



**GRID CODE
CONSULTATION DOCUMENT**

**Grid Code Requirements for Synchronous
Generating Units Exceeding Rated MW**

The purpose of this document is to consult on the above Grid Code Modification Proposal with authorised electricity operators liable to be materially affected by the proposed changes and forms the basis of the subsequent Report to the Authority

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SUMMARY OF PROPOSALS

- 0.1 Reactive power capability requirements for Synchronous Generating Units are set out within CC.6.3.2 of the Grid Code. The provisions specify that when a Synchronous Generating Unit is operating at its original designed output (Rated MW) it must be capable of supplying Reactive Power in the range between 0.85 Power Factor Lagging (Export) and 0.95 Power Factor Leading (Import).
- 0.2 Ongoing improvements in the efficiency of turbine blades means that generators are able to extract more mechanical power, and consequently supply more active electrical power, from the same amount of fuel without making changes to the boiler/gas burner or the electrical generator. When more efficient blades are fitted as part of a unit's refurbishment, this results in the ability to operate above the Rated MW level for the unit.
- 0.3 Such operation is beneficial both financially and environmentally as more energy is produced from the same amount of fuel. However, at operating levels above Rated MW the Reactive Power capability of the unit is reduced. National Grid has expressed concerns regarding the potential implications for the GB Transmission System (in both planning and operational timescales) of Synchronous Generating Units exceeding their Rated MW and consequently reducing the reactive power capability available to the system. When written, the existing Grid Code provisions did not necessarily envisage Synchronous Generating Units operating, for any substantial length of time, above their Rated MW.
- 0.4 Currently, a Generating Unit may operate above Rated MW providing this would be within the Performance Chart, Unit CEC, Registered Capacity, MEL and PN. Where a Generator has requested an increase in CEC above Rated MW, such that National Grid becomes specifically aware of potential operation above Rated MW, conditions have been included in the Bilateral Agreement to ensure that system security can be maintained without excessive operational costs. In circumstances where National Grid is not aware of such operation any system impact cannot be taken into account.
- 0.5 The proposal is an interim measure that will:
 - allow new generators and those subject to CEC increases to operate above Rated MW whenever possible, but require them to reduce their output when this is required for Transmission System security;
 - preserve the arrangements for existing generators
 - not result in additional transmission investment or operational costs;
 - not require additional investment by generators.
- 0.6 A separate Grid Code Working Group will be tasked with considering the wider issue of the provision of reactive power by all types of generators across the whole of their operating range.
- 0.7 The existing provision relating to Non Synchronous Generating Units have been deemed to be still appropriate and valid for this type of plant and therefore the proposed Grid Code amendment is not applicable to this type of plant.

A. INTRODUCTION

1. Paragraph 2 of Condition C14 of the Transmission Licence granted to the National Grid Electricity Transmission plc ("National Grid") provides that National Grid shall, in consultation with Authorised Electricity Operators liable to be materially affected thereby, periodically review the Grid Code and its implementation. That paragraph also requires National Grid, following such review, to send to the Authority:-
 - (a) a report on the outcome of such review;
 - (b) any proposed revisions to the Grid Code as National Grid (having regard to the outcome of such review) reasonably thinks fit for the achievement of the objectives set out in sub-paragraph (b) of Condition C14 of the Transmission Licence; and
 - (c) any written representations or objections from Authorised Electricity Operators (including any proposals by such operators for revisions to the Grid Code not accepted by National Grid in the course of the review) arising during the consultation process and subsequently maintained.
2. This review examines proposed clarification to the Grid Code regarding the appropriate technical obligations for Synchronous Generating Units who operate above their Rated MW level. The proposals were developed through the Grid Code Rated MW Working Group.
3. The proposed changes to the Grid Code were discussed with the Grid Code Review Panel (GCRP) on 5th February 2009. Panel Members agreed that National Grid should issue a Consultation Paper regarding the proposed changes.
4. Comments upon the proposed changes within this consultation should be sent to National Grid by **16th March 2009** as detailed in section C. The comments will be reviewed and responded to.
5. Following this consultation, National Grid will prepare a Report to the Authority detailing National Grid's recommended changes to the Grid Code and all comments/responses received from Authorised Electricity Operators through this consultation. Once sent to the Authority this report will be made available on National Grid's website.
6. Where Authorised Electricity Operators' responses have been marked as confidential they will not be published within the version of the Report to the Authority placed on the National Grid website.
7. The revisions to the Grid Code proposed by National Grid and sent to the Authority, require approval by that body and will, if approved, come into force on such date (or dates) of which you will be notified by National Grid, in accordance with the Authority's approval.

