Transmission Entry / Exit (TEE)

Working Group Draft Report

5h March 2010

1 SCOPE

This document sets out the draft report (Issue 1) of Working Group 2 (WG2) as part of the Fundamental Review of the GB SQSS. The Working Group has been formed by the GB SQSS Project Steering Group and forms part of the project for the Fundamental Review of the GB SQSS. The baseline Standard for the review was the draft GB SQSS dated 29 April 2008 although there has been a subsequent re-issue (and renaming to NETS SQSS) at offshore go-live in June 2009. The terminology used within this report is retained as GB SQSS in reflection of the Terms of Reference and current licence conditions but can be considered, for the purposes of this report, as interchangeable with NETS SQSS.

The GB SQSS provides a co-ordinated set of criteria and methodologies for use in planning, operating and maintaining the GB onshore and offshore transmission systems. The fundamental review of the Standard reflects a need to update or revise the Standard arising from background changes to equipment / operating regimes or to ensure alignment with other Standards or Codes.

Working Group 2 considered, as part of the review into Transmission Entry and Exit (TEE) criteria, the onshore generation connection criteria set out in Section 2 of the GB SQSS and the onshore demand connection criteria set out in Section 3.

Section 2 of the Standard covers the connections which extend from the generation points of connection into the main interconnected transmission system (MITS). Similarly, section 3 of the Standard covers demand connections from the lower voltage side of the Grid Supply Point transformers back into the MITS.

Specifically excluded from the review were offshore connections (whether offshore generation or demand connections) which fall within the scope of the Offshore Transmission Systems workstream (WG5).

1.1 Working Group Membership

The provisional Working Group membership, established at project initiation in October 2008, was:

Colin Bayfield (Chair)	SPT
David Carson	SPT/SPD
Roger Yuile	SHETL
Neil Carter	NGET

Arising from an identified need to extend the knowledge and experience input from a wider industry and academic base, additional members were invited to the working group. In March 2009, the revised group membership was:

Colin Bayfield (Chair)	SPT
David Carson	SPT/SPD
Roger Yuile	SHETL
Neil Carter	NGET
Predrag Djapic	SEDG
Goran Strbac	SEDG
Louise Schmitz	British Energy
Frank Prashad	RWE npower
Alan Creighton	CE Electric

In November 2009, Colin Bayfield was unable to continue with the work of the group and the chairperson role was undertaken by David Carson.

1.2 WG2 Terms of Reference

The formal Terms of Reference are provided as Appendix A of this report.

2 CONTENTS

3 EXECUTIVE SUMMARY

The Working Group considered the issues associated with Generation Connection Criteria Applicable to the Onshore Transmission System (Section 2) and the Demand Connection Criteria Applicable to the Onshore Transmission System (Section 3) of the SQSS.

3.1 Generation Connection Criteria

At present, the generation connection criteria for connection to the transmission system does not differentiate, in respect of connection security, between base load power stations and those with intermittent fuel sources or indeed power stations of differing capacities. System access, charging and compensation is based upon compliance with the Security and Quality of Supply Standard (SQSS) and this principle flows through the Connection and Use of System Code (CUSC), which constitutes the contractual framework for connection to, and use of, the high voltage transmission system.

Currently generation customers are able to choose to have a connection to the system that is below the deterministic minimum required which will result in reduced access to the transmission system and the electricity market which has a consequential impact on some commercial aspects of their development.

The current methodology within the GB electricity market is to provide secure access for all generation and individual generators

The Working Group proposals consider that it is possible to alter the focus of the methodology to revise the level of security provided as the determistic minimum (with an associated reduction in access to the electricity market) with the ability for the customer to choose a higher level of connection security. The deterministic minimum criteria would be amended to reflect the differing size and intermittency of new generation technology, effectively reducing the transmission system capacity provided for smaller and intermittent generation. This approach, which would need to be coordinated with amendments in the commercial and charging regime, could establish more targeted incentives for each generator to determine the exact security of their connection to the transmission system. Further work still remains necessary to determine the impact that significant volumes of generation each connected by a single circuit could have on the overall integrity of the tranmsiison system.

It was noted by the working group that National Grid has previously reviewed, consulted upon with the industry and had approved the charging incentives for individual generators to select a lower level of connection security under the current SQSS.

3.2 Demand Connection Criteria

The primary area for consideration by the Working Group was the consistency and transparency of the contribution towards security which is assumed for generation embedded within a demand group. Distribution network operators are required by their Licence to comply with Engineering Recommendation P2/6 which considers the contributions of embedded generation at a very detailed level. The SQSS currently considers contributions at a much less granular level.

The Working Group concluded that, while a more detailed assessment of expected generation contribution to an SQSS group would be ideal, the two standards should broadly align in terms of philosophy and approach.
The Group proposals therefore aim to ensure that the treatment and impact on demand assumptions for the purposes of security assessments are consistent in concept and application.

It was therefore proposed by the Working Group that the existing provisions in the grid Code, where the network operator considers the security contribution of small and medium embedded power stations within their data submissions, would continue with additional guidance provided within the National Grid Guidance Notes for Network Operators – Submission of Grid Code Data. The treatment of large embedded power stations necessitates a review of Table 3.2 with consideration of amendments that bring closer alignment to Engineering Recommendation P2/6.

4 INTRODUCTION

Working Group 2 considered, as part of the review into Transmission Entry and Exit (TEE) criteria, the onshore generation connection criteria set out in Section 2 of the GB SQSS and the onshore demand connection criteria set out in Section 3. The group considered both aspects and identified change proposals with respect to each section.

For each section, the report places the existing arrangements in context and addresses the issues and regional differences. Change proposals are discussed together with their possible impact.

However, during the review, it was identified that the impact of the change proposals or the issues raised, may precipitate some changes in other sections of the document.

The structure of the report is therefore reflective of this and provides discussion and change proposals for both sections 2 and 3 under review by the group, and a supplementary section to address associated recommendations for the wider document.

The final sections of the document provide proposed draft coding of the affected sections to facilitate both the scope and the spirit of the working group developments to be consolidated by the Drafting Group. These sections are indicative only and represent how the relevant sections *may* look. It is acknowledged that final drafting may significantly modify the content.

5 ENTRY PRINCIPLES (GENERATION CONNECTION CRITERIA)

5.1 Introduction

The basic structures and principles of the Security and Quality of Supply Standards were reflective of the legacy systems where generation was predominantly derived from large dedicated installations producing bulk energy which was then transmitted across country to load centres.

The subsequent updating and harmonisation with the corresponding security standards of the Scottish TOs to create a GB SQSS on the run up to BETTA go-live in April 2005 retained the same basic principles. The GB SQSS was updated to accommodate the Offshore Transmission regime in June 2009 and renamed the NETS SQSS.

The current SQSS criteria apply to the connection of any 'power station' to the onshore transmission system without making any distinction in terms of size or intermittency. Therefore, the SQSS requirements which require the connection to be able to withstand planned or unplanned outages with 'no loss of power infeed' drives the provision of similar connectivity and resilience for very large high load-factor generation sites such as CCGT or nuclear installations and much smaller directly connected generators with intermittent fuel sources such as wind farms. The Commercial and Charging arrangements have been constructed to be intrinsically linked to the connection security provided under the SQSS.

Given the increasing growth in renewable generation developments in a wide range of site capacities, the Licensees' overarching obligations to develop an economic and efficient system may be prejudiced by the provision of significant transmission infrastructure for intermittent or small generation developments.

5.2 Existing Connection Criteria

Section 2 of the Standard establishes the Generation Connection philosophy and deterministic criteria (with additional cost benefit assessment) for application to the security of connections for 'power stations' under system intact, planned outage and post-fault conditions.

Applicable criteria ensure that the transmission system shall be planned such that:

- For the background condition of an intact system:
  - equipment loads shall not exceed the relevant pre-fault rating
  - acceptable system voltages and margins
  - the system shall be stable
- With a pre-existing intact system for a secured fault outage of
  - a single transmission circuit, generation unit or reactive power source
  - a double circuit supergrid fault
  - a double circuit overhead line fault (SHETL & NGET only)
    - there shall be no loss of supply capacity other than as specified in section 3
    - system loads shall not result in unacceptable overloading of transmission equipment
    - system voltages and margins shall be within acceptable ranges
    - the system shall be stable

- With a pre-existing outage of a single transmission circuit and for a secured fault outage of a single transmission circuit; a pre-existing outage of a generation unit or reactive power source for a secured fault outage of a single transmission circuit; or a fault outage of a section of busbar or mesh corner
    - there shall be no loss of supply capacity other than as specified in section 3
    - system loads shall not result in unacceptable overloading of transmission equipment
    - system voltages and margins shall be within acceptable ranges
    - the system shall be stable

5.3 Relevant SQSS Reviews

Outwith the Fundamental Review workstreams, two SQSS Review Requests are relevant to the consideration of Entry Connection criteria. The two review requests are GSR003 and GSR007 which are summarised in the following sections:

5.3.1 SQSS Review GSR003 - Design of Generation Connections

The GSR003 review 'Design of Generation Connections' was raised to address a perceived conflict between licence obligations to design generation connections to the Section 2 criteria and the transmission licensees' statutory obligations to develop and maintain efficient and economical systems of electricity transmission. In some cases where generation connections to radial parts of the 132kV transmission network have been designed to Section 2 requirements, the resulting investment proposals have been judged uneconomical.

Analysis undertaken by the working group, which used an actual case study in addition to generic examples, showed that the application of the criteria of Section 2 could in some cases, drive uneconomic network investment where large infrastructure reinforcements were being triggered to remove small levels of generation constraints.

The GSR003 review group formed an initial conclusion that Section 2 should be amended to permit a level of investment less than that required by the deterministic criteria, where economically justified for radial parts of the 132kV network. In making this conclusion concerns were expressed by NGET on the ability of the TO to carry out an accurate cost benefit study and this was reconciled with a view offered by the Scottish company's that in Scotland, only the TO/DNO's had visibility of the significant volume of embedded generation activity to be taken into account in the cost benefit study.

The terms of reference for the GSR003 review indicated that the current consultation on GB generation access arrangements were "out of scope" and the current market access arrangements and incentives prevailed. The consultation on market access arrangements has progressed and some measures of reform are in place. NGT have now offered a view that a strengthening of the locational messages has removed the need for this review, however the Scottish TO's remain to be convinced of the effectiveness of the new measures and see the introduction of an economic test for investment as a "safety net" to ensure economic investment. As such it is proposed, subject to the approval of the GBSQSS Review Group, to progress the findings of the GSR003 to a consultation stage where all stakeholder may contribute to the review.

