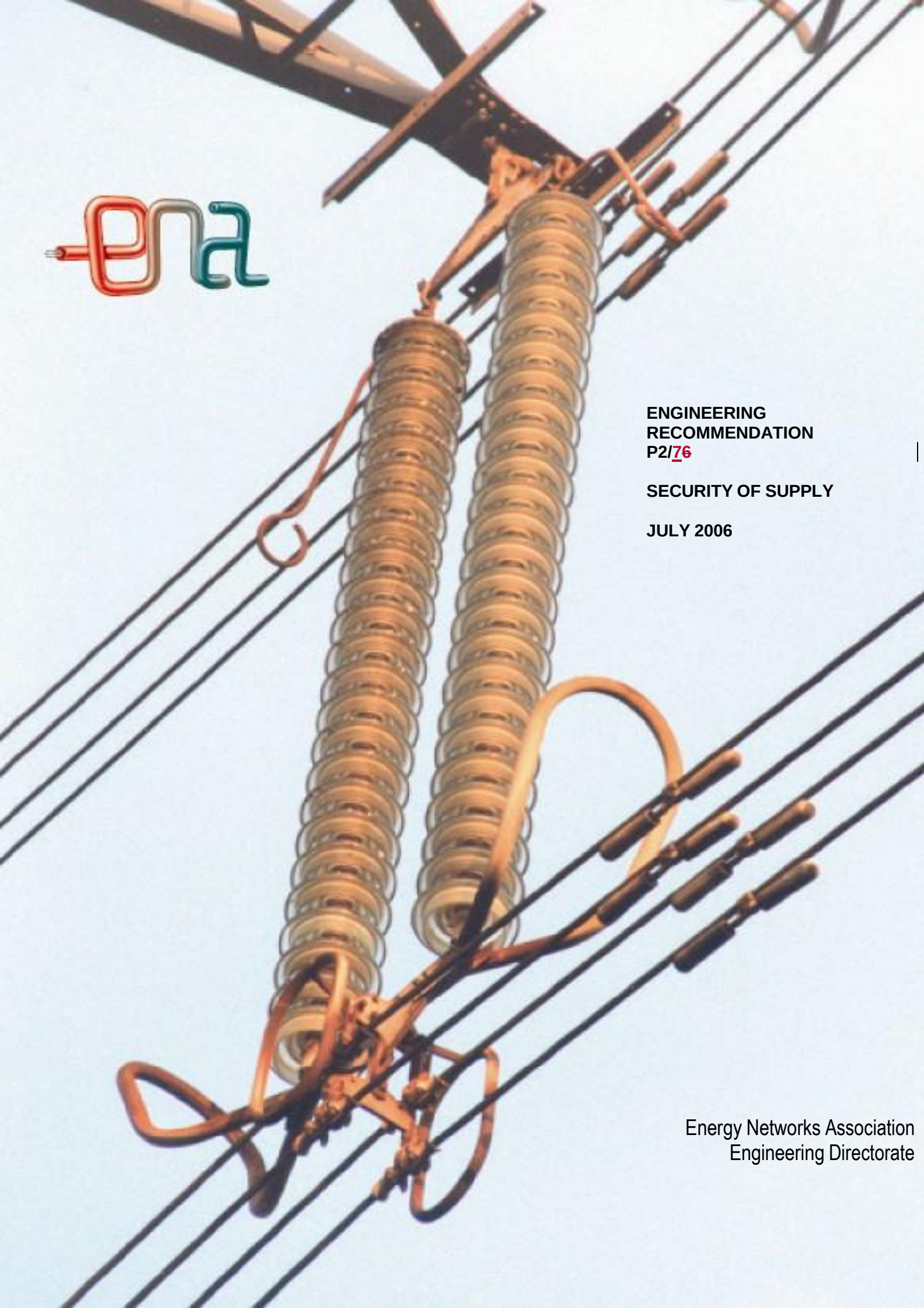

ENGINEERING RECOMMENDATION P2/7~~6~~

SECURITY OF SUPPLY

JULY 2006

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SECURITY OF SUPPLY

~~1~~ INTRODUCTION

This Engineering Recommendation is a revision of Engineering Recommendation P2/~~6~~5 (ER P2/~~6~~5) issued in 2006~~1978~~, which it supersedes. It is intended as a guide to system planning. Issue 7 of this document has been written to recognise the changes to the load and generation connected to distribution networks since ER P2/6 was published in 2006. In particular it recognises that:

- some demand customers are modifying their electricity consumption in response to market signals; this means that further consideration has to be given to establishing the true demand on the network;
- in addition to providing security of supply from network assets and distributed generation, demand side services can also contribute to security of supplies; and
- the nature and type of distributed generation connected to the network mean that their contribution to security of supplies is different to that in preceding versions of ER P2/6

In order to accommodate these changes the emphasis of this document is now focused on defining the minimum level of security of supply that should be achieved rather than how that level should be achieved. Guidance on the means of achieving the prescribed security of supply is set out in an updated version of Engineering Report 130 [Ref 1].

~~ER P2/5 took into account the results of extensive reliability studies using fault statistics and risk analysis and the relationship of these to the costs of system reinforcements, including the effects on losses. ER P2/6 does not revisit these analyses; it simply replaces the previous Table 2, which related solely to large steam and Open Cycle Gas Turbine sets (that were prevalent at the time ER P2/5 was published in 1978), with a new Table 2 that takes account of modern types of Distributed Generation (DG). In addition to the new Table 2 the guidance on how to assess the security contribution from generation has been captured in a new ENA Engineering Technical Report, ETR130 [Ref 1]; this ETR also contains the references to the background work on the methodology and data capture that underlie the new Table 2.~~

~~With regard to the contribution to System Security afforded by DG, Table 2 provides deterministic values that will allow an assessment to be made. However, it may be necessary to carry out a more detailed assessment to determine the contribution from a particular DG plant. Guidance on how to conduct such a detailed assessment is contained in ETR 130 [Ref 1] and a computerised modelling program. The application guide for the modelling program is contained in ETR 131 [Ref 2][1].~~

1. Scope

The purpose of this Engineering Recommendation is to define the standard to which a Group Demand should be secured. It details the factors that should be taken into consideration to establish the magnitude of the Group Demand that needs to be secured and also the means of securing that demand using a combination of network assets and non-network assets. It does not detail how the DNO should meet the standard, however guidance on the means of achieving the prescribed security of supply is set out in Engineering Report 130 [Ref 1].

This document does not set out any minimum requirements for the security of supply for connections to generating facility. This document deals with the security of DNOs distribution network. It does not apply to the security of the connection between the

DNOs distribution network and an individual customer, which should be agreed between the DNO and that customer.

~~**2 RECOMMENDED LEVELS OF SECURITY**~~

~~Table 1 sets out the normal levels of security required for distribution networks classified in ranges of Group Demand.~~

~~If it is known that higher voltage reinforcement is expected in the near future, the improvement in security resulting from this reinforcement may enable lower voltage reinforcement to be deferred[2]. Any departure from the recommended normal level of security defined in this document may require detailed risk and economic studies to be undertaken including any costs of generation operation. An instance where a departure would be justified is for Class E, where the characteristics of the demand curve are such that normal maintenance procedure would entail risk of consumer disconnection. In these cases earlier reinforcement would be required unless alterations to maintenance procedures could be made economically.~~

~~[1] The modelling tool is run in Microsoft Excel ® 2000; it will not run in earlier versions.~~

~~[2] Such a deferment may require a derogation to be sought from Ofgem. Ofgem publishes guidance on the need for derogations on its website.~~

2. Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ENA Engineering Report (EREP) 130 (2014) - Application guide for assessing the capacity of networks containing distributed generation.

ENA Engineering Report (EREP) 131 (2012) - Analysis package for assessing generation security capability – Users' guide.

~~1.~~3. Terms of definitions ~~3 DEFINITIONS~~

For the purposes of this Engineering Recommendation the following definitions apply.