B. DESCRIPTION OF THE PROPOSED AMENDMENTS AND THEIR EFFECTS

8. Background

- 8.1 Reactive power capability requirements for Synchronous Generating Units are set out within CC.6.3.2 of the Grid Code. The provisions specify that when a Synchronous Generating Unit is operating at its original designed output (Rated MW) it must be capable of supplying Reactive Power in the range between 0.85 Power Factor Lagging (Export) and 0.95 Power Factor Leading (Import).
- 8.2 The provisions do not specify the reactive capability requirements at active power levels other than Rated MW. They assume that a Synchronous Generating Unit's capability will be determined by its performance chart. When the obligations were incorporated into the Grid Code it was not envisaged that Generating Units would operate above Rated MW for any substantial length of time.
- 8.3 The Grid Code provisions are utilised to plan and operate the GB Transmission System in accordance with National Grid's licence conditions¹. Any deviations from the capabilities assumed in planning studies could have detrimental implications for the GB Transmission System in the form of losing local voltage support and reducing the transient, dynamic and voltage stability margins. This could lead to an increase in infrastructure and operational costs which will affect all system users.
- 8.4 Ongoing improvements in the efficiency of turbine blades means that generators are able to extract more mechanical power, and consequently supply more active electrical power, from the same amount of fuel without making changes to the boiler/gas burner or the electrical generator. When more efficient blades are fitted as part of a unit's refurbishment this results in the ability to operate above the Rated MW level for the unit. This operation at higher efficiency has both economic and environmental benefits associated with producing electrical energy from less fuel.
- 8.5 In some cases the potential operation of Synchronous Generating Units above their Rated MW has been brought to the attention of National Grid via the CUSC modification process as it has close interaction with a formal request to increase the Power Station's TEC/CEC (Unit) allocation. These instances have been managed on an individual basis via amendments to the Power Station's Bilateral Agreement. The conditions specified in the Bilateral Agreement have been site specific and reflective of the local system constraints and operational conditions relevant to that individual Generator at its point of connection i.e. there have been no generic provisions.
- 8.6 It has been acknowledged by National Grid and generators that the current ad-hoc arrangements for managing the technical implications of Synchronous Generating Units exceeding their Rated MW do not provide the level of transparency regarding the associated technical obligations currently expected by Users, and increase complexity in operating the Transmission System.

¹ SHETL and SPT have a similar licence obligation regarding planning of their Transmission System.

9. Working Group Discussions

- 9.1 The rationale behind the proposals was developed through discussions in the Grid Code Rated MW Working Group. The Working Group Terms of Reference and the complete record of how the change proposals were developed can be found in the Working Group Report:

https://www.nationalgrid.com/uk/Electricity/Codes/gridcode/workinggroups/gener_units Rated mv/