5.3.2 SQSS Review GSR007 - Review of Infeed Loss Limits

SQSS Review Request GSR007 was raised by EDF Energy in February 2008, to review the normal and infrequent loss limits in the SQSS. Currently, the SQSS requires that the transmission system is planned on the basis of accepting a normal (i.e. relatively frequent) loss of power infeed of up to 1000MW and an infrequent (i.e. in the region of up to four occurrences per year) loss of power infeed of up to 1320MW. The SQSS requires that the transmission system is operated such that, under prevailing system conditions and for the secured event of the 'most onerous loss of power infeed' occurring, unacceptable frequency conditions shall not arise. These 1000MW and 1320MW threshold limits to the normal and infrequent power infeed loss would become inappropriate in the event of new single units of capacity in excess of 1320MW being connected to the system. The connection of such large capacity units is currently being considered by several parties.

The review recommended that:

- The threshold level for the 'Normal Infeed Loss Risk' should be increased to 1320MW
- The threshold level for the 'Infrequent Infeed Loss Risk' should be increased to 1800MW

While industry consultation remains to be concluded and Authority approval received, the Working Group baseline assumption has been that the Normal and Infrequent Infeed Loss Risk thresholds will be raised in accordance with the recommendations. However, where appropriate, the text within the document generally refers to 'Normal Infeed Loss Risk' or 'Infrequent Infeed Loss Risk' as opposed to the definitive capacities, and therefore can be considered generic in approach.

5.4 Treatment of Exporting GSPs

Notwithstanding the commercial and constraint implications for exporting GSPs, the approach to the technical issues of security for exporting GSPs or composite sites where embedded generation continues to grow and offset standing demand, requires to be addressed.

The practical question for exporting GSPs with respect to Security Standards is for the application of the relevant criteria, i.e. is it a 'generator' or a demand group? This is particularly relevant as generation group security is proposed to be non-firm for smaller generator groups which is likely to be the case for GSPs in export mode.

In order to protect demand group security, additional paragraphs within the Standard are proposed to expand on the previous 'overlap of criteria' section to ensure that the demand group security is not detrimentally impacted by the presence of generation which results in the host GSP exporting back to the transmission system. Section 7.3 addresses this issue.

5.5 Appropriate Access

As discussed in the introduction to this section, the SQSS criteria applicable for the connection of a 'power station' to the onshore transmission system are not conditional on plant size or intermittency but purely on the declaration made by the generator for the access to the electricity market.

As a result, the recent rapid growth of renewable generation developments, with a wide variety of generation capacities, seeking connection to the transmission system require the connection to be able to withstand planned or unplanned outages with 'no loss of power infeed', unless the generator has chosen to accept a reduction in the security of their connection. This results in the provision of similar connectivity and resilience of connection to all parties. Therefore, the connection connectivity for very large, high load factor generation sites such as CCGT or nuclear installations will be broadly similar with that provided for smaller developments and those with intermittent fuel sources.

From a technical perspective, the working group endeavoured to develop a methodology which facilitated appropriate levels of connection arrangements which are determined by the size and type of generation and reflective of its contribution to security. The objective was to have a philosophy which is consistent with the underlying methodology applicable to demand group connections. The methodology also facilitates the application of scaled connection resilience by applying levels of connection criteria which increase with generator capacity.

5.6 Review of Background Conditions

In setting the background conditions for designing generation connections, Section 2 states that the output of a power station shall be set to its registered capacity. This is the maximum amount of active power deliverable by a power station at the grid entry point as declared by the generator. The generator declares their Registered Capacity within their Standard Planning Data submissions forming part of their application for connection to the transmission system. This is separate to the rated MW of any generating unit or group of generating units and does not relate to the transmission capacity that the generator wishes to have for their power station nor the charging arrangements.

5.6.1 Basis of Capacity

Consideration requires to be given to determining the most appropriate 'capacity' terminology as this forms the basis of system access and equipment capability when designing transmission entry connections. Currently, the baseline parameter used in section 2 is Registered Capacity but, given current and future network considerations, it was considered that this does not provide the best basis for defining the transmission capacity which the connection is designed to accommodate.

Currently, the general practice when designing the transmission system to accommodate the power export for a power station, is to use the total Transmission Entry Capacity (TEC) that has been requested or contracted.

Consideration was given to replacing the use of the registered capacity parameter in Section 2 with TEC which defines the level of access to the transmission system for which the generator contracts with the GBSO and is more appropriate for the application of security and access rights.

However, in light of ongoing CUSC amendment proposals arising from the Transmission Access Review (TAR), TEC may change from being a constant value (other than as modified by application or the use of short term access products) as is usually the case under present access arrangements. Future access arrangements may allow a generator to vary their TEC, but clearly when investing they will have a maximum output in mind. Under the TAR work streams the term Local Capacity Nomination (LCN) has been developed to describe the maximum access capacity that a generator will require in a given transmission-charging year.

It is proposed that a term be included in the NETS SQSS which reflects the commercial position of the generation and can be used to determine the appropriate capacity of transmission assets under Section 2. It was noted that certain embedded generators do not have TEC, nor access rights for the transmission system. The treatment of those generators will require consideration prior to implementation of any proposals. This proposal shall be kept under review and finalised to align with the outcomes of the ongoing CUSC amendment proposals arising from the TAR. Proposed wording for the definition of LCN, in broad alignment with the CUSC amendments, is appended in Appendix E.

5.7 Development of Minimum Connection Designs

Subject to the review of the commercial implications of any proposals, the working group endeavoured to develop a deterministic methodology which will enable the establishment of appropriate levels of connection security based on the aggregate of generation capacity connected (LCN) and generation load factor.

A primary objective of the analysis and proposals is that the deterministic rules provided would be supported by cost benefit analysis and would ensure consistent and appropriate application of the guidance. It was considered that the most appropriate vehicle for the clear and transparent presentation of the rules would be by means of a reference table similar to (but by definition more complex than) the corresponding reference table for demand groups.

This reference, proposed to be included as Table 2.1, will facilitate consideration of the impact on generator output of outage scenarios such as:

- Planned outage of a single transmission circuit or single section of busbar
- Planned outage of a single generator circuit
- Fault of a single generator circuit
- Fault of a single generator circuit
- Fault of any two transmission or generator circuits (on same double circuit overhead line)
- Fault of a single section of busbar or mesh corner
- Planned outage of any single transmission circuit, single section of busbar or mesh corner followed by a fault of any single transmission circuit, single section of busbar or mesh corner

Eight scenarios for the connection of generation developments were identified which were then classified in a manner comparable with demand group categories and assigned identification letters A to H.

The connection scenarios have been overlaid with equipment types and ratings which enabled the generation groups to be assigned with bands of generation capacity which could be associated with the generation group classification.

The generation group classifications were further broken down to three levels of load factor. In reflection of the relative contribution by a high capacity/low load factor development and a lower capacity/higher load factor site, high-level assessments indicated that high load factor sites should be advanced to the higher classification.

The detailed change proposals are summarised in section 5.11 with the draft coding and the new reference table included within Appendix C.

5.7.1 Follow On

To aid application, it has been identified within the section on Future Work (section 7.4.7) that it may be beneficial to the user of the Standard that further guidance should be provided on typical connection systems which facilitate compliance with the deterministic requirements of table 2.1, either in tabular / text form or as single line schematics.

Similarly, the capacity bands and load factors have been determined from an equipment perspective together with high-level assessments. Cost Benefit Analysis is proposed within Future Work to inform and fine-tune both the capacity band levels and the load factors.

5.8 Customer Choice

The existing NETS SQSS Section 2 allows variations in connection designs from the deterministic criteria where requested by customer choice, provided such variations do not reduce the security of the MITS, adversely affect other customers or compromise the ability of any transmission licensee to meet their obligations.

Application of the existing Section 2 deterministic criteria results in generators having access to the system which is generally unrestricted by the connection all year round in intact conditions, i.e. the connection design provides sufficient transmission capacity to deliver the generator's output to the boundary of the MITS under year round intact conditions.

A recent change to NGET's charging methodology (as detailed in GB ECM-11) has sought to provide more cost reflective economic signals to inform generator choice in the connection design by splitting the TNUoS charge into local and wider locational components. It was acknowledged within the group that any change, such as those proposed, would require fundamental review of the existing commercial provisions within the CUSC and Charging Methodology.

The proposals for connection designs of varying security, based on the size and load factor of the generator, have been developed purely from the point of view of the benefit to security of supply. For example, a small capacity generator with a low load factor will only supply a relatively small volume of energy to the GB market, such that it is not appropriate that a fully firm connection be provided to minimise the risk to the security of supply. On the other hand, loss of a large capacity generator with a high load factor, poses a greater risk to security of supply, so it is appropriate that that its access to the system be fully secured in order to minimise that risk.

It has been suggested that the proposed connection designs for a revised Section 2 shall be specified as minimum connection designs. For example it may not be considered desirable from a security of supply point of view for a high capacity generator with a high load factor to request a single circuit connection; therefore it may be proposed that customers do not have the option to request connection designs lower than the proposed deterministic criteria.

An important aspect is upholding the principle of a Customer being able to choose the security of their access to the energy market. Customers would be free to request connection designs higher than the proposed minimum standards and this option will enable the customer to assess their incremental capital costs to improve the connection security against the economic benefits of having an improved access to the market.

5.9 Impact of TEC/LCN Trading

Following the discussions in section 5.6.1, while Generating Capacity for a particular generator, or group of generators, is unlikely to change significantly over time (i.e. the plant remains unchanged), the level of access to the system required by the development may vary with time.

The group discussions concluded that generation capacity was no longer appropriate in determining the capability of the generator connection assets. Therefore, irrespective of whether the appropriate parameter is TEC or LCN, fundamentally, the value is open to change or trade. As a result, over time, the movement in TEC/LCN will increase or reduce the available capacity headroom for the corresponding generation connection.

The potential for trade produces a few scenarios:

- If TEC/LCN is traded internally to a generation group, the net impact on the connection is zero and therefore the technical consequences may be little or negligible.
- A TEC/LCN trade between groups will inevitably mean that there will be a loss of generation in one group and a gain in another.
    - The donor group which loses generation will now have an excess of capability and potentially stranded assets
    - The recipient group which gains additional TEC/LCN will require to be assessed to ensure that the generation connection can accommodate the increase.
    - The overall impact on the system with regard to the differing generation background and the potential impact on system stability would also require to be addressed.

The trades would be processed under the STCP 18-3 for TEC changes and therefore the local system and the wider network would be assessed for relative impact.

