GC0077 Suppression Of Sub-Synchronous Resonance From Series Compensators

What stage is this document at?

01	Workgroup Report
02	Industry Consultation
03	Report to the Authority

This proposal seeks to modify the Grid Code to provide clarity to Users over how Transmission Owners mitigate Sub-synchronous Oscillation risks when installing new plant and apparatus on the National Electricity Transmission System

This document is open for Industry Consultation. Any interested party is able to make a response in line with the guidance set out in Section 5 of this document.

Published on: **17 July 2014**
Length of Consultation: **20 Working Days**
Responses by: **15 August 2014**

National Grid recommends:
GC0077 should be implemented as it better facilitates applicable Grid Code objectives (i), (ii) and (iii)

High Impact:
None identified

Medium Impact:
Transmission Owners
Transmission Users

Low Impact:
None identified

Contents

About this document

This Industry Consultation outlines the information required for interested parties to form an understanding of a defect within the Grid Code and seeks the views of interested parties in relation to the issues raised by this document.

Parties are requested to respond by 15 August 2014 to:

Grid.Code@nationalgrid.com

Document Control

Version	Date	Author	Change Reference
0.1	31 October 2013	National Grid	Draft Industry Consultation
0.2	15 January 2014	National Grid	Draft Industry Consultation for GCRP
1.0	17 July 2014	National Grid	Industry Consultation

Any Questions?

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1 Executive Summary

1.1 Transmission Owners (TOs) are in the process of procuring and installing Series Capacitive Compensation (SCC) equipment to increase boundary power transfer capability. SCC reduces the inductivity of transmission lines which results in the line being 'virtually' shortened. Consequently, the transmission angle is reduced and acceptable system stability maintained at a higher power transfer than would otherwise be possible.

1.2 It is known that SCC devices can cause Sub-synchronous Resonance at frequencies that can interact with the natural torsional modes of synchronous generators. Transmission Licensees installing SCC devices have assessed the impact of their equipment design to ensure that Sub-synchronous Resonance risks are appropriately mitigated. The Transmission Licensees believe it is consistent with their obligations for this assessment to be carried out in this case.

1.3 A similar phenomenon, known as Sub-synchronous Torsional Interaction, can occur when HVDC Convertors are connected, either by Transmission Licensees or Users. Again, the interaction risk needs to be appropriately mitigated.

1.4 For both of these phenomena, it is possible that synchronous generator owners may wish to take further measures to protect their own equipment.

1.5 It is proposed that the Grid Code is changed to provide clarity that Transmission Licensees installing SCC devices or HVDC Convertors will ensure that Sub-synchronous Resonance and Sub-synchronous Torsional Interaction risks, captured under the broader term of "sub-synchronous oscillations", are appropriately mitigated.

1.6 Views are invited upon the proposals outlined in this industry consultation, which should be received by 15 August 2014. Further information on how to submit a response can be found in section 5.

National Grid View

1.7 National Grid supports the implementation of GC0077 as it better facilitates the Applicable Grid Code Objectives (i), (ii) and (iii). This is achieved by clarifying for Transmission Users the way that sub-synchronous oscillations will be managed at their Connection Site.

2 Why Change?

Background

2.1 The National Electricity Transmission System (NETS) comprises a number of mechanical, electrical, electromechanical and electronic systems. All of these elements will have resonant oscillatory modes at a range of frequencies. These modes can be excited by disturbances to the system, such as routine switching events or changes in demand. Normally these oscillations are quickly reduced by the damping effect of the NETS. However, if the oscillations are at a resonant frequency and are not sufficiently damped, then the oscillations can increase.

2.2 Sub-synchronous resonance is the phenomenon whereby the turbine and shaft system of a synchronous generator can oscillate with the electricity network and/or the equipment connected to it. The oscillations of concern occur at sub-synchronous frequencies (i.e. less than 50Hz) and are independent of the fundamental frequency. There are certain frequencies where this effect can occur; these are called resonant frequencies or modes. In some circumstances sub-synchronous resonance can adversely affect synchronous generators and the system, with the effects ranging from long term degradation to a major failure.