- 9.2 The Generating Units exceeding their Rated MW Working Group was established and tasked with discussing and reviewing the technical issues raised by Synchronous Generating Units operating above their Rated MW level, and proposing a technical solution to the matter.
- 9.3 Reactive power (MVar) is required to operate a power system and is associated with the control of voltage. The provision of reactive power to support voltages is a localised issue, as transmission of reactive power degrades much more quickly than MW over distance. Therefore the utilisation (and associated capability) of reactive power on the GB Transmission System can be extremely critical in some geographical areas.
- 9.4 Synchronous Generating Units could, if permitted, operate above Rated MW up to a level which is determined by the physical constraints of the unit. The design of the GB Transmission System was based upon operation at Rated MW and that operation above this baseline would have an impact on National Grid. National Grid has obligations to design and maintain a secure, efficient and economic system, within the terms of the Grid Code and the GB Security and Quality of Supply Standards (GBSQSS). Synchronous Generating Units exceeding their Rated MW may result in additional investment being required on the GB Transmission System, mainly as reactive compensation to make up the shortfall no longer available from generators operating above their Rated MW.
- 9.5 It was agreed that it was important to gauge the scale and consequential impact on the GB Transmission System of any operation at levels above Rated MW. Historically the assumption was that Synchronous Generating Units could not exceed their Rated MW for any significant length of time although this was not always the case. If further Synchronous Generating Units now began operating differently it may require National Grid (and other Transmission Owners where applicable) to design, operate and maintain the system in a different way.

9.6 Quantifying the Issue

- 9.6.1 At present it is mostly pre-vesting plant which has the greatest potential for operating above their Rated MW as it is most likely to be undergoing refurbishment. It was noted that all types of plant had the potential for operating above their Rated MW following refurbishment. Advice received indicated that it was technically feasible for Synchronous Generating Units to operate between 5% and 10% above their Rated MW following turbine blade replacement. The cumulative effect of a sizable portion of the generation fleet exceeding their Rated MW by this amount would have a material impact on the GB Transmission System in terms of the provision of Reactive Power on the system.
- 9.6.2 Analysis completed by National Grid attempted to quantify the cumulative effects, across one GB Transmission System boundary with well known reactive

capability requirements. The analysis was based on all pre-vesting coal-fired plant operating at 5% and 10% above their Rated MW with a reduced reactive power capability in line with unit's MVA rating.

- 9.6.3 The analysis found that should all the pre-vesting Generators operate 5% above their Rated MW it would necessitate the installation of an additional 5 Mechanically Switched Capacitors (MSCs) at a cost of £30m. Should the Generators operate 10% above their Rated MW it would necessitate an additional 20+ MSCs at a cost of £150m, and thermal reinforcement work to accommodate the increased transfers of £80m giving a total investment cost of £230m.
- 9.6.4 The study assumed that the increase in MW would result in other Generating Units being taken off. It was acknowledged that by pulling back the non pre-vesting generation to keep the system in balance, as opposed to taking units off, the overall impact of those units operating above Rated MW on this boundary would be less. However, it was thought unlikely that there would be large numbers of units operating at part load. It was noted that an increased output from some Synchronous Generating Units may displace other plant which may not be able to operate above their Rated MW.
- 9.6.5 The study undertaken did not consider any issues regarding stability, which may require dynamic Static VAR Compensator's (SVC) which are significantly more expensive than MSCs. The additional investment, on the GB Transmission System identified by the study did not form part of current allowed capital expenditure, as agreed under the current Price Control Reviews.
- 9.6.6 It was agreed that further, more detailed, analysis of the costs was not necessary, as it was acknowledged that assessment of the benefits of generation operating above Rated MW for comparison with the costs of managing/operating the system is very difficult; requiring prediction of the effects on market MW prices.
- 9.6.7 The ability of National Grid to pull back Synchronous Generating Units to their Rated MW level within gate closure was discussed. National Grid informed the group that it would be difficult to analyse, process and inform the relevant Power Station of the necessary instruction within gate closure, more time would be required especially if there were a number of Power Stations operating above Rated MW.

9.7 Potential Solutions

- 9.7.1 The Working Group discussed various solutions which would address both National Grid's and User's requirements regarding Synchronous Generating Units exceeding their Rated MW. Each potential solution was discussed, the debate focusing on the technical, planning and operational practicalities of the particular solution.

Site Specific Criteria

- 9.7.2 This is the current arrangement. Synchronous Generating Units would be allowed to exceed their Rated MW in a limited set of circumstances specified in the Bilateral Agreement (to be determined by National Grid).
- 9.7.3 This arrangement does not provide any transparency regarding the requirements. From an operational perspective it will make managing the

system more complex given the possibility that each Synchronous Generating Unit could have a different set of obligations regarding the provision of Reactive Power.