NOTE: Defined terms are capitalised where they are used in the main text of this report.

Circuit

A Circuit is the part of an electricity supply system between two or more circuit breakers, switches and/or fuses inclusive. It may include transformers, reactors, cables and overhead lines. Busbars are not considered as Circuits and are to be considered on their merits.

Circuit Capacity

The appropriate continuous ~~cyclic~~ rating~~s~~ or cyclic rating or, where ~~they~~it can be satisfactorily determined, the appropriate emergency ratings, taking into account the relevant environmental conditions and the expected demand profile, should be used for all Circuit equipment and associated protection systems.

Circuit capacity should be assessed in MVA.

~~For First Circuit Outages, the Circuit Capacity will normally be based on the cold weather ratings, but if the Group Demand is likely to occur outside the cold weather period the ratings for the appropriate ambient conditions are to be used. Where the Group Demand does not decrease at the same rate as the Circuit Capacity (eg with rising temperature) special consideration is needed.~~

~~For Second Circuit Outages, in view of the proportions of Group Demand to be met in Table 1, the most appropriate ratings to use will usually be those for spring/autumn conditions.~~

~~"Classes of Supply" are defined in MW, but Circuit requirements should be assessed in MVA with due regard for generating plant MW sent out and MVAr capability where appropriate.~~

Cold Load Pickup

The difference between the **Measured Demand** on a **Circuit** following re-energisation of a **Circuit** after being de-energised and the demand that the **DNO** would have reasonably expected on the **Circuit** had no such de-energisation occurred.

Demand Side Response (DSR)

Demand that is controlled in response to an instruction issued as part of an agreed demand side management arrangement with the **DNO** or other party

~~**Declared Net Capability (DNC)**~~

~~The declared gross capability of a Distributed Generation (DG) plant, measured in MW, less the normal total parasitic power consumption attributable to that plant.~~

~~NOTE 1: Declared Net Capability (DNC) as used in this Engineering Recommendation should not be confused with declared net capacity (DNC) as used in the Electricity Act and Statutory Instrument 2001 3270.~~

~~NOTE 2: For the purpose of this definition the term "parasitic power consumption" refers to the electrical demand of the auxiliary equipment, which is an integral part of the DG, essential to the DG's operation. For the avoidance of doubt "parasitic power consumption" does not include demand supplied by the DG to an on-site customer.~~

~~NOTE 3: The DNC of Intermittent Generation is taken as the aggregate nameplate capacity of all the units within the DG plant, less any parasitic load.~~

Distributed Generation (DG)

A generating facility~~plant~~ connected to the distribution network, where a generating facility~~plant~~ is an installation comprising one or more generating units.

Distribution Network Operator (DNO)

~~The organisation that owns and/or operates a distribution network and is responsible for agreeing the connection of DG to that network. A DNO might also be referred to as a Distributor.~~

The person or legal entity named in Part 1 of the **Error! Reference source not found.** and any permitted legal assigns or successors in title of the named party.

First Circuit Outage (FCO)

Signifies a fault or an pre-arranged Circuit outage, but in classes C to F supplies to consumers should not be interrupted by arranged outages.

Generation Unit Load Factor

$$\frac{\text{Total electrical energy sent-out by the unit per year (MWh)}}{\text{8760(h) x Declared Net Capability of the unit (MW)}}$$

Generator

A person who generates electricity under licence or exemption under the Act. from Section 4.1(a) of the Electricity Act 1989 or the Electricity (Northern Ireland) Order 1992.

Group Demand

The DNO's estimate of the maximum demand of the group being assessed for ER P2/76 compliance with appropriate allowance for diversity. When estimating the maximum demand of the group the DNO should, where necessary, take into consideration (but not be limited to) the following: the **Latent Demand** due to **DG**, the **Latent Demand** due to **DSR**, the **Latent Demand** due to storage, the effect of **Suppliers** time of use tariffs, the effect of **Network Operator** price signals, the effects of **Cold Load Pickup** and, META data effects (instantaneous peak vs time averaged flow).The Group Demand at grid supply points must be consistent with the demand data submitted to a transmission company under the terms of the GB Grid Code.