The impact of TEC/LCN trading or movement is not considered to fundamentally affect the proposals although high levels of activity in TEC/LCN trading or re-declarations will have an impact on work levels (although this will impact irrespective of SQSS changes)

5.10 Regional Variations

There are two Regional Variations currently contained within Section 2 of the SQSS

5.10.1 System Stability Studies

Regarding Generator Connection Capacity requirements, section 2.8 sets the background conditions:

2.8 The connection of a particular power station shall meet the criteria set out in paragraphs 2.9 to 2.13 under the following background conditions:

2.8.1 the active power output of the power station shall be set equal to its registered capacity;

2.8.2 for connections in the England and Wales area, the reactive power output of the power station shall be set to the full leading or lagging output that corresponds to an active power output equal to registered capacity;

2.8.3 for connections in the SPT and SHETL areas, the reactive power output of the power station shall be set to the full leading or lagging output that corresponds to an active power output equal to registered capacity or, for the purpose of assessment of system stability, that which may reasonably be expected under the conditions described in paragraph 2.8.5;

2.8.4 for connections to an offshore transmission system, the reactive power output of the offshore power station/s shall normally, and unless otherwise agreed, be set to deliver zero reactive power at the offshore grid entry point with active power output equal to registered capacity; and the reactive power delivered at the interface point shall be set in accordance with the reactive requirements placed on the offshore transmission licensee set out in Section K of the STC (System Operator – Transmission Owner Code); and

2.8.5 conditions on the GB transmission system shall be set to those which ought reasonably to be expected to arise in the course of a year of operation. Such conditions shall include forecast demand cycles, typical power station operating regimes and typical planned outage patterns modified where appropriate by the provisions of paragraph 2.11.

The variation was included at the time of re-drafting to reflect that some pre-existing generators, if running at full lead or lag, would result in system voltage non-compliance and therefore the obligation is unnecessarily onerous.

It is proposed that the regional variation can be removed if the ‘reasonableness’ test can be applied, where considered appropriate, across the GB network. This would consolidate paragraphs 2.8.2 and 2.8.3 with a suitable ‘reasonableness’ test appended to the consolidated paragraph. Proposed wording is included in the code proposals contained in Appendix C.

5.10.2 Post Fault Criteria – Background Conditions

The section on Generation Connection Capacity Requirements sets out background conditions, pre-fault criteria and post fault criteria with and without local system outages. The Post Fault Criteria for a background condition of no local system outage states:

2.10 The transmission capacity for the connection of a power station shall also be planned such that for the background conditions described in paragraph 2.8 with no local system outage and for the secured event of a fault outage on the onshore transmission system of any of the following:

2.10.1 a single transmission circuit, a reactive compensator or other reactive power provider;

2.10.2 a double circuit overhead line on the supergrid;

2.10.3 a double circuit overhead line where any part of either circuit is in the England and Wales area or the SHETL area;

2.10.4 a single transmission circuit with the prior outage of another transmission circuit;

2.10.5 a section of busbar or mesh corner; or

2.10.6 a single transmission circuit with the prior outage of a generating unit, a reactive compensator or other reactive power provider;

there shall not be any of the following:

2.10.7 a loss of supply capacity except as permitted by the demand connection criteria detailed in Section 3;

2.10.8 unacceptable overloading of any primary transmission equipment;

2.10.9 unacceptable voltage conditions or insufficient voltage performance margins; or

2.10.10 system instability.

This regional difference was included at drafting because a double circuit fault on parts of the 132kV SPT active network can result in non-compliance with the criteria detailed in sections 2.10.7 to 2.10.10.

However, this regional difference is repeated in section 4 (Design of the Main Interconnected Transmission System) of the Standard. Specifically, Paragraph 4.6 replicates the criteria in respect of “the minimum transmission capacity of the MITS shall also be planned……for the secured event of a fault outage of……”.

Given that the issue identified is on the active 132kV SPT system, inclusion of this criteria within Section 2 of the Standard is not considered appropriate and can therefore be removed.

While outwith the remit of this working group, retention of the paragraph within Section 4 has been assumed by WG2 as, notwithstanding the conclusions and recommendations of the MITS Working Group (WG3), Section 4 of the Standard is considered the most appropriate location for the criteria. This could be followed in future with a consultation with the TO to identify issues, solutions and opportunities which would enable the removal of the regional difference.

It would be possible to entirely remove the regional difference at this point in time by removing the criteria from Section 4 also, but in the knowledge that it may trigger derogation applications or significant system investment.

5.11 Change Proposals

The working group proposals fundamentally categorise a single generator (or a group of generators) connecting to the transmission system by the aggregate of the Local Capacity Nomination (LCN). This group aggregate LCN determines the minimum appropriate level of security afforded by the generator connection.

The eight classifications of generators have associated bands or generator capacity which are facilitated by matching connection methods and appropriate equipment capacities. As discussed in section 5.3.2, the change proposals are generic although presented on the basis that the recommendations of GSR007 are implemented.

The generation groups and preliminary LCN bands are as indicated in Table 1:

Generation Group Classification	Group Aggregate Local Capacity Nomination (LCN)	
A	0	< 50
B	≥50	< 100
C	≥100	<300
D	≥300	<700
E	≥700	<Normal Infeed Loss (1320)
F	≥Normal Infeed Loss (1320)	<Infrequent Infeed Loss Risk (1800)
G	≥Infrequent Infeed Loss Risk (1800)	<2 x Infrequent Infeed Loss Risk (3,600)
H	≥2 x Infrequent Infeed Loss Risk (3,600)	-

Table 1: Generation Groups and Preliminary Capacity Bands

The typical or preferred connection method for each classification is as indicated in Table 2

Generation Group Classification	Typical Connection Arrangements
A	Single circuit, sub-transmission connection voltage
B	Single circuit with connection at a transmission voltage
C	Two circuits, each of greater than 50% capability with no interconnection between the circuits at the generation site.
D	Two circuits of full capacity, terminating on a single busbar.
E	Two circuits of full capacity, terminating on a double busbar with a single bus-coupler.
F	Two circuits of full capacity, terminating on a double busbar with a single bus-coupler and one bus-section.
G	Three circuits of full capacity, terminating on a double busbar with a single bus-coupler and 2 bus-sections.
H	Four circuits, ‘1½ switch’ or Double busbar, 2xDouble-coupler, Multiple-BS 'mesh-type' arrangement

Table 2: Typical Connection Arrangements for Generation Groups

As previously indicated, subdivision of each Generation Group into three load factor bands (provisionally set at ≤40%, >40%≤70% and >70%) is proposed. The indicated connection arrangements in Table 2 would represent the average for the Generation Group but also enables more secure connections for developments with higher load factors when compared with another site with an identical LCN but a lower load factor, for example a generator with 90% load factor within the Class E Generation Group may warrant the security afforded by a Class F connection.

The application of the methodology may require active management schemes. An example of such an application would be where the 'minimum standard' connection is rated for 50% of the generator capacity under a circuit outage of a connection circuit. In this scenario, the loss of a connection circuit would trigger a signal to the generator to automatically scale-back output to a pre-determined level within a prescribed period of time. Failure of the generator management scheme would result in a time-out tripping of the remaining system connections to avoid damage to connection assets.

The proposed methodology is considered appropriate, economic and efficient in the context of development of the overall transmission network, although it is acknowledged that it will necessitate a review of the commercial regime. Focused cost benefit analysis is ongoing but not as yet concluded. It is believed that the CBA will not affect the basic philosophy but will influence and inform:

- The generation capacity bands (i.e. the group aggregate LCN) and thereby the appropriate level of security afforded
- Treatment of load factors and the influence on the appropriate level of security
- Exposure to overhead line faults. Section 2.7 of the current Standard states that "The maximum length of overhead line connections in a generation circuit for generating units which are directly connected to the GB transmission system shall not exceed:
    - 5km for generating units of expected annual energy output greater than or equal to 2000 GWh,
    - otherwise 20km."

  The cost benefit analysis will therefore inform additional clarification on the appropriate security which takes account of the overhead line components in the generator circuit.
- Exposure to a wider system/weather event which may have a detrimental impact on generation secured by a single circuit overhead line – there is some nervousness regarding the wider system impact if, under the proposed methodology, a significant number of generators are secured on single circuits, which, while individually modest in capacity, the aggregate across the country could be large and potentially exceed the Normal Infeed Loss Risk of 1320MW or indeed the Infrequent Infeed Loss Risk of 1800MW.

5.12 Assessing Impact of Change Proposals

In terms of application, the primary benefit arising from implementation of the changes is the provision of appropriate security of connection for generation developments. Given that this reduces the total asset base for the transmission networks and hence, a direct reduction in the total charges seen by the end customer, the proposals achieve an efficient and economic solution.

By establishing generator connections which are proportional and appropriate for the generator capacity, this will inevitably reduce the access rights for generation developments in the smaller generation bands. Again depending on development size, this will result in contractual arrangements whereby generators may not receive compensatory payments in the event of loss of generation.

In the event that the generation developer, for economic or commercial reasons, requests a level of security greater than that indicated by the revised Standard, then the incremental costs would be deemed customer choice and therefore fundable by the developer. This is similar in principle to the existing position where a requested reduction in the security of connection introduces restrictions within their agreement together but provides associated charging discount.

As the change proposals will only become applicable on go-live, the assessment of generation connection criteria under the new methodology would only occur for applications following that date. The pre-existing connections will not be reassessed retrospectively as, in reality, the connectivity will more than meet the new requirements. Subsequent applications to the same group or Users submitting Modification Applications for increases in capacity may be able to utilise the headroom established by the revised criteria and therefore more capacity may be able to be connected to the network with little or no infrastructure investment.

5.12.1 Impact on Other Codes or Standards

Clearly the SQSS technical Standard and the commercial Codes, such as the Connection and Use of System Code (CUSC) and the Statement of the Connection Charging Methodology must be complementary and consistent. The impact of these proposals will mean a lower standard of connection (and the consequential access restrictions and use of system charging discount) for particular users. Whilst the connection design variation criteria contained in Chapter 2 will provide a means for users that require an alternative standard of connection to request them, the charging treatment of this decision will need to be reviewed to ensure consistency. Discussions with the Commercial Charging activities within NGET have been initiated. Therefore, the working group recommends that the SQSS changes are not implemented until suitable commercial mechanisms have been put in place.

6 EXIT PRINCIPLES (DEMAND CONNECTION CRITERIA)

6.1 Introduction

A fundamental aspect of the review of the exit principles is that there shall be no deterioration in the security of supply for demand connections, from that currently provided.

The formal Terms of Reference for the review are provided as Appendix A. The review therefore aims to, where possible and appropriate, align the NETS SQSS with P2/6 to ensure that there is transparency in approach and consistency of application and presentation. It also considered the regional differences and the scope for rationalisation, as well as assessing the implications for networks with increasing levels of 'embedded' generation

6.2 Existing Connection Criteria

Section 3 of the Standard establishes the Demand Group philosophy and deterministic connection security rules (based on probabilistic analysis) for application when planning the connection of blocks of demand. The rules address both system intact conditions and planned outage conditions. Where the system is depleted by a planned outage, the deterministic rules apply demand levels which are appropriate during maintenance periods. The ability to transfer demand between adjacent demand groups as a means of satisfying connection criteria is also considered.

