comparison. Losses are proportional to

$$\mathbf{I^2\ R}$$

where '**I**' is the peak load in amps on the section of line concerned and '**R**' is the DC resistance at 20°C of the conductor or equivalent conductor on that section in ohms per km per conductor.

It can be seen that if the line is heavily loaded then a small load increase will dramatically increase the cost of losses.

The setting of overall design parameters for the network takes account of the economic loading of conductors so that the long-term effect of losses is minimised.

4.10 Economic Analysis.

A number of options may be available to provide new or increased capacity to a customer. In evaluating the cost/savings involved in each option, the time at which these will be incurred is relevant. Therefore, to compare different options economically all cash flows are evaluated in terms of the current value of money. All future cash flows are converted to present value by discounting. The time span of the analysis should extend to the point when options have attained equivalent stages of development. This does not always happen and depending on the project a time span of up to 20 years may be considered.

The main costs to be included in the analysis are:

- Gross cost of networks and stations and reinforcements;
- Retirements – (Present Stores Value minus the cost of dismantling);
- Losses;
- Continuity (e.g. value on Customer Minutes Lost, and how the project might affect continuity);
- Relevant transmission costs – to be advised by the TSO.

In assessing the various options the detailed planning criteria must be considered. Thus factors such as network configuration, operation and protection policy on looped and radial circuits and limitations on station types (looped, tail, or teed) are addressed.

The cost of the feeding arrangement to provide the capacity required will be the most economic solution based on the above calculations.

The principles of the charges for connection are contained in the "Charges for Connection to the Distribution System".

4.11 Protection Information

Protection systems and devices are provided for ESB Networks system and plant. Typically they cause plant to be switched out to protect ESB Networks system, staff and customers in the event of a fault on the system. How they operate will depend on their location on the system and the plant they are installed to protect. ESB Networks' plan for network development including protection in order to minimise the extent and duration of any fault-related outage, damage to plant and duration of voltage dips to a reasonable level. Some protection schemes used are as follows:

Impedance (distance) protection

This operates by determining the impedance of a fault back to source, and tripping the faulted feeder to clear a fault. Impedance protection is generally installed on 110kV feeders, 38kV feeders ex 110kV stations, on 38kV feeders in loops or meshes and on some feeders on open radial networks.

Differential Protection

This operates by determining the difference in current between the two ends of a feeder. It is installed on 110kV busbars, power transformers and on HV feeders when the impedance of the feeder is too low for impedance protection to be effective. The latter includes cable networks and very short overhead lines

Earth Fault Protection

This is provided in many variations depending on the way the system neutral is treated. This form of protection can be wattmetric or transient (38kV), directional comparison (110kV), residual overcurrent (110kV, MV) or directional residual overcurrent (MV).

Protection on MV networks

Phase overcurrent protection is provided on 38kV/MV station MV feeders to protect against phase faults.This can be by relays and circuit breakers, reclosers or expulsion/current limiting fuses

Reclosing is provided on long MV feeders. This ensures that – where a fault is transient (e.g. a falling branch) – supply interruption will be very short. Customer processes in such locations should be designed to tolerate recloser operation e.g. self-priming pumps, use of ups, ride through facility etc.

A number of additional schemes are in use across the ESB system. These include permissive intertrip schemes, rudimentary busbar protection schemes, circuit breaker fail schemes and parameter changeover logic.

LV Protection
This is comprehensively covered in ESB's National Code of Practice for Customer Interface.

The above are some of the protection schemes in use by ESB Networks. The protection required on the network in any given location is assessed and designed to suit the particular circumstance while complying with ESB Networks' policy and practice.

5.0 Specific Requirements for Generators.

In addition to the aspects considered above there are some factors which apply specifically to Generators connecting to the Distribution system. Details of Embedded Generator Requirements are specified in the Distribution Code. Please refer to ESB Networks' Guide to the Process for Connection to ESB Networks' Distribution System for the Generator Application Form.

Also all generators greater than a given threshold [7]are also referred to the TSO to determine their impact on the transmission system.

5.1 Voltage Rise

When a generator is connected to the Distribution system the voltage at the point on the Distribution network will rise above its 'normal' level. In order to keep the voltage within standard for other customers connected to this network it is necessary to limit the level of this voltage rise. Depending on the size of the generator and the short- circuit level on the network this will often require a dedicated connection to be made to a substation.

5.2 Flicker

While flicker is an issue, which is considered in assessing new loads, it is a particularly important issue for generators as the output from certain generators can vary rapidly. This can translate into voltage fluctuations, the major effect of which is flickering of standard light bulbs. All generators are evaluated to assess the likelihood of this and, depending on the characteristics of the equipment, a connection to a stronger point on the network may be necessary.

Similarly, should a fault cause the generator to be disconnected from the Networks System, then the resulting voltage variation must be within acceptable limits.

5.2 Harmonics

Some generators produce harmonics which can distort the connection voltage to such an extent that electrical equipment may not operate correctly.

Generators are assessed to determine the likelihood of this and in certain cases an alternative connection method may be required.

5.3 Network Protection

Protection on the distribution system is designed to isolate faults automatically so that the minimum number of customers is disconnected for the shortest possible time necessary to clear the fault. The correct operation of these devices must take into account the presence of generation. To ensure that the security of connection of existing customers is not adversely affected by the introduction of generation it may be necessary to install additional or upgrade existing protection devices.

Details of the permitted emission limits and the protection requirements are detailed in the Distribution Code.

6.0 System Planning Issues

Some more general issues which are considered as part of planning for the whole system are as follows:

6.1 Security of Connection

Security of Connection is an important consideration in the planning of the Distribution System. ESB Networks are planned on the basis of maintaining a level of supply reliability which meets the needs of the majority of customers. However ESB Networks, in common with other power utilities, do not guarantee standby supply being available in all circumstances. Accordingly customers with critical loads should ensure that alternative supplies (e.g. generators, UPS systems) are available if their process is critical.