NOTE: Further advice on estimating Group Demand for groups containing DG is given in EREPTR 130 [Ref 1].

NOTE: **Group Demand** is the sum of the **Latent Demand** and the **Measured Demand**.

Latent Demand

Demand that would appear as an increase in **Measured Demand** if the DG was not operating, the DSR was not implemented or other means (eg time of use tarrif, storage etc) of suppressing the **Measured Demand** within the network (for which the **Group Demand** is being assessed) was not operating.

Measured Demand

Summated demand measured at the normal (network) infeed points to the network for which **Group Demand** is being assessed.

Network Operator

A **Distribution Network Operator** or a **Transmission System Network Operator**.

Intermittent Generation

Generation plant where the energy source of the prime mover can not be made available on demand.

Non-intermittent Generation

Generation plant where the energy source for the prime mover can be made available on demand.

Persistence (T_m)

T_m represents the minimum time for which an Intermittent Generation source is expected to be capable of continuously generating for it to be considered to contribute to securing the Group Demand.

NOTE: The treatment of Persistence is considered more fully in ETR 130 [Ref 1].

Second Circuit Outage (SCO)

Signifies a fault following an arranged Circuit outage.

NOTE: The recommended levels of security are not intended at all times to cater for a first fault outage followed by a second fault outage or for a simultaneous double fault outage. Nevertheless, in many instances, depending upon switching and/or loading/generating arrangements, they will do so.

Secured Outage
A **First Circuit Outage** or **Second Circuit Outage** after which some demand should be supplied.

Supplier
(a) A person supplying electricity under an Electricity Supply Licence or;
(b) A person supplying electricity under exemption under the Electricity Act 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004); in each case acting in its capacity as a supplier of electricity to customers in Great Britain.

System Security
The capability of a system to maintain supply to a defined level of demand under defined outage conditions.

Transmission System Operator
The entity that operates the high voltage electricity transmission system.

Transfer Capacity
The capacity of an adjacent network which can be made available within the times stated ~~for the First and Second Circuit Outages~~ in Table 1. Transfer Capacity will be limited by Circuit Capacity or other practical limitations on power flow. ~~associated with the outage(s) in question.~~

4. Recommended levels of supply

Table 1 sets out the normal levels of security required for distribution networks classified in ranges of **Group Demand**.

If it is known that higher voltage reinforcement is expected in the near future, the improvement in security resulting from this reinforcement may enable lower voltage reinforcement to be deferred[1]. Any departure from the recommended normal level of security defined in this document may require detailed risk and economic studies to be undertaken including any costs of generation operation. An instance where a departure would be justified is for Class E, where the characteristics of the demand curve are such that normal maintenance procedure would entail risk of consumer disconnection. In these cases earlier reinforcement would be required unless alterations to maintenance procedures could be made economically.

[1] Such a deferment may require a derogation to be sought from Ofgem. Ofgem publishes guidance on the need for derogations on its website

2.5. 4 CAPABILITY OF A NETWORK TO MEET DEMAND

a. The existence and possible provision of Transfer Capacity should always be considered when assessing the need for reinforcement.

b. The capability to meet a Group Demand after First and Second Circuit Outages should be assessed as:

- The appropriate cyclic rating of the remaining transmission or distribution Circuits which normally supply the Group Demand, following outage of the most critical Circuit (or Circuits); plus
- Transfer Capacity which can be made available from alternative sources; plus
- For demand groups containing DG, the contribution of the DG to network capacity as specified in Table 2.

c. Note that the assessed capacity may need to be reduced to ensure that, under normal running conditions, equipment is not loaded to a point where it would suffer loss of life.

d. Table 2 sets out the contribution to System Security expected from DG connected within a demand group; see ETR 130 [Ref 1] for background notes and guidance on application. This contribution depends on the DG plant availabilities and operating régimes.

e. When using this Engineering Recommendation to assess the contribution from DG, it is recommended that account is taken of the forecast operating plans and probable operating régimes and capabilities of the DG plant.

f. When using Table 2, and the supporting tables, to identify the contribution to System Security afforded by a particular DG plant, there are two considerations that need to be taken into account:

1) Table 2 provides a simple analysis that will produce a result within the confidence level of the data used to derive that Table.