Applicable criteria ensure that the transmission system shall be planned such that:

- For the background condition of an intact system:
  - equipment loads shall not exceed the relevant pre-fault rating
  - acceptable system voltages and margins
  - the system shall be stable
- For a secured fault outage of a single transmission circuit, single section of busbar or mesh corner with, and without, a pre-existing planned outage of a transmission circuit, generation unit or reactive power source:
  - the loss of system demand shall be in accordance with the reference table (Table 3.1)
  - system loads shall not result in unacceptable overloading of transmission equipment
  - the system shall be stable
- System switching shall not result in unacceptable voltage performance

In addition to the look-up reference for the minimum planned connection capacity following a secured event, the Standard also provides guidance with regard to the contribution of embedded large power stations to the security of the demand group. However, there are regional differences in treatment of embedded generation between England & Wales and Scotland. In addition, the NETS SQSS section 3 does not specify limits on contribution to security which differs from the approach by P2/6.

6.3 Appropriate Levels of Demand Security

The basic precept of section 3 is that Demand Groups shall have a security of supply which increases with size, i.e. a 500MW demand block will have a more resilient system connection than a 5MW block of demand. The prescribed levels are provided in tabular look-up form within the Standard and are the minimum levels to be provided with enhanced security being provided where reasonably economic to do so.

Application of the deterministic criteria is clear-cut with the conclusion being consistent, transparent and auditable. In simple networks, application is precise but interconnected networks at lower voltages can lead to imperfect assessments. The issue is considered in the following sections.

6.3.1 Improved Planning Code Data Exchange (Consultation B/07)

Grid Code consultation B/07 "Improved Planning Code Data Exchange for Compliance Assessments", was initiated in response to concerns over the transparency and relative responsibilities of the DNOs under their P2/6 security standard obligations and the SO/TO responsibilities for compliance under the NETS SQSS.

Following discussions between DNO and NGET representatives, it was considered that, as the Grid Code's Planning Code and Data Registration Code provide the formal means of data exchange for boundary sites, a Grid Code working group was the most appropriate method of reviewing the data exchange processes, identifying the issues and recommending means of improving the scope and quality of the data which would enable both parties to demonstrate compliance with the relevant standards.

The GCRP Working Group identified a number of areas where the data exchanged between DNOs and TOs as part of the formal "Week 24" process did not enable a fully robust assessment of the security of supply obligations.

- Historically, the Winter Peak Demand supplied through Week 24 data submission formed the basis of National Grid's assessment of compliance during the summer maintenance (access) period, with Access Period Demand being assumed to be 67% of Winter Peak Demand unless better data was available.
- Ensuring that the circuits connecting the GB Transmission System to a DNO System at a Connection Point (i.e. "Transmission Interface Circuits") are maintainable in accordance with the NETS SQSS. This would ensure availability of a continuous maintenance outage window of acceptable duration for each Transmission Interface Circuit, such that each one could be placed on a maintenance outage without prejudicing the overall security of the Connection Point.
- Ensuring that any Transfer Capability declared in planning timescales is available in operational timeframes
- Establish interdependencies between demand groups (i.e. identification of Access Groups) to ensure that demand transfer is possible and that the independent assessment of component demand groups does not "double-count" capability or provide an overly-optimistic view when compared with an Access Group view.

The recommendation in the B/07 Consultation was an improvement to the 'Week 24' Data Exchange and additional data capture to provide additional granularity on the network, capability, load and time-related demand. The Authority approved the proposals and implementation will commence in 2010.

6.3.2 Treatment of Demand Transfer in Assessing Group Security

As identified within the B/07 working group, there can frequently be inter-dependencies between demand groups, particularly where the lower voltage networks have significant degrees of interconnection, whether operationally normally interconnected or interconnectable for contingencies.

The issues for demand transfer capability with respect to security of demand groups are:

- where transfer capability is declared, ensure that the capacity is useable
- understand the implications of transferring demand to adjacent independent group(s)
- confirm that the adjacent group to which the demand is transferred remains compliant
- ensure that there are no conflicting maintenance outage requirements for the recipient demand group

6.4 Alignment With P2/6

When comparing the demand criteria aspect of the NETS SQSS with P2/6, there are a number of areas where the two Standards are not aligned. Some of the mis-alignments are presentational and therefore readily addressed. Proposals to resolve the presentational issues are included within section 6.6.1.

Other aspects are more wide-ranging and fundamental and these are summarised in the following sections:

6.4.1 Assumptions for Derivation of Group Demand

When considering the load demand on a supply point governed by the NETS SQSS, e.g. a Grid Supply Point with two or more transmission interface circuits, the Group Demand applicable within the NETS SQSS security assessment is effectively the aggregate demand 'seen' by the interface circuits.

In planning timescales, under the terms of the Grid Code, the Network Operator(s) will provide to the Transmission System Operator, an estimate of Group Demands. This estimate of the maximum demand will be consistent with the corresponding P2/6 assessments and considers the aggregate of the demand on the entire network native to the Grid Supply Point associated with the transmission interface circuits, making due allowance for diversity. This submission of estimated system maximum demands enables a corresponding assessment for future compliance of the transmission system with the SQSS exit criteria. In addition to the forward-looking compliance assessments, the TO/SO also considers compliance in light of the actual measured demands on the boundary circuits. The bottom-up estimate by the network operators and the top-down real-time data of the SO should generally be within reasonable error tolerances.

Where the connections associated with the network are wholly demand and the load measurements are synchronised and simultaneous in time, the Group Demand from the top down (i.e. SQSS Group Demand) and from the bottom up (i.e. P2/6 Group Demand) will be broadly similar. However, when the connections in the native network contain demand blocks with non-simultaneous peaks, host significant embedded generation or have merchant generators connected to the network, there is scope for wider variations between estimated and actual Group Demand values.

6.4.2 Contribution of Embedded Generation to Security

The treatment of embedded generation differs significantly between the SQSS and P2/6. Embedded generation in the context of the SQSS is more aligned with large or significant power stations connected to the native network while the focus of the update to P2/6 from P2/5 was to facilitate a better estimate of the contribution of small embedded generators to demand group security.

Where network assets are insufficient to meet the security requirements, the contribution from small-scale generation to P2/6 groups is assessed at a fairly detailed level and aims to provide support over fairly short time spans. Achievability of analysis over a wider SQSS network with an order of magnitude in terms of generators together with consideration of appropriateness of support time spans could render a P2/6-type assessment in an SQSS context problematic.

6.5 Regional Differences

There is currently one regional difference within section 3 (section 3.5.3 and associated tables 3.2 and 3.3) of the Standard which relates to the effective contribution of generation to demand group security. There are issues with both treatments which require to be resolved.

The proposed resolution is discussed in section 6.6.3.

6.6 Change Proposals

As discussed in section 6.1, a pre-condition of the review is that there shall not be a detrimental impact on the security of supply to demand groups. Therefore, the proposed changes aim to improve consistency with corresponding information within P2/6 and align, as far as reasonably practical at this time, SQSS assessment philosophies with those of P2/6.

Recommendations for the revised SQSS section 3 coding are provided in Appendix D and these reflect corrections to minor formatting and numbering anomalies which are present in Version 2 of the Standard. The proposed changes are summarised in the following sections.

6.6.1 Presentational Changes

The demand group "Minimum planning supply capacity following secured events" deterministic reference provided as table 3.1 has a corresponding table in P2/6. In order that their presentation is consistent and enable ease of reference to demand groups, it is proposed that:

- Demand Group Class be introduced and the nomenclature and banding be consistent with P2/6, i.e. Demand Classes A (≤1MW) through to Class F (>1500MW)
- The orientation of Table 3.1 be aligned with P2/6 – currently the table is orientated in descending order while the corresponding table in P2/6 is in ascending order, with the larger groups at the top.

6.6.2 Group Demand

As discussed in section 6.4.1, there is an anomaly between the security assessments of the SQSS and P2/6 in the circumstances that the Demand Group has embedded generation which may have the effect of masking the true Group Demand. This arises due to potential inconsistencies in the derivation of the demand level to be secured and the contribution of generation to the group security.

Given that resolution of the differences cannot be achieved within the SQSS in isolation and some reservations exist regarding the spread of supporting data behind the P2/6 tables, it is considered that a full alignment of the two Standards will require a joint assessment and modification process. The full alignment may also require refreshing the generator contribution assessment by considering the improved generator population and historical output data which should be available for the period of time since P2/6 was issued in July 2006.

However, until such time as the joint review is undertaken, in order to improve the transparency, consistency and quality of the assessment, it is proposed that procedural changes and data capture are implemented to enable the TO/SO and the network operators to better align their respective security assessments.

Improvements in the consistency and transparency of the Group Demand assessments from both P2/6 and SQSS perspectives will be achieved by consolidation of the two demand components:

- As part of the annual system security assessment and Grid Code compliant data submission, Network Operators assess the demand levels at a transmission interface point, taking due account of demand diversity and demand masked by embedded generation within their network. In general terms, generation visible to Network Operators will be Medium or Small power stations and in assessing the demand which will reasonably be imposed on the transmission system, the Network Operator's shall consider any future demand increases which would be imposed arising from a change in the operating regime of an existing medium or small power station.
- Large power station output and the demand supplied locally will be visible to TOs/SOs irrespective of whether the large power station is connected at the transmission interface point or deeper within the Network Operator's network.

It is considered that the 'Week 24' data and improved data exchange process under B/07 will provide sufficient information to the TO/SO to facilitate the SQSS assessment without significant impact on the complexity of the process. As part of the 'Week 24' process, clarity will be sought on generator assumptions, technology types, common-mode failure mechanisms in order to enable an assessment of the probability and risk.

6.6.3 Contribution of Generation

Where network assets do not have the required capability to meet the security standard, the assessment of the contribution to the local network security from embedded and directly connected generation requires to be undertaken.

It is a requirement that the loss of generation or DG contribution should never have a greater impact on System Security than the loss of a Circuit. This requirement is tested by comparing the capacity of the largest Circuit(s) with the contribution from generation.

Contributions to demand group security has been structured with differing criteria and methodology for large power stations and medium/small stations embedded within networks (Small, Medium and Large power stations for each of the licence areas of NGET, SPT and SHETL are as defined by the Grid Code). Small and Medium power station output is generally assessed by Network Operators and reported to the SO in accordance with their obligations under the Grid Code. The output of Large power stations is visible to the transmission system operator directly.

It is proposed to harmonise the methodology for contribution of large power stations to security across GB with the elimination of the regional differences between Tables 3.2 and 3.3. It is also considered that the tables do not necessarily reflect the current plant portfolio or operating regimes. Therefore, in addition to consolidating the tables and eliminating the regional differences, it is proposed to re-focus the contribution of large power stations to be technology-specific which permits consideration of both intermittent and non-intermittent fuel sources. In order to align philosophies with P2/6, persistence of generation over various time periods is utilized. The indicated values are, in the main, consistent with the P2/6 methodology and judgment although some values are indicative at this point in time and will be fine-tuned within the follow-on phase of the assessment. This assessment may require significant academic research and analysis. Table 3.3 becomes redundant and its removal is proposed.