It should be noted that the Security of Connection is not only dependent on the Distribution connection methodology but also on the Transmission System Security and Planning Standards.

Policies relating to security of connection include the following:

- Under normal feed conditions, protection/automatic switching arrangements shall be such that a single fault will not result in loss of supply to a 38kV line length /station load product of greater than 200MW kms;
- Under normal or standby feeding conditions protection/automatic switching arrangements shall be such that a single fault will not isolate more than two looped HV/MV stations;
- Except under exceptional circumstances a tail fed 38kV station with a normal load in excess of 5MVA shall be looped unless full standby is available at MV. Exceptional circumstances might include excessive line lengths required to loop a station and physical difficulties in obtaining a suitable route. Alternatively, MV standby to the 38kV station may be adequate, thereby deferring the need for a 38kV standby.

- The minimum re-energisation standard of connection to loads in excess of 15MVA shall be such that the connection may be re-energised automatically within 10 seconds for a single fault;
- Except in exceptional circumstances, standby will be available for single point loads greater than or equal to 1MVA provided they are on a looped connection.

6.2 Continuity

The nature of continuity and how it is measured is such that the following are system standards, and are not applicable to a particular customer.

Continuity performance standards distinguish between customers connected from:

- Urban distribution networks;
- Rural systems

and also distinguish between outages that arise due to faults or voluntary switching. The continuity targets to be reached by 2005 and agreed with CER are as follows:

Network	Customer Minutes Lost (CML)
Urban	50
Rural	350
Overall Network	275

Table 7

These values are average annual targets. They do not represent the maximum duration that may be experienced by a single customer, but rather the average outage duration over our total customer base. Major work programmes are being undertaken at present to improve continuity performance, with a view to meeting targets agreed with the CER.

When a fault occurs ESB-Networks will endeavour to re-energise customer connections as soon as practicable. The target restoration time when manual re-energisation is necessary is that 95% of fault outages would be restored within 4 hours.

Appendix 1: Examples of Disturbing Loads

Table 8.1: Examples of Disturbing Loads

No.	Load Type	Impact	Factors	Mitigation
1.	**Welders**	Flicker	Number and Rating	Restriction on Operation Reinforced Network Connection
			Usage Pattern	
			Welder Type	
2.	**Large Motor or Generator**	Flicker	Rating (kVA)	Restriction on starts per day Reinforced Network Connection
			Machine characteristics	
			Starting arrangements	
3.	**Rectifiers & Inverters**	Harmonics	Control method (e.g. 6 or 12 pulse)	Harmonic Filter Reinforced Network Connection
			Filtering Arrangements	

Appendix 2: LCTAS in the context of a Business Park or Town Centre

When a new HV station is required to provide connections to customers in a Business Park, Town Centre or other large Residential/ Commercial Development (a “Business Park”), the Least Cost Technically Acceptable connection method for the development will be determined by considering the following questions in conjunction with the various criteria outlined in sections 4.1 to 4.10 of this document:

What is the Site Cost?

ESB will seek to purchase a suitable site from the developer of the Business Park and will make a payment to the developer in return for the transfer of the freehold interest in the substation site with suitable right of way access and a suitable access roadway to a public road.

The amount to be paid will relate to the value of the substation site at the time of the earliest (definitive) grant of full planning permission for the development. The amount will be finally negotiated to the agreement of both parties on receipt of full planning permission for the substation. It is intended that the payment will equate to the typical value of such land in or near the location of the development and would be arrived at using best industry practice.

Where the ESB Networks is required to pay the developer a price for the site which is in excess of the value as determined in the above manner, or where the ESB Networks is required to buy a site outside of the development at a price in excess of the value as determined in the above manner, then the ESB Networks will recoup these additional costs in full from the developer.

<u>What Type of Substation will be Built?</u>

There are three alternative HV substation types:

- Outdoor station with AIS switchgear.
- Indoor single-storey station with GIS switchgear.
- Indoor multi-storey station with GIS switchgear.

In general indoor GIS stations can be built on smaller sites than outdoor AIS stations. ESB Networks defines the Least Cost Technically Acceptable substation type in any particular situation by estimating the overall development costs including the site cost. Where the substation type which is being built is other than the Least Cost Technically Solution substation type as identified by this process, then ESB Networks will determine the additional cost which it will incur and will recoup these costs in full from the developer.

What is the Condition of the Site?

ESB Networks defines the Least Cost Technically Acceptable site conditions as good level open ground with unimpeded access. Where the site conditions are other than these then ESB Networks will determine the additional cost which it will incur in developing a substation at the site and will recoup these additional costs in full from the developer.

What is the Location of the Site?

ESB Networks defines the Least Cost Technically Acceptable site location as being near the centre of the development within easy reach of all of the new customers in order to minimise the cable runs required to provide connections, and which facilitates the long term development of the networks in the area. Where the site location is other than this then ESB Networks will determine the additional cost which it will incur in developing a substation at the site and will recoup these additional costs in full from the developer. These will include the additional costs which ESB Networks will incur in extending its networks to other customers outside the confines of the Business Park from this sub-optimally located station.

Does the Developer Have Any Special Requests?

Where the developer makes any special requests of ESB Networks, which ESB Networks agrees to accede to then ESB Networks will determine the cost of these special requests and will recoup these costs in full from the developer.

Are there any other Factors to be Considered?

Where an issue arises during either the design or construction of the substation which has not been explicitly detailed above and which requires ESB to pursue a course of action involving expenditure which is demonstrably over and above the Least Cost Technically Acceptable, then ESB Networks will recoup these costs in full from the developer.