'Top-Hat' Approach

- 9.7.4 A potential solution of providing a reactive power capability equivalent to 0.85 lagging to 0.95 leading power factor at Rated MW at Active Power outputs up to 'x%' above Rated MW ('top-hat' approach) was evaluated. Additional analysis undertaken by National Grid attempted to quantify the reinforcement required to cater solely for the loss of generator MVAR capability (compared with a capability of 0.85 power factor lagging at the output level) from those Generating Units exceeding their Rated MW. This involved redistributing the generation as in the 110% Rated MW study previously undertaken, but modelling the Generating Units with 0.85 power factor lagging capability at the increased MW output. These studies identified the reinforcements required for the altered Active Power transfers. Subtracting this requirement from the total requirement previously identified showed a need for approximately 13 MSCs in the 110% study that could be attributed to the reduced Reactive Power capability. For a 5% rise in MW output no significant additional investments were identified.
- 9.7.5 It was noted that these studies were very limited, having considered only one boundary and one demand level, and that further work would be necessary to inform a full cost/benefit analysis.
- 9.7.6 Further consideration was given to allowing generators to operate up to 105% Rated MW with a reactive capability equal to the range required at Rated MW, whilst for output levels exceeding 105%, the Synchronous Generating Unit would be required to provide a capability between 0.85 power factor lagging and 0.95 power factor leading at the higher level.
- 9.7.7 This approach would result in limited additional capital expenditure by National Grid (which resulted in the percentage cap). However information from the generator community indicated that it would not be possible to deliver the top hat approach within the existing thermal capability of the machine (due to physical constraints of the plant) and it would be difficult to assess whether additional investment would enable this capability without extensive tests which would take months to plan and ascertain results from.

Transient Capability Solution

- 9.7.8 The concept of different continuous and short term reactive power capabilities was identified as a potential solution. In practice this would mean allowing the despatch of MVAR within a reduced capability (for example 0.90 power factor lagging which is comparable to MW output 6% above Rated MW) during normal operation of the GB Transmission System. During post fault circumstances the Synchronous Generating Unit would have to be capable of providing 0.85 lagging at their pre-fault MW output level for a limited period.
- 9.7.9 During this time National Grid would re-configure the network to alleviate the effects of the fault. After this period of time the Synchronous Generating Unit transformer would be tapped to return the unit's output to within its performance chart. It was noted that if National Grid had not rectified the problem within the specified time slot, it would take Bid Offer Acceptances (BOA) either to reduce the MW of the unit to allow the reactive power output to be sustained or from other Generating Units in order to reduce the reactive output requirement of the unit being stressed. Initial indicators have suggested that BOA expenditure

would be significantly less than the cost of procuring additional MSCs.

- 9.7.10 Analysis has illustrated that it is rare for National Grid to despatch a Generating Unit outside the 0.90 lagging envelope (analysis based on sample size from Generators across the GB Transmission System) during normal operation of the GB Transmission System. The National Grid Electricity Control Room indicated that 1.5 hours was an acceptable timeline to re-configure the network to alleviate the effects of the faults and/or to issue BOAs.
- 9.7.11 The solution would result in a change to the leading side capability. If the capability followed the excitation limiter characteristic there would be a slight reduction in the amount of MVar available. The magnitude of these changes is such that, in terms of voltage control, they will not have a material effect on the planning and operation of the system. Furthermore, with the exception of a few units, the lead MVar capability is only required overnight when machines are less likely to be operating at full output.
- 9.7.12 This solution would not result in any additional capital expenditure to be incurred by National Grid and the other Transmission Owners and would also simplify and add clarity to the Reactive Power provisions.
- 9.7.13 It was recognised that this arrangement would address all of the issues. However, following further consideration it became evident that the time for which a Generating Unit can operate outside its continuous rating under all circumstances is difficult to identify and likely to be shorter than the time required by National Grid to secure the GB Transmission System. Therefore it was agreed that this proposal could not be implemented due to the technical limitations of the Synchronous Generating Units.