Where network assets are insufficient to meet the security requirements and, consistent with the philosophy regarding the assessment of Group Demand, it is therefore proposed that, until such time as a joint SQSS / P2/6 review is possible, assessment of support from generation would be considered as follows:

> **Small or Medium Power Stations** – as the Network Operator's assessment of group demand inherently takes account of embedded small or medium power stations and their impact on group demand, there is no requirement to consider this support separately (where the changes to the operating regime of a small or medium power station is foreseen, the consequential impact on group demand will have been considered by the Network Operator).
>
> **Large Power Stations** – taking account of relevant factors such as source fuel, common mode failure mechanisms and the persistence of the technology indicated in Table 3.2, an assessment by the TO/SO of an appropriate level of support which possesses the relevant characteristics for support.

It is considered that this methodology will enable assumptions which are consistent across the P2/6 and SQSS boundary by adopting the network operators assessment and thereby eliminating the necessity of replicating the analysis within the SQSS context.

6.7 Assessing Impact of Change Proposals

The substantive changes proposed will require additional data analysis and investigation into Demand Group security which may have minor resource implications for TO and SO organisations.

The provision of clearer guidelines and assumptions to be made by Network Operators when preparing their demand group assessments in compliance with their Grid Code obligations will facilitate a more consistent and transparent understanding of the demand levels which require to be secured.

Given that the proposals provide a more consistent structure to the existing assessment and not a fundamental change in approach, it is not considered that there will be a significant impact on investment plans. Future methodologies aimed at identifying the true standing demand that is secured by a transmission interface and separately assessing the true contribution of local generation to the security of that connection, may have an impact on investment plans. This could be either advancement or deferral of reinforcement schemes, depending on the site-specific circumstances of high latent demand (i.e. demand obscured from measurement by the presence of generation) and capped generator contribution. Occurrence is likely only for marginal groups which are already close to triggering reinforcement projects.

7 ASSOCIATED CHANGES AND FURTHER WORK

7.1 Introduction

As part of the review into Sections 2 and 3 of the NETS SQSS, implications for other sections of the SQSS have been identified. These are basically code changes to support the proposed changes for sections 2 and 3 or additional coding to remove ambiguity in the treatment of either or both sections 2 and 3.

7.2 Generation Point of Connection

The existing NETS SQSS clause 1.10 states that, "The generation connection criteria applicable to the onshore transmission system are set out in Section 2 and cover the connections which extend from the generation points of connection and reach into the MITS." The associated definitions for terms in this clause are:

Generation point of connection	For the purpose of defining the boundaries between the MITS and generation circuits, the generation point of connection is taken to be the busbar clamp in the case of an air insulated substation, gas zone separator in the case of a gas insulated substation, or other equivalent point as may be determined by the GB transmission licensees for new types of substation.
Generation circuit	The sole electrical connection between one or more generating units and the Main Interconnected Transmission System, i.e. a radial circuit which if removed would disconnect the generating units.
Main interconnected transmission system (MITS)	This comprises all the 400kV and 275kV elements of the GB transmission system and, in Scotland, the 132kV elements of the GB transmission system operated in parallel with the supergrid, but excludes generation circuits, transformer connections to lower voltage systems and external interconnections between the GB transmission system and external systems.
GB transmission system	The system consisting (wholly or mainly) of high voltage electric lines owned or operated by a GB transmission licensee and used for the transmission of electricity from one power station to a substation or to another power station or between substations or to or from any external interconnection, and includes equipment owned or operated by a GB transmission licensee in connection with the transmission of electricity but does not include any remote transmission assets.

The implication of clause 1.10 and the definition for generation point of connection is that connections arising from the application of Section 2 will become part of the MITS. This may not always be the case when, for example, generators can be directly connected to the GB transmission system via 132kV radial circuits, which clearly do not fall under the definition of *MITS*.

Furthermore, with proposals to specify single circuit connections as minimum designs for lower classes of generation, not all proposed future connection designs can be classed as *MITS*. As a consequence it is suggested that the scope of Section 2 as defined in clause 1.10 is unnecessarily restrictive and requires to be altered. The proposed change is summarised in section 7.3 and proposed wording for the revised section is included in Appendix B.

7.3 Change Proposals

As discussed in section 7.1, the review of sections 2 and 3 highlighted issues within other areas of the SQSS which require to be addressed. The proposed changes are summarized below and proposed code changes are provided in the relevant appendices.

Changes proposed are:

Section 1 (Introduction) –

- Additional code (as paragraph 1.36) to remove ambiguity going forward as demand groups acquire more generation. The objective of the code is to provide a consistent and transparent basis for determining appropriate levels of security to composite connections.
- Clarification on the scope of section 2 and updating section 1.10 of the NETS SQSS to resolve the mis-classification of assets. It is proposed that generation connection criteria be applicable to the assets between a grid entry point (defined as a point at which a generating unit or a CCGT module, as the case may be, which is directly connected to the GB transmission system, connects to the GB transmission system) and the MITS.

Code text which reflect the proposals is provided in Appendix B.

Section 11 (Definitions) – arising from the proposed changes in sections 2 and 3, a number of new definitions will be required to be included in Section 11. Proposed code for the definitions is appended as Appendix E.

7.4 Further Work To Be Undertaken

As discussed in section 5.11, some follow on work is required in order to fully populate the deterministic rules.

7.4.1 (Entry) Cost Benefit Analysis for Generation Connection Methodology

The aim of the cost benefit analysis which is to be concluded is to inform and determine aspects and variables of the methodology described. These include:

- The generation capacity bands (i.e. the group aggregate LCN) and thereby the appropriate level of security afforded
- Treatment of load factors and the influence on the appropriate level of security
- Exposure to overhead line faults. Section 2.7 of the current Standard states that "The maximum length of overhead line connections in a generation circuit for generating units which are directly connected to the GB transmission system shall not exceed:
    - 5km for generating units of expected annual energy output greater than or equal to 2000 GWh,
    - otherwise 20km."

  The cost benefit analysis will therefore inform additional clarification on the appropriate security which takes account of the overhead line components in the generator circuit.

7.4.2 (Entry) System Resilience – Generation on Single Circuit Risk

There is a perceived risk that, if a number of small generators are, due to their size and under the proposed methodology, secured on a single circuit, then there is potential for a single event such as widespread gales, lightning or snow to cause a significant portion of the single circuits supporting these generators to trip out. If the penetration of non-firm or single circuit connections is significant, then the perceived risk is that the resulting loss of generation may exceed the Normal Infeed Loss Risk (1320MW as proposed under GSR007) or indeed the Infrequent Infeed Loss Risk (1800MW as proposed under GSR007).

An assessment therefore requires to be made of:

- The probability of such an event occurring
- The extent of the impacted area
- For firm connections, the probability of one circuit remaining connected in identical environmental conditions to the faulted circuit. i.e. the incremental risk of moving from firm to unfirm connections

It was considered that this level of assessment was difficult to achieve within the working group as this expertise is outwith the skill set and knowledge base of the group members. This may form another area of work either within or outwith the SQSS Fundamental Review workstream. This area of interest may require the input of appropriate consultants or specialists.

7.4.3 (Exit) Generation Contribution to Group Demand Security

The proposals have been based on a pragmatic high-level approach to determine the effective contribution from a possible range of connected generators utilising the data available to the TO/SO. As experience, data and systems develop over time, it may be more appropriate to move to a lower-level assessment based on the site-specific conditions. This would result in the aggregate of the contributions from the range of generators being considered and be a more accurate representation which may liberate additional support with greater confidence. Clearly, experience and data requires to be gathered over a period of time to enable a more accurate assessment to be made and it is recommended that industry research could be established to better inform future reviews.

The Persistence values included within the draft Table 3.2 contained in Appendix D, while consistent with P2/6 assumptions at this time, are provided for indicative purposes only as it is considered that the P2/6 data requires refreshing in the light of more recent and comprehensive data as well as populating the table with emerging technologies.

7.4.4 (Exit) Alignment with P2/6

In order that a true demand assessment can be made which is consistent bottom-up and top-down, clarity of demand levels and generation output is required. This requires identification of the true and absolute demand of the relevant networks which is independent of any generation netting. With that background, visibility of generator contribution can enable a realistic assessment of the contribution to demand security in planning timescales. It is considered that this assessment would be facilitated by a joint SQSS and P2/6 approach.

The criteria for Class E demand groups within the SQSS Table 3.1 refers to the demand during the maintenance period. While the SQSS definition of Maintenance Period Demand enables an assessment at 67% of peak in the event of insufficient data, P2/6 is prescriptive in that Maintenance Period Demand is not defined and the value is always set at 67% of peak. While this may generically provide a reasonable assessment, it could lead to inconsistencies and incorrect assessments. It is recommended that, in the event that a joint assessment of the Standards is undertaken, the opportunity should be taken to align the definitions of Maintenance Period Demand.

It is considered that a Joint SQSS / P2/6 assessment would facilitate a structured analysis of the assessment of contribution of generation to group security to take account of the generation annual load factor, the availability of generation under outage conditions, fuel source availability, common-mode failure mechanisms and establishing a generation contribution cap. Again, reiterating the comments in section 6.6.3, such an assessment of generation contribution will require further work to update, develop or extend the P2/6 methodology and may require detailed academic research and analysis.

7.4.5 (Exit) Data Provision by Network Operators

The Grid Code requires Network Operators to provide data to the SO in order that the relevant transmission system assessments can be carried out. It is considered that minor modifications may be required to the Grid Code to enable / require Network Operators to provide additional transparency of the implicit assumptions regarding the operation of small and medium power stations within the Network Operator’s estimate of Group Demand. This will include details of the generation plant connected, including the capacity and energy source. Any change requirements for the Grid Code remain to be identified.

7.4.6 (Entry) Impact on Commercial Codes

As discussed in section 5.12.1, there could be a significant impact on the commercial arrangements around the charging and financial returns for generator connection, access and constraints. The technical considerations and methodologies have therefore been presented in isolation but acknowledging there will be an impact. As the methodology develops and becomes more mature, it is proposed to engage with the SO Commercial Charging group to consider the necessary change proposals and anticipated implementation timescales.

7.4.7 (Entry) Standard Connection Schemes (Appendix A)

Although not specifically an Entry issue, the subject arises when considering 'approved' or 'recommended' connection schemes or substation configurations which ensure compliance with the Standard.

It is proposed that Appendix A of the Standard be developed further to indicate connection configurations which ensure compliance. This is seen as an appropriate successor and update opportunity for the Design Memorandum 099/55 on Supergrid Switching Arrangements.

8 CONCLUSIONS

The Working Group have had good quality robust discussions and contributions from all members. The wide range of skills and company representation assisted with gaining a positive and productive outcome.

While there remains some validation works and fine-tuning of the change proposals by modelling or Cost Benefit Analysis, it is considered that the philosophy and structure of the change proposals are sound and on the correct lines. It is considered that the proposals are positive in principle and will provide a good base for the appropriate, economic and efficient development of the transmission system in future.