2) In the event that it is necessary to carry out more detailed analysis or if the type of DG under consideration is not listed under Table 2, reference should be made to the guidance given in ETR 130 [Ref 1].

g. It is a requirement that the loss of a DG contribution should never have a greater impact on System Security than the loss of a Circuit(s). This requirement is tested by comparing the capacity of the largest Circuit(s) with the contribution from each DG. For Non-intermittent Generation the DG contribution is assessed using the data in Table 2-3. This specifies the number of generating units (N) in a multi-unit plant that are equivalent in reliability terms to a First Circuit Outage (FCO). Intermittent generators are considered as single units for this evaluation. The tests that must be met for each DG are that:

- the cyclic rating of the largest transmission or distribution Circuit supplying the Group Demand is greater than the contribution of either; the N largest DG units for Non-intermittent Generation; or the DG capability for Intermittent Generation; and

~~• the cyclic rating of the two largest transmission or distribution Circuits supplying the Group Demand is greater than the contribution of the N+1 largest DG units for Non-intermittent Generation.~~

~~For this assessment the total contribution of the DG is calculated as F% (as defined in Tables 2-1 and 2-2) of the DNC. N is the number of Non-intermittent generation units equivalent to a FCO, as specified in Table 2-3. Further guidance on the assessment of DG, and its treatment both where these assumptions are not valid (ie where the DG is dominant), and where generation should be discounted on a de-minimis basis, is given in ETR 130 [Ref 1].~~

~~h. For generation contributions to count towards System Security it is essential that all other technical issues (eg protection stability, fuel supply control etc) and commercial issues (eg operating régime) are fully considered. Further guidance is given in the ETR 130 [Ref 1].~~

Demand can be secured using **Circuits** or a combination of **Circuits** and other means.

When carrying out a security assessment consideration should be given to ensure that the **Circuit Capacity**, the capability of other means and the value of demand used correspond with the same point in time.

Guidance on best practice in respect of determining the contribution of the following means of meeting **Group Demand** after **First Circuit Outages** and **Second Circuit Outages** is detailed in ETR130**.** Factors contributing to meeting Group Demand include:

- The appropriate rating of the remaining **Circuits** which normally supply the **Group Demand**, following outage of the most critical **Circuit** (or **Circuits**); plus
- **Transfer Capacity** which can be made available from alternative sources; plus
- For demand groups containing **DG**, **DSR**, or other means, the assessed contribution of the **DG**, **DSR,** or other means of providing network capability.

Due consideration shall be given to ensure voltage limits are maintained during **Secured Outages** and that voltage step change are kept to prescribed limits.

Capability of Circuits

A **Circuit** should not be loaded to a point where it would suffer unacceptable loss of life.

For **First Circuit Outages**, the **Circuit Capacity** will normally be based on the rating corresponding to when the **Group Demand** occurs.

For **Second Circuit Outages**, the **Circuit Capacity** will normally be based on the rating corresponding with the time when a pre-arranged **First Circuit Outage** is likely.

The existence and possible provision of **Transfer Capacity** should always be considered when assessing the need for reinforcement.

Capability of non-circuit based capacity

The loss of a single **DG** security contribution, **DSR** security contribution or single point failure of any other system providing a security contribution should not have a greater impact on **System Security** than the loss of a Circuit(s).

NOTE: Whilst DSR can be used as a contribution to network capability, this contribution may be less than its contribution towards **Latent Demand.**

Impact of Active Network Management, other control systems or protection systems

Where **DG** security contribution or **DSR** security contribution is associated with an Active Network Management (ANM) system, other control system or protection system, consideration should be given to the most material common mode failure of that ANM, control or protection system. Such a failure could have an impact on the security contribution from the **DG** or **DSR**.