9.8 Market Arrangements

- 9.8.1 It was acknowledged that there may be some benefit in developing the existing commercial/market mechanism for the mandatory provision of reactive power which would operate alongside the formal technical requirements specified in the Grid Code. It was acknowledged that the correct mix of technical requirements and commercial arrangements could provide the optimum solution for the mandatory provision of reactive power which is required for the security of the GB Transmission System.
- 9.8.2 As such a formal request was made to the Balancing Services Standing Group (BSSG) to consider the following questions:
- If there was a reduction in the technical requirements for the mandatory provision of Reactive Power, from 0.85 to 0.90 on the lagging side, could the market support the procurement of the 'shortfall' of MVar via an appropriate 'commercial/market mechanism'?
 - Could the market support the procurement of MVar for a 0.85 lagging transient (post fault) requirement? If yes, what would be the market arrangements?
- 9.8.3 The BSSG indicated that it would be possible to develop commercial arrangements for the provision of MVar such that the technical provisions may be re-evaluated. The BSSG asked for additional clarification regarding the size of the potential problem such that the optimum solution may be identified and

developed accordingly.

- 9.8.4 Quantification of the problem would be a significant piece of work which would require time to complete. The assessment would have to consider the cost of National Grid procuring the additional MVar (e.g. compensation equipment) against the cost to Generators of procuring larger Units which would be able to fulfil the reactive power requirements at all operating levels and as such was deemed to be a wider issue than that being considered by the proposed amendment.

9.9 New Technologies Implications

- 9.9.1 At May 2008 GCRP² National Grid presented a paper which identified potential Grid Code compliance issues for new technologies. The capability of new technology generation to comply with the existing reactive power provisions has been identified as a potential issue
- 9.9.2 To address the new technology and market arrangements issues, National Grid proposed the establishment of a joint BSSG/Grid Code Working Group to discuss the reactive power issues. National Grid recommended that this new Working Group complete the necessary analysis required to quantify the size of the issue and look more closely at the feasibility of modifying the existing technical performance obligations.

10. Proposed Solution

- 10.1.1 Given the pending review of appropriateness of the existing technical performance obligations for reactive power by a different Working Group, the proposed solution is an interim arrangement which may be summarised as follows and will:

- alleviate National Grid's concerns regarding system security;
- enable Generators to operate above Rated MW as often as possible;
- apply consistent, visible operating conditions to all generators.

- 10.1.2 For existing units that have conditions specified in their Bilateral Agreement relating to their reactive power capability at outputs above Rated MW, the existing arrangements will be preserved and the Grid Code will specify that for such units the Bilateral Agreement may specify the reactive capability requirements.

- 10.1.3 For existing units that operate above Rated MW (ie. they have a CEC (Connection Entry Capacity) greater than Rated MW) but have no relevant provisions in the Bilateral Agreement, the existing arrangements will continue and the Grid Code requirements will be unchanged.

- 10.1.4 For new connections, and for existing power stations that request a formal increase in their CEC, above Rated MW, the Grid Code will specify the following additional technical requirements:

- the Generating Unit must be capable of continuous operation at least 0.9 p.f. lagging;

² https://www.nationalgrid.com/NR/ronlyres/18EE6072-C4DA-4526-97C1-FEE54C81E88B/25330/pp08_21_NewGenTechfinal.pdf

- the leading power factor capability will be based on the under excitation limiter characteristic;
- National Grid will be able to request that a Generating Unit submits a Physical Notification (PN) no higher than its Rated MW at no cost should it see a system need (providing the unit has a reduced reactive power capability at the higher output level). The request will be made as soon as National Grid determine there is a system need and will be at least 1 hour prior to gate closure.

10.1.5 It is also proposed to clarify that when operating at output levels other than Rated MW, Synchronous Generating Units should operate to the performance chart of the Unit.