Appendix A — Working Group Terms of Reference

Great Britain Security and Quality of Supply Standard
Fundamental Review
Transmission Entry and Exit Working Group Terms of Reference

Working Group: 2	**Chairperson:** Colin Bayfield
Title of Working Group: Transmission Entry and Exit (TEE)	

Background:

This Working Group has been formed by the GB SQSS Project Steering Group and forms part of the project for the Fundamental Review of the GB SQSS as detailed in the GBSQSS Fundamental Review Project Definition Document.

The draft GB SQSS dated 29 April 2008 contains a co-ordinated set of criteria and methodologies that the relevant transmission licensees will be required to use in the planning, operation and maintenance of the GB transmission system (i.e. both the onshore transmission system and the offshore transmission systems).

The onshore generation connection criteria set out in Section 2 of the GB SQSS, cover the connections which extend from the generation points of connection and reach into the main interconnected transmission system (MITS). The onshore demand connection criteria set out in Section 3, cover the connections which extend from the lower voltage side of the GSP transformers and again reach into the MITS. The criteria for minimum transmission capacity on the MITS set out in Section 4 extend from the generation points of connection through to the demand points of connection on the high voltage side of the GSP transformers.

Accordingly, there is a degree of overlap of criteria and in those parts of the GB transmission system where more than one set of criteria apply, the requirements of all relevant criteria must be met.

There is a range of issues relating to onshore transmission entry, onshore transmission exit and the MITS and these are, to a certain extent, interdependent. Separate Working Groups are to address issues relating to the main interconnected transmission system (WG3) and planning and operational contingency criteria (WG4). The focus of this Working Group is on the transmission entry and exit principles. Clearly close liaison with the other Working Groups will be necessary.

Scope:

The TEE Working Group will review the onshore generation connection and the onshore demand connection criteria of the GB SQSS and make change proposals as necessary. All change proposals should be relative to the draft GB SQSS dated 29 April 2008 rather than relative to the existing GB SQSS dated 2004. Offshore generation and demand connection criteria fall within the scope of the Offshore Transmission Systems work area (WG5).

Considerations will include:

- Alignment, where appropriate, of the onshore demand connection criteria with Engineering Recommendation (ER) P2/6;
- The treatment of demand transfer (i.e. the ability to transfer demand from one demand group to another) in assessing grid supply point compliance;
- The treatment of exporting grid supply points;
- Whether a deterministic approach for the establishing investment in local transmission capacity to provide a level of secure generation access is appropriate for all types of generation (e.g. conventional and intermittent);
- Whether revisions are appropriate to the deterministic criteria to take due account of potentially high levels of renewable intermittent generation in the 'background conditions' against which the generation connection criteria are applied;
- Develop appropriate criteria and/or methodologies, taking due account of the findings of the TAR, for local generation connections within a TEC Trading Zone;
- Customer Choice (i.e. the 'Variations to Connection Designs' clauses);
- Regional differences in criteria and methodologies (i.e. between the NGET, SPT and SHETL transmission systems);
- Overlap with the MITS; and
- Criteria for assessing the consequences of any change proposal.

In addition, the Working Group shall take due account of:

- Interactions with the work of other Fundamental Review Working Groups;
- The potential impact of the findings of other relevant reviews (e.g. Transmission Access Review, the 'Review of the 'Design of Generation Connections' (GSR 003) and the 'Review of Infeed loss Limits' (GSR007)); and
- In the context of any change proposals to the GB SQSS arising, compatibility with other industry Codes (e.g. GB Grid Code).

Deliverables:

The Working Group deliverables include:

- Outline Principles Document (15 October 2008)
  Written report to the Programme Manager on issues being addressed, new issues arising, approach adopted for addressing issues, progress to date and likely outcome (where reasonably known).
  The Programme Manager will then consolidate the individual 'Outline Principles Documents' from each Working Group into a single document and submit for consideration by the Project Steering Group.
- High Level Proposals (December 2008)
  Written report to the Programme Manager on progress in the form of high level proposals to address issues.
  The Programme Manager will then consolidate 'High Level Proposals' reports from all Working Groups into a single document and submit for consideration by the Project Steering Group (January 2009).

• Draft Change Proposals (May 2009)
Issue detailed proposals and assist the GB SQSS Drafting Working Group, as necessary, in developing draft change proposals to the GB SQSS in the form of additional and/or modified change proposals to the NGET change proposals dated 29 April 2008.
The Programme Manager, with the assistance of the GB SQSS Drafting Working Group, will consolidate the draft change proposals from all Working Groups into a single set of change proposals and submit for consideration by the Project Steering Group.

• Final Change Proposals (August 2009)
Issue final detailed proposals taking account of comments received on draft change proposals.
The Programme Manager, with the assistance of the GB SQSS Drafting Working Group, will prepare the consolidated set of change proposals to the GB SQSS (i.e. in the form of draft amendments to the draft GB SQSS dated 29 April 2008) and submit for consideration by the Project Steering Group.

• Final Change Proposals Consultation (First Consultation), (Sept to Oct 2009)
Assist the Project Steering Group, as required, to conduct a targeted consultation on the consolidated final change proposals with participants of the Industry Peer Review Group.
Following the First Consultation the GB SQSS Drafting Working Group will (with assistance of other Working Groups as necessary) amend the final change proposals to take due account of comments received. The revised final change proposals will be submitted to the Project Steering Group for onward submission to the GB SQSS Review Group for sign-off.
The Project Steering Group (on behalf of the GB SQSS Review Group) will then submit the final Change proposals to Ofgem.

In addition to the above, the Working Group shall:

- Prepare and maintain Working Group Risk and Assumptions Registers in accordance with the requirements set out in the Project Definition Document;
- Prepare and maintain a detailed plan covering the scope and deliverables contained within these Terms of Reference, again in accordance with the requirements set out in the Project Definition Document; and
- Liase with other Working Groups; particularly on areas of interaction; and take due account of other reviews which are currently in progress (e.g. Transmission Access Review).

Programme:

The Working Group detailed program should align with the overall Project Plan.

Members:

Provisional Working Group membership:

- Colin Bayfield SPT Chairperson
- David Carson SPT
- Roger Yuile SHETL
- Neil Carter NGET

Meetings:

The meetings for the Working Group will alternate between Scotland and England and consideration will be given to using technology to minimise travel requirements.

Approved by:

Project Manager:	Andrew Hiorns
Working Group Chairman:	Colin Bayfield
Date:	14 October 2008

Appendix B NETS SQSS Section 1 (Introduction) Code Recommendations

Onshore Criteria and Methodologies

1.10 The generation connection criteria applicable to the *onshore transmission system* are set out in Section 2 and cover the connections which extend from the *grid entry points (GEPs)* and reach into the *MITS*. The criteria also cover the risks affecting the *national electricity transmission system* arising from the *generation circuits*.

Overlap of Criteria[1]

1.24 As described above, and illustrated in Figures 1.1, 1.2 and 1.3, there will be parts of the *GB transmission system* where more than one set of criteria apply. In such places the requirements of all relevant criteria must be met.

1.25 In particular, should an *offshore transmission system* be connected to the onshore *MITS* by two or more *offshore transmission circuits* routed to different onshore *substation*s, those *offshore transmission circuits* would parallel the *MITS* and, accordingly, become classified as part of the *onshore transmission system.* In such cases the onshore criteria set out in Section 4, 5 and 6 would also apply to those *offshore transmission circuits*.

1.26 When determining the applicable connection security for Generation or Demand connection arrangements where that Generation or Demand is connected to the onshore transmission system, the following criteria philosophy should be applied:

Demand Connections – for sites which are exclusively or predominately demand connections, the applicable connection security is covered in section 3 "Demand Connection Criteria Applicable to the Onshore Transmission System"

Generation Connections - for sites which are exclusively for the purposes of generating electricity the appropriate connection security is detailed in section 2 "Generation Connection Criteria Applicable to the Onshore Transmission System".

Exporting GSPs – where sites are composite and have a mixture of demand connections and generation connections, the security afforded to the block of demand customers shall be not less than that provided for a standard demand connection of an identical size. The applicable security standard should therefore be the more secure of the corresponding criteria of section 2 or section 3.

Specifically excluded from this category is a generation site with on-site station demand. Such sites shall be treated as a Generation site connected to the onshore transmission system with appropriate security levels.

[1] It should be noted that the paragraph numbering relates to the baseline GBSQSS draft 9 version 2 dated 29 April 2008. Due to a paragraph removal (1.20), in the subsequently issued NETS SQSS Version 2.0 dated June 24, 2009, the corresponding paragraph numbers are 1.23, 1.24 with the additional paragraph being 1.25. The above code will require to take cognisance of the revised numbering.

Appendix C NETS SQSS Section 2 (Entry) Code Recommendations

2. Generation Connection Criteria Applicable to the Onshore Transmission System

2.1 This section presents the planning criteria applicable to the connection of one or more power stations to the onshore transmission system. The criteria in this section will also apply to the connections from a GSP to the onshore transmission system by which power stations embedded within a customer's network (e.g. distribution network) are connected to the onshore transmission system.

2.2 In those parts of the onshore transmission system where the criteria of Section 3 and/or Section 4 also apply, those criteria must also be met.

2.3 In planning generation connections, this Standard is met if the connection design either:

2.3.1 satisfies the deterministic criteria detailed in paragraphs 2.5 to 2.13; or

2.3.2 varies from the design necessary to meet paragraph 2.3.1 above in a manner which satisfies the conditions detailed in paragraphs 2.15 to 2.18.

2.4 It is permissible to design to standards higher than those set out in paragraphs 2.5 to 2.13 provided the higher standards can be economically justified. Guidance on economic justification is given in Appendix E.

Limits to Loss of Power Infeed Risks

2.5 For the purpose of applying the criteria of paragraph 2.6, the loss of power infeed resulting from a secured event on the onshore transmission system shall be calculated as follows:

2.5.1 the sum of the registered capacities of the generating units disconnected from the system by a secured event, plus

2.5.2 the planned import from any external systems disconnected from the system by the same event, less

2.5.3 the forecast minimum demand disconnected from the system by the same event but excluding (from the deduction) any demand forming part of the forecast minimum demand which may be automatically tripped for system frequency control purposes and excluding (from the deduction) the demand of the largest single end customer.

2.6 Generation connections shall be planned such that, starting with an intact system, the consequences of secured events on the onshore transmission system shall ensure that the loss of power infeed, for the aggregate of the dependent Local Capacity Nominations shall not exceed the levels specified in table 2.1.

2.7 The maximum length of overhead line connections in a generation circuit for generating units which are directly connected to the GB transmission system shall not exceed: [1]

2.7.1 5km for generating units of expected annual energy output greater than or equal to 2000 GWh; otherwise

2.7.2 20km.