DNOs should not assume all generation can or will be manageable via an ANM scheme.

Security contribution from multiple sources

Where security of supply is provided by means other than **Circuits,** consideration shall be given to the availability and scheduling of planned outages of the asset providing those security contributions.

Table 1

Class of supply	Range of Group Demand	Minimum demand to be met after: First Circuit Outage	Minimum demand to be met after: Second Circuit Outage	Notes
A	Up to 1MW	In repair time: Group Demand	Nil	Where demand is supplied by a single 1000kVA transformer the "Range of Group Demand" may be extended to cover the overload capacity of that transformer.
B	Over 1MW and up to 12MW	(a) Within 3 hours: Group Demand minus 1MW (b) In repair time: Group Demand	Nil	
C	Over 12MW and up to 60MW	(a) Within 15 minutes: Smaller of (Group Demand minus 12MW); and 2/3 of Group Demand (b) Within 3 hours: Group Demand	Nil	Group Demand will be normally supplied by at least two normally closed Circuits or by one Circuit with supervisory or automatic switching of alternative Circuits.
D	Over 60MW and up to 300MW	(a) Immediately: Group Demand minus up to 20MW (automatically disconnected) (b) Within 3 hours: Group Demand	(c) Within 3 hours; For Group Demands greater than 100MW: Smaller of (Group Demand minus 100MW); and 1/3 Group Demand (d) Within time to restore arranged outage: Group Demand	A loss of supply not exceeding 60 sec is considered as an immediate restoration. The Recommendation is based on the assumption that the time for restoration of Group Demand after a Second Circuit Outage will be minimised by the scheduling and control of planned outages, and that consideration will be given to the use of rota load shedding to reduce the effect of prolonged outages on consumers.
E	Over 300MW and up to 1500MW	(a) Immediately: Group Demand	(b) Immediately: All consumers at 2/3 Group Demand (c) Within time to restore arranged outage: Group Demand	The provisions of Class E apply to infeeds to the distribution system but not to systems regarded as part of the interconnected Supergrid to which the provisions of Class F apply. For the system covered by Class E consideration can be given to the feasibility of providing for up to 60 MW to be lost for up to 60 seconds on First Circuit Outage if this leads to significant economies. This provision is not intended to restrict the period during which maintenance can be scheduled. The provision for a Second Circuit Outage assumes that normal maintenance can be undertaken when demand is below 67%. Where the period of maintenance may be restricted paragraph 3 of section 2 applies.
F	Over 1500 MW	In accordance with the relevant transmission company licence security standard		

*for the purpose of complying with the requirement to supply the ‘minimum demand to be met’, activation of DSR is equivalent to restoration of demand.

Table 2

Type of Distributed Generation	Contribution (see Note 1 below)
Generation as listed in Tables 2-1A and 2-1B	F % of DNC
Generation as listed in Tables 2-2A and 2-2B	F % of DNC (see Note 2 below)
Plant operating for 8 hours (see Note 3 below)	Smaller of value derived from relevant row above; or 11 % of Group Demand
Plant operating for 12 hours (see Note 3 below)	Smaller of value derived from relevant row above; or 12 % of Group Demand

NOTE 1: The contributions derived from this table apply from the point of time when the DG is connected or reconnected to the demand group following the commencement of an outage. This may be immediately if the DG does not trip, otherwise it will be from the point of time when the DG is reconnected.

NOTE 2: The value derived applies to the complete DG plant irrespective of the number of units.

NOTE 3: The values in these two rows assume that the operating period is such that operation spans the peak demand, and the demand at start-up is the same as the demand at shut-down, ie operation is symmetrically placed on the daily load curve. If these conditions do not apply, the contribution could be optimistic (eg at one extreme, the contribution would be zero if the operating period did not span the peak demand at all), in which case the generation ought to be treated as a special case and therefore subject to detailed studies to assess the expected level of contribution – See ETR 130 [Ref 1].

Table 2-1 F factors in % for Non-intermittent Generation

The F factors for non-intermittent generation are related directly to the number of units in the generating station. It is assumed that the energy source for the prime mover is available on demand so that Persistence does not need to be considered.