10.1.6 The proposal will allow Generating Units to operate above Rated MW whenever possible without reducing system security or requiring Transmission System investment. The proposal will ensure greater consistency and clarity of the requirements for Generating Units.

10.1.7 The proposal includes a mechanism for enabling National Grid to instruct a Synchronous Generating Unit to resubmit their PN when there is a system need, as long as this instruction is received at least 1 hour prior to gate closure. A Transmission Related Agreement (TRA) will sit alongside the Bilateral Agreement to allow National Grid to recoup BOA costs where these have been incurred as a result of a generator failing to resubmit its PN.

11. Proposed Grid Code Changes

11.1 It is proposed to amend the Connection Conditions and Balancing Code 1 (Pre-Gate Closure) of the Grid Code such that it:

- allows generators to operate above Rated MW, and realise the benefits of using more efficient plant, when there is no risk to GB Transmission System security;
- preserves current arrangements for existing parties;
- specifies consistent, visible reactive capability requirements for new plant and existing plant wishing to increase its output;
- will not result in increase expenditure on the GB Transmission System.

11.2 The proposed changes to the relevant clauses of Balancing Code 1 (Pre-Gate Closure) and the Connection Conditions are shown in Appendix A.

12. Impact on GB Transmission System

12.1 The proposed changes will ensure that use can be made of more efficient technologies being developed for generating plant, with both cost and environmental benefits, without incurring additional system investment costs or reducing the security of the GB Transmission System.

13. Impact on Grid Code Users

13.1 The Grid Code is currently silent regarding Synchronous Generating Units' MVAR output requirements at operating levels above and below Rated MW. The proposals will provide clarity to the Grid Code community regarding the associated technical obligations for Synchronous Generating Units' operating above or below their Rated MW.

13.2 The additional technical obligations for new connections (or existing power stations requesting an increase in their unit CEC) will provide clarity to the Grid Code community and provide certainty to allow investment decisions to be made.

13.3 The existing obligations for Non Synchronous Generating Units are not impacted by this proposal and therefore not subject to any proposed amendment(s).

14. Assessment Against Grid Code Objectives

14.1 The proposed changes outlined in Grid Code Consultation A/09 (Grid Code Requirements for Synchronous Generating Units Exceeding Rated MW) would better facilitate Grid Code Objectives:

i) to permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity;

and

ii) to facilitate competition in the generation and supply of electricity;

and

iii) to promote the security and efficiency of the electricity generation, transmission and distribution system in Great Britain

by providing clarity regarding the technical obligations for Generating Units exceeding their Rated MW.

15. Impact on Industry Documents

15.1 *Impact on Core Industry Documents*

15.1.1 Grid Code Consultation A/09 (Grid Code Requirements for Synchronous Generating Units Exceeding Rated MW) has no impact upon other Core Industry Documents.

15.2 *Impact on other Industry Documents*

15.2.1 Grid Code Consultation A/09 (Grid Code Requirements for Synchronous Generating Units Exceeding Rated MW) has no impact upon other Industry Documents.

16. Environmental Assessment

16.1 The environmental impact of the proposal will be net positive as more energy is produced from the same amount of fuel utilised by the Synchronous Generating Unit.

C. RESPONSES

17. This section will contain a summary of responses received during the Consultation and will be completed as part of the Report to the Authority.
18. Views are invited upon the proposals outlined in this report. Specially views on the following areas would be welcomed:
- Impact of the proposals on Grid Code Users.
 - Clarity and transparency of the proposals for Synchronous Generating Units operating above Rated MW.
 - Appropriateness of the proposed solution given the GB Transmission System requirement for MVar, technical functionality of plant and the pending, wide ranging, Grid Code review of Reactive Power provisions.
 - Any improvements or changes to the proposals that in a respondent's view would better facilitate the objectives of the Grid Code.
19. Your formal responses may be:-

Posted to: Lilian Macleod
Electricity Codes
Regulatory Frameworks
National Grid Electricity Transmission plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

Emailed to: lilian.macleod@uk.ngrid.com

APPENDIX A: PROPOSED GRID CODE CHANGES

The proposed legal text is reflective of the current Grid Code baseline as specified in Issue 3 Revision 32.