[1] The overhead line length aspect of connection circuits will be considered within the follow-on work as outlined in section 7.4.

Generation Connection Capacity Requirements

Background conditions

2.8 The connection of a particular power station shall meet the criteria set out in paragraphs 2.9 to 2.13 under the following background conditions:

2.8.1 the active power output of the power station shall be set equal to its local capacity nomination;

2.8.2 the reactive power output of the power station shall be set to the full leading or lagging output that corresponds to an active power output equal to local capacity nomination; or, for the purpose of assessment of system stability, that which may reasonably be expected under the conditions described in paragraph 2.8.4;

2.8.3 for connections to an offshore transmission system, the reactive power output of the offshore power station/s shall normally, and unless otherwise agreed, be set to deliver zero reactive power at the offshore grid entry point with active power output equal to local capacity nomination; and the reactive power delivered at the interface point shall be set in accordance with the reactive requirements placed on the offshore transmission licensee set out in Section K of the STC (System Operator – Transmission Owner Code); and

2.8.4 conditions on the onshore transmission system shall be set to those which ought reasonably to be expected to arise in the course of a year of operation. Such conditions shall include forecast demand cycles, typical power station operating regimes and typical planned outage patterns modified where appropriate by the provisions of paragraph 2.11.

Pre-fault criteria

2.9 The transmission capacity for the connection of a power station shall be planned such that, for the background conditions described in paragraph 2.8, prior to any fault there shall not be any of the following:

2.9.1 equipment loadings exceeding the pre-fault rating;

2.9.2 voltages outside the pre-fault planning voltage limits or insufficient voltage performance margins; or

2.9.3 system instability.

Post-fault criteria – background condition of no local system outage

2.10 The transmission capacity for the connection of a power station shall also be planned such that for the background conditions described in paragraph 2.8 with no local system outage and for the secured event of a fault outage on the onshore transmission system of any of the following:

2.10.1 a single transmission circuit, a reactive compensator or other reactive power provider;

2.10.2 a double circuit overhead line;

2.10.3 a single transmission circuit with the prior outage of another transmission circuit;

2.10.4 a section of busbar or mesh corner; or

2.10.5 a single transmission circuit with the prior outage of a generating unit, a reactive compensator or other reactive power provider;

there shall not be any of the following:

2.10.6 a loss of supply capacity except as permitted by the demand connection criteria detailed in Section 3 or loss of generation capability comprising of the aggregate of the Local Capacity Nominations for that secured event shall not exceed the corresponding levels set out in Table 2.1;

2.10.7 unacceptable overloading of any primary transmission equipment;

2.10.8 unacceptable voltage conditions or insufficient voltage performance margins; or

2.10.9 system instability.

2.11 Under planned outage conditions it shall be assumed that the prior circuit outage specified in paragraphs 2.10.3 and 2.10.5 reasonably forms part of the typical outage pattern referred to in paragraph 2.8.4 rather than in addition to that typical outage pattern.

Post-fault criteria – background condition with a local system outage

2.12 The transmission capacity for the connection of a power station shall also be planned such that for the background conditions described in paragraph 2.8 with a local system outage on the onshore transmission system, the operational security criteria set out in Section 5 and Section 9 can be met.

2.13 Where necessary to satisfy the criteria set out in paragraph 2.12, investment should be made in transmission capacity except where operational measures suffice to meet the criteria in paragraph 2.12 provided that maintenance access for each transmission circuit can be achieved and provided that such measures are economically justified. The operational measures to be considered include rearrangement of transmission outages and appropriate reselection of generating units from those expected to be available, for example through balancing services. Guidance on economic justification is given in Appendix E.

2.14 For a secured event, the permitted loss of generation capability comprising of the aggregate of the Local Capacity Nominations for that secured event shall not exceed the corresponding levels set out in Table 2.1.

Table 2.1 Permitted Loss of Generation Capability (Aggregate LCN) for Secured Events

Generation Group	Group Aggregate Generation Capacity (Local Capacity Nomination)		Source Fuel Load Factor	Timescale	Initial and Subsequent System Conditions						
					Intact						Planned outage of any single transmission circuit, single section of busbar or mesh corner
	Minimum	Maximum			Planned outage of a single transmission circuit or single section of busbar	Planned outage of a single generator circuit	Fault of a single transmission circuit	Fault of a single generator circuit	Fault of any two transmission or generator circuits (on same double circuit overhead line)	Fault of a single section of busbar or mesh corner	Fault of any single transmission circuit, single section of busbar or mesh corner
A	0	< 50	<= 40%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			40 – 70%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			70 – 100%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
B	>=50	< 100	<= 40%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			40 – 70%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			70 – 100%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
C	>=100	<300	<= 40%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					50% of Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity
			40 – 70%	Immediately	Nil	Nil	Nil	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					50% of Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity
			70 – 100%	Immediately	50% of Total Group Generation Capacity	Nil	50% of Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					50% of Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity
D	>=300	<700	<= 40%	Immediately	50% of Total Group Generation Capacity	Nil	50% of Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					50% of Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity
			40 – 70%	Immediately	50% of Total Group Generation Capacity	Nil	50% of Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage	Total Group Generation Capacity	Total Group Generation Capacity					50% of Total Group Generation Capacity
				In time to restore fault			Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity
			70 – 100%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
E	>=700	Normal Infeed Loss (1,320)	<= 40%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			40 – 70%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			70 – 100%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	Nil	Nil	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
F	>=Normal Infeed Loss (1,320)	<Infrequent Infeed Loss Risk (1,800)	<= 40%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Nil	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			40 – 70%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Nil	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity	Total Group Generation Capacity	Total Group Generation Capacity	
			70 – 100%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	Nil	Nil
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	
G	> =Infrequent Infeed Loss Risk (1800)	<2 x Infrequent Infeed Loss Risk (3,600)	<= 40%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	TGGC less Infrequent Infeed Loss Risk
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	
			40 – 70%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	TGGC less Infrequent Infeed Loss Risk
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	
			70 – 100%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	TGGC less Infrequent Infeed Loss Risk
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	
H	> =2 x Infrequent Infeed Loss Risk (3,600)	-	<= 40%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	TGGC less Infrequent Infeed Loss Risk
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	
			40 – 70%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	TGGC less Infrequent Infeed Loss Risk
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	
			70 – 100%	Immediately	Total Group Generation Capacity	50% of Total Group Generation Capacity	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	Total Group Generation Capacity	TGGC less Normal Infeed Loss Risk	TGGC less Infrequent Infeed Loss Risk
				In time to restore outage		Total Group Generation Capacity					Total Group Generation Capacity
				In time to restore fault				Total Group Generation Capacity		Total Group Generation Capacity	

2.15 The load factor applicable for the Group Aggregate Generation Capacity reflects either a single generator development or a group of generator developments of identical technologies or load factors. Where neither scenario applies, then the applicable load factor can be derived by either:

2.15.1 Where more than one generator contributes to the Group Aggregate Generation Capacity and when those generators are of mixed technologies or with load factors in differing bands, then the equivalent load factor for the aggregate of N generators in the group can be determined by:

$$LF_E = \sum_1^N \left(\frac{(LocalCapacityNom)_N}{\sum_1^N (LocalCapacityNom)} \times (LF)_N \right)$$ Or;

2.15.2 Where, in planning timescales, the generator load factor for application in table 2.1 is unknown or remains undefined, a generic load factor for the source energy from table 2.2 can be utilised:

Table 2.2 Generic Generator Load Factor

Source Energy	Generic Load Factor
Biomass	0.85
CCGT	0.75
CHP (Continuous Process)	0.75
CHP (Landfill)	0.80
Coal / Clean Coal	0.75
Hydro	0.40
Nuclear	0.75
Tidal	0.45
Wave	0.25
Wind	0.30

Switching Arrangements

2.16 Guidance on substation configurations and switching arrangements are described in Appendix A. These guidelines provide an acceptable way towards meeting the criteria of paragraph 2.6. However, other configurations and switching arrangements which meet those criteria are acceptable.

Variations to Connection Designs

2.17 Variations, arising from a generation customer's request, to the generation connection design necessary to meet the requirements of paragraphs 2.5 to 2.13 shall also satisfy the requirements of this Standard provided that the varied design satisfies the conditions set out in paragraphs 2.16.1 to 2.16.3. For example, such a generation connection design variation may be used to take account of the particular characteristics of a power station.

2.18 Any generation connection design variation must not, other than in respect of the generation customer requesting the variation, either immediately or in the foreseeable future:

2.18.1 reduce the security of the MITS to below the minimum planning criteria specified in Section 4; or

2.18.2 result in additional investment or operational costs to any particular customer or overall, or a reduction in the security and quality of supply of the affected customers' connections to below the planning criteria in this section or Section 3, unless specific agreements are reached with affected customers; or

2.18.3 compromise any transmission licensee's ability to meet other statutory obligations or licence obligations.

2.19 Should system conditions subsequently change, for example due to the proposed connection of a new customer, such that either immediately or in the foreseeable future, the conditions set out in paragraphs 2.18.1 to 2.18.3 are no longer satisfied, then alternative arrangements and/or agreements must be put in place such that this Standard continues to be satisfied.

2.20 The additional operational costs referred to in paragraph 2.18.2 and/or any potential reliability implications shall be calculated by simulating the expected operation of the GB transmission system in accordance with the operational criteria set out in Section 5 and Section 9. Guidance on economic justification is given in Appendix E.

Appendix D NETS SQSS Section 3 (Exit) Code Recommendations

3. Demand Connection Criteria Applicable to the Onshore Transmission System

3.1 This section presents the planning criteria applicable to the connection of demand groups to the remainder of the GB transmission system.

3.2 In those parts of the GB transmission system where the criteria of Section 2 and/or Section 4 also apply, those criteria must also be met.

3.3 In planning demand connections, this Standard is met if the connection design either:

3.3.1 satisfies the deterministic criteria detailed in paragraphs 3.6 to 3.11; or

3.3.2 varies from the design necessary to meet paragraph 3.3.1 above in a manner which satisfies the conditions detailed in paragraphs 3.17 to 3.20.

3.4 It is permissible to design to standards higher than those set out in paragraphs 3.6 to 3.11 provided the higher standards can be economically justified. Guidance on economic justification is given in Appendix E.

Demand Connection Capacity Requirements

3.5 The Group Demand which is applicable for the assessment of connection capacity requirements is dependent on the nature of the associated connections, i.e.:

3.5.1 where the network associated with a transmission connection comprises solely of demand connections, i.e.

- there are no power stations of any size, and
- the process generation associated with any composite-user site does not have the ability to exceed the associated on-site demand,

the Group Demand is equal to the Network Operator's estimated maximum demand for the group which they believe could reasonably be imposed on the GB transmission system, after taking due cognisance of demand diversity.