Table 2-1A High confidence data

Type of generation	Number of units									
	1	2	3	4	5	6	7	8	9	10+
Landfill gas	63	69	73	75	77	78	79	79	80	80
CHP sewage treatment using a spark ignition engine	40	48	51	52	53	54	55	55	56	56

Table 2-1B Sparse data

Type of generation	Number of units									
	1	2	3	4	5	6	7	8	9	10+
Waste to energy	58	64	69	71	73	74	75	75	76	77
CCGT	63	69	73	75	77	78	79	79	80	80
CHP sewage treatment using a Gas Turbine	53	61	65	67	69	70	71	71	72	73

NOTE: This table is provided for guidance, however the data sets used to create this table have limited statistical robustness and the DNO should take care when using these F factors for these types of generation. It is preferable to seek site specific data when looking to assess the contribution to System Security from the types of DG listed in this table.

Table 2-2 F factors in % for Intermittent Generation

The F factors for Intermittent Generation are related directly to the period of continuous generation (ie Persistence) and are not affected by the number of units at an individual site.

NOTE: Recommended values of T_m are shown in Table 2-4.

Table 2-2A High confidence data

Type of generation	Persistence, T_m (hours)							
	½	2	3	18	24	120	360	>360
Wind farm	28	25	24	14	11	0	0	0

Table 2-2B Sparse data

Type of generation	Persistence, T_m (hours)							
	½	2	3	18	24	120	360	>360
Small hydro	37	36	36	34	34	25	13	0

NOTE 1: The “small hydro” DG plants used to produce Table 2-2B were all rated below 1MW with water storage.

NOTE 2: This table is provided for guidance, however the data sets used to create this it have limited statistical robustness and the DNO should take care in establishing appropriate F factors for this type of generation. It is preferable to seek site specific data when looking to assess the contribution to System Security from a small hydro DG plant.

Table 2-3 Number of DG units (N) contributing to FCO

Type of generation	Number of units									
	1	2	3	4	5	6	7	8	9	10+
Landfill gas	1	2	2	2	2	2	3	3	3	3
CCGT	1	2	2	2	2	2	3	3	3	3
CHP sewage treatment, using a spark ignition engine	1	2	3	4	4	5	5	6	6	7
CHP sewage treatment using a Gas Turbine	1	2	2	3	3	3	4	4	4	4
Waste to energy	1	2	2	2	3	3	3	3	4	4
Wind farm	1 (see Note below)									
Small hydro	1 (see Note below)									

NOTE: For Intermittent Generation N is assumed to be 1 in all cases because the DNC used to determine the contribution to System Security is the DNC of the complete plant.

Table 2-4 Recommended values for T_m

This table provides recommended values for T_m for three system conditions that may apply at the time that an infeed is lost. For example, "Switching" values apply where the DG contribution is only required for the time necessary to reconfigure the system by switching operations.

P2/6 demand class	Switching (see Note 1 below)	Maintenance	Other outage (see Note 2 below)
A (FCO)	N/A	N/A	N/A
B (FCO)	3 hours	2 hours	24 hours
C (FCO)	3 hours	18 hours	15 days
D (FCO and SCO) (see Note 3 below)	3 hours (see Note 4 below)	24 hours	90 days
E (FCO and SCO) (see Note 3 below)	N/A	24 hours	90 days

NOTE 1: Switching values for T_m are only appropriate where sufficient Transfer Capacity exists within the times specified in ER P2/6 Table 1.

NOTE 2: Examples of "other outage" are an unplanned outage or an outage as part of a major project.

NOTE 3: SCO only applies for demands greater than 100MW.

NOTE 4: FCO only applies where compliance is achieved by automatic demand disconnection of 20MW or less.

REFERENCES

1. Engineering Technical Report 130: Application Guide for Assessing the Capacity of Networks Containing Distributed Generation.

2. Engineering Technical Report 131: Analysis Package for Assessing Generation Security Capability – Users' Guide.