Proposed Changes to Connection Conditions

Amend CC.6.3.2 (a) and CC.A.6.2.7.1 as follows:

CC.6.3.2 (a) **When supplying Rated MW, All all Synchronous Generating Units** must be capable of ~~supplying Rated MW~~ **continuous operation** at any point between the limits 0.85 **Power Factor** lagging and 0.95 **Power Factor** leading at **the Synchronous Generating Unit** terminals. **At Active Power** output levels other than **Rated MW**, all **Synchronous Generating Units** must be capable of continuous operation at any point between the **Reactive Power** capability limits identified on the **Generator Performance Chart**.

In addition to the above paragraph, where **Synchronous Generating Unit(s)**

- (i) have a **CEC** which has been increased above **Rated MW**, and such increase takes effect on or after 1st May 2009, or have a **Completion Date** on or after 1st May 2009, the minimum lagging **Reactive Power** capability of such **Synchronous Generating Unit(s)** must be 0.9 **Power Factor** at all **Active Power** output levels in excess of **Rated MW**. Further, the **User** shall comply with the provisions of and any instructions given pursuant to BC1.8 and the relevant **Bilateral Agreement**; or
- (ii) have a **CEC** in excess of **Rated MW** and a **Completion Date** before 1st May 2009, alternative provisions relating to **Reactive Power** capability may be specified in the **Bilateral Agreement**, and where this is the case such provisions must be complied with.

The short circuit ratio of **Synchronous Generating Units** shall be not less than 0.5.

CC.A.6.2.7.1 The security of the power system shall also be safeguarded by means of MVar **Under Excitation Limiters** fitted to the generator **Excitation System**. The **Under Excitation Limiter** shall prevent the **Automatic Voltage Regulator** reducing the generator excitation to a level which would endanger synchronous stability. The **Under Excitation Limiter** shall operate when the excitation system is providing automatic control. The **Under Excitation Limiter** shall respond to changes in the **Active Power** (MW) and the **Reactive Power** (MVar), and to the square of the generator voltage in such a direction that an increase in voltage will permit an increase in leading MVar. The characteristic of the **Under Excitation Limiter** shall be substantially linear from no-load to ~~rated load~~ **the maximum Active Power** output of the **Generating Unit** at any setting and shall be readily adjustable.

Proposed Changes to Balancing Code 1 (Pre Gate Closure Process)

Insert new clause.

BC1.8 Provision of **Reactive Power** capability

BC1.8.1 Under certain operating conditions **NGET** may identify through its **Operational Planning** that an area of the **GB Transmission System** may have insufficient **Reactive Power** capability available to ensure that the operating voltage can be maintained in accordance with **NGET's** licence standards.

In respect of **Synchronous Generating Unit(s)**

- (i) that have a **CEC** in excess of **Rated MW**; and
- (ii) that are not capable of continuous operation at any point between the limits 0.85 **Power Factor** lagging and 0.95 **Power Factor** leading at the **Synchronous Generating Unit** terminals at **Active Power** output levels higher than **Rated MW**; and
- (iii) that have either a **Completion Date** on or after 1st May 2009, or where its **CEC** has been increased above **Rated MW** such increase takes effect on or after 1st May 2009; and
- (iv) that are in an area of potential **Reactive Power** capability deficiency,

NGET may instruct the **Synchronous Generating Unit(s)** to limit its submitted **Physical Notifications** to no higher than **Rated MW** for a period specified by **NGET**. Such an instruction must be made at least 1 hour prior to **Gate Closure**, although **NGET** will endeavour to give as much notice as possible. The instruction may require that a **Physical Notification** is re-submitted. The period covered by the instruction will not exceed the expected period for which the potential deficiency has been identified. Compliance with the instruction will not incur costs to **NGET** in the **Balancing Mechanism**. The detailed provisions relating to such instructions will normally be set out in the relevant **Bilateral Agreement**.