3.5.2 where the underlying network hosts connections to Small or Medium power stations (or composite user sites with export potential), the generation can result in differences between the true and measured demand. The group demand therefore shall be equal to the Network Operator's estimated maximum demand for the group, which they believe could reasonably be imposed on the GB transmission system after making an appropriate allowance for load diversity and any demand masked by the export from Small and Medium power stations which are not expected to have the same operating regime in the future.

3.5.3 where the network associated with a transmission connection hosts the connection of one or more large power stations, irrespective of whether the large power station is connected at the transmission interface point or embedded within the Network Operator's system, the Group Demand at the date and time of the system/site maximum demand or other relevant assessment period is equal to:

3.5.3.1 the Network Operator's Group Demand in accordance with either paragraph 3.5.1 or 3.5.2, plus (where relevant for system connectivity and power flows):

3.5.3.2 the output of Large Power Station(s)

Where considered appropriate, diversity may be applied to the summation of the power flows arising from consideration of paragraphs 3.5.3.1 and 3.5.3.2.

3.6 The transmission capacity for the connection of a particular demand group shall meet the criteria set out in paragraphs 3.7 to 3.11 under the following background conditions:

3.6.1 when there are no planned outages, the demand of the demand group shall be set equal to group demand;

3.6.2 when there is a planned outage local to the demand group, the demand of the demand group shall be set equal to maintenance period demand;

3.6.3 the security contribution of Small and Medium power stations embedded is implicitly accounted for in the group demand established by the Network Operator as in paragraph 3.5.2 and need not be considered separately;

3.6.4 the security contribution of Large power stations embedded within a Customer's network (e.g. a distribution network) or connected at the transmission interface point, shall be as specified in section 3.13 and Table 3.2

3.6.5 any transfer capacity (i.e. the ability to transfer demand from one demand group to another) declared by Network Operators shall be represented taking account of any restrictions on the timescales in which the transfer capacity applies; and

3.6.6 demand and generation outside the demand group shall be set in accordance with the planned transfer conditions using the appropriate method described in Appendix C.

3.7 The transmission capacity for the connection of a demand group shall be planned such that, for the background conditions described in paragraph 3.6, under intact system conditions there shall not be any of the following:

3.7.1 equipment loadings exceeding the pre-fault rating;

3.7.2 voltages outside the pre-fault planning voltage limits or insufficient voltage performance margins; or

3.7.3 system instability.

3.8 The transmission capacity for the connection of a demand group shall also be planned such that for the background conditions described in paragraph 3.6 and for the planned outage of a single transmission circuit or a single section of busbar or mesh corner, there shall not be any of the following:

3.8.1 a loss of supply capacity for a group demand of greater than 1 MW;

3.8.2 unacceptable overloading of any primary transmission equipment;

3.8.3 voltages outside the pre-fault planning voltage limits or insufficient voltage performance margins; or

3.8.4 system instability.

3.9 The transmission capacity for the connection of a demand group shall also be planned such that for the background conditions described in paragraph 3.6 and the initial conditions of

3.9.1 an intact system condition; or

3.9.2 the single planned outage of another transmission circuit, generating unit, a reactive compensator or other reactive power provider,

for the secured event of a fault outage of

3.9.3 a single transmission circuit,

there shall not be any of the following:

3.9.4 a loss of supply capacity such that the provisions set out in Table 3.1 are not met;

3.9.5 unacceptable overloading of any primary transmission equipment;

3.9.6 unacceptable voltage conditions or insufficient voltage performance margins; or

3.9.7 system instability.

3.10 In addition to the requirements of paragraphs 3.7 to 3.9, for the background conditions described in paragraph 3.6, the system shall also be planned such that operational switching does not cause unacceptable voltage conditions.

3.11 For a secured event on connections to more than one demand group, the permitted loss of supply capacity for that secured event is the maximum of the permitted loss of supply capacities set out in Table 3.1 for each of these demand groups.

Table 3.1 Minimum planning supply capacity following secured events

Class	Group Demand		Initial system conditions	
	Minimum	Maximum	Intact system	With single *planned outage*[Note 1]
A	0	≤1 MW	**In repair time** *Group Demand*	Nil
B	>1 MW	≤12 MW	**Within 3 hours** *Group Demand* minus 1 MW **In repair time** *Group Demand*	Nil
C	>12 MW	≤60 MW	**Within 15 minutes** Smaller of (*Group Demand* minus 12MW) and two-thirds of *Group Demand* **Within 3 hours** *Group Demand*	Nil
D	>60 MW	≤300 MW	**Immediately** *Group Demand* minus 20 MW[Note 2] **Within 3 hours** Group Demand	**Within 3 hours** Smaller of (*Group Demand* minus 100 MW) and one-third of *Group Demand*. **Within time to restore *planned outage*** *Group Demand*
E	>300 MW	≤1500 MW	I**mmediately** *Group Demand*[Note 3]	**Immediately** *Maintenance Period Demand* **Within time to restore *planned outage*** *Group Demand*
F	>1500 MW	∞	I**mmediately** *Group Demand*	**Immediately** *Group Demand*

Note 1 The planned outage may be of a transmission circuit, generating unit, reactive compensator or other reactive power provider

Note 2 The group demand may be lost for up to 60 seconds if this leads to significant economies

Note 3 Up to 60MW may be lost for up to 60 seconds if this leads to significant economies

Assessment of Contribution to Security from Generation

3.12 Where network assets are insufficient to meet the security requirements, it is necessary to assess the contribution to security from large power stations connected at either the transmission connection interface or embedded within the Network Operator's system. This will identify whether the aggregate generation capacity of the large power station connected to the network has the potential to meet any deficit in System Security from network assets.

3.13 The combined contribution by Large power stations shall never have a greater impact on system security than the loss of the largest circuit infeed to the group. The contributions from local power stations provide additional capacity to enable the supply of demand which may not otherwise be met following a secured event, but shall not replace the requirement for system connection. The assessment of contribution of generation to group security will therefore consider;

3.13.1 the generation annual load factor

3.13.2 the availability of generation under outage conditions

3.13.3 the fuel source availability, i.e. whether energy is continuous, stored, storable or predictable

3.13.4 common-mode failure mechanisms such as common fuel source, connections or plant stability / ride-through capability

3.13.5 capping of generation contribution in the event that the generation contribution is dominant with respect to circuit infeed capability.

3.14 The effective contribution of Large power stations to demand group importing capacity, shall not exceed the levels indicated in table 3.2 while taking due account of the considerations detailed in section 3.13

Table 3.2 Maximum effective contribution of embedded Large Power Stations to *demand group* importing capacity (% of LCN)

	Generation Technology	Persistence (Hours)							
		1/2	2	3	18	24	120	360	>360
Non-Intermittent Fuel Sources	Landfill Gas	63%							
	CHP	40%							
	CCGT	63%							
	Biomass	58%							
Intermittent Fuel Sources	Wind	28%	25%	24%	14%	11%	0%	0%	0%
	Hydro	37%	36%	36%	34%	34%	25%	13%	0%
	Wave	28%	25%	24%	14%	11%	0%	0%	0%
	Tidal	14%	12%	10%	5%	0%	0%	0%	0%

Switching Arrangements

3.15 Guidance on substation configurations and switching arrangements are described in Appendix A. These guidelines provide an acceptable way towards meeting the criteria of this chapter. However, other configurations and switching arrangements which meet the criteria are also acceptable.

Variations to Connection Designs

3.16 Variations, arising from a demand customer's request, to the demand connection design necessary to meet the requirements of paragraphs 3.6 to 3.11 shall also satisfy the requirements of this Standard provided that the varied design satisfies the conditions set out in paragraphs 3.18.1 to 3.18.3 For example, such a demand connection design variation may be used to reflect the nature of connection of embedded generation or particular load cycles.

3.17 Any demand connection design variation must not, other than in respect of the demand customer requesting the variation, either immediately or in the foreseeable future:

3.17.1 reduce the security of the MITS to below the minimum planning criteria specified in Section 4; or

3.17.2 result in additional investment or operational costs to any particular customer or overall, or a reduction in the security and quality of supply of the affected customers' connections to below the planning criteria in this section or Section 2, unless specific agreements are reached with affected customers; or

3.17.3 compromise any GB transmission licensee's ability to meet other statutory obligations or licence obligations.

3.18 Should system conditions change, for example due to the proposed connection of a new customer, such that either immediately or in the foreseeable future, the conditions set out in paragraphs 3.18.1 to 3.18.3 are no longer satisfied, then alternative arrangements and/or agreements must be put in place such that this Standard continues to be satisfied.

3.19 The additional operational costs referred to in paragraph 3.18.2 and/or any potential reliability implications shall be calculated by simulating the expected operation of the GB transmission system in accordance with the operational criteria set out in Section 5 and Section 9. Guidance on economic justification is given in Appendix E.

Appendix E NETS SQSS Section 11 (Definitions) Code Recommendations

Recommendations for additional Terms and Definitions arising from proposed modifications to sections 2 and 3 of the NETS SQSS which will require to be included within Section 11 of the Standard:

Connection Entry Capacity	
Declared Net Capacity (DNC)	The total gross generating capability (in MW) of a distributed Generation (DG) plant less the on-site demand of the generating station auxiliary equipment.
Group Aggregate Generation Capacity	The arithmetical summation of the Local Capacity Nomination or Declared Net Capacity (DNC) whichever is applicable (expressed in MW) for each generation site connected to a single transmission connection point. No allowance is made for diversity or non-simultaneous peaks.
Group Demand	For a single GSP or OSP: The Network Operator's or Embedded Customer's forecast maximum demand for the GSP or OSP taking demand from the GB transmission system, taking account of diversity/non-enduring 'negative demand' and provided in accordance with the requirements of the Grid Code. For multiple GSPs or OSPs: The sum of the Network Operator's or Embedded Customer's forecast maximum demands for the GSPs or OSPs taking demand from the GB transmission system, taking account of diversity/non-enduring 'negative demand' and provided in accordance with the requirements of the Grid Code.
Local Capacity Nomination	The maximum volume (MW) to which a Generator is entitled to obtain transmission access products (and/or overrun) which will not exceed the Connection Entry Capacity of that Generator. Local Capacity Nomination can be shared by multiple Generators when requested by those Generators, and will form the basis on which charges are levied in return for transmission access and provision of the assets required to facilitate this.
Maintenance Period Demand	This is the demand level expected to be experienced by a GSP or Access Group, provided in accordance with the requirements of the Grid Code by Network Operators or non-embedded customers taking demand from the National Electricity Transmission System. This level should be such that the period in which maintenance could be undertaken is not unduly limited. In the absence of data of adequate quality, Maintenance Period Demand should be set at 67% of the Group Demand.
Transfer Capacity	Where, for the purposes of assessing the security of an Access Group, the Network Operator reasonably considers it appropriate that revised User System configurations (potentially including revised demand information) should be taken into account, the Network Operator shall submit data in accordance with the requirements of the Grid Code. Effectively, this defines that circuit capacity which can be made available from adjacent demand groups within prescribed times periods.