2.3 Individual synchronous generators provide positive damping to the system. Positive damping reduces system oscillations; negative damping increases system oscillations. When different synchronous generators are connected to the same area of network, the different damping characteristics of these generators can unfavourably coincide with the network's characteristics and form resonant frequencies (frequencies at which the damping is low or negative) and so oscillations can increase.

2.4 Two broad changes to the GB electricity system will affect the likelihood of sub-synchronous oscillations occurring:

(i) The introduction of Series Capacitive Compensation (SCC) to maximise the transfer capability of network circuits. SCC reduces the inductivity of transmission lines which results in the line being 'virtually' shortened. Consequently, the transmission angle is reduced and acceptable system stability can be maintained at a higher power transfer than would otherwise be possible. However, SCC can create the conditions necessary for sub-synchronous resonance; and

(ii) The increasing use of inverter technologies, such as in High Voltage Direct Current (HVDC) connections. The high speed controls used in these technologies can introduce negative damping to the system, thus increasing the likelihood of a sub-synchronous problem of torsional interaction (termed Sub-synchronous Torsional Interaction) occurring. However, if designed to do so, they can provide positive damping. In order to do this effectively, it is usually necessary to evaluate the frequency characteristics of all local power system components, including synchronous generators.

2.5 In August 2013, following approval of *GC0040: Information Required to Evaluate Sub-synchronous Resonance*[1] by the Authority, National Grid implemented changes to the Grid Code that oblige new generators to provide technical information about their plant to NGET, so that NGET and

[1] GC0040 Decision Letter - http://www.nationalgrid.com/NR/rdonlyres/22CA955E-1EF8-4D5E-A845-57EB34265A3D/61760/GC0040DecisionLetter.pdf

other affected parties can calculate resonant frequencies. This information exchange facilitates evaluation and, if necessary, mitigation of the risk of Sub-Synchronous phenomena including Sub-Synchronous Resonance and Sub-Synchronous Torsional Interaction on the NETS.

The Issue

2.6 Transmission Owners (TOs) are in the process of installing SCC equipment to increase boundary power transfer capability. Concern over the impact that this could have on synchronous generating units was highlighted in a paper submitted to the September 2013 Grid Code Review Panel, a copy of which can be found in Annex 1.

2.7 Although the Grid Code facilitates information exchange for Sub-synchronous Resonance[2] and places a duty on DC Converters not to cause a Sub-synchronous Resonance problem on the Total System[3], there is no explicit requirement on TOs to ensure that SCC installations employ sufficient damping to mitigate the risk of unwanted Sub-synchronous Resonance interactions.

2.8 It is known that such devices can cause Sub-synchronous Resonance at frequencies that can interact with the natural torsional modes of synchronous generators. It is proposed that the Grid Code is changed to make it clear that Transmission Licensees will mitigate the risk of damage to synchronous generating units appropriately, and that information may be shared with Users where necessary.

2.9 It is also known that Sub-synchronous Torsional Interaction can occur between HVDC installations and synchronous generators. The proposed change is intended to capture the range of sub-synchronous phenomena using the term “sub-synchronous oscillations”.

[2] Grid Code PC.A.5.3.2 (g)

[3] Grid Code CC.6.3.16 (a)

3 Solution

3.1 The proposed solution is to include a requirement within the Connection Conditions of the Grid Code to provide clarity that Transmission Licensees installing SCC devices or HVDC Convertors will ensure that sub-synchronous oscillation risks are appropriately mitigated in accordance with Licence Standards (the Grid Code term for NETS SQSS).

3.2 The proposal includes provision for additional conditions to be stipulated within a User's Bilateral Agreement. These could capture a description of how Licence Standards had been applied (for example, which circuit outages had been considered) and any additional risk management measure which has been deployed by the User, and could include generating plant protection performance details if necessary.

System Operator Transmission Owner Code (STC)

3.3 Section D, Paragraph 2.2.6 of the STC, stipulates that Transmission Owners are obligated to ensure their Transmission System complies with the minimum technical, design and operational criteria and performance requirements set out or referred to in Connection Conditions (CC) 6.1, 6.2, 6.3 and 6.4 and in Planning Code 6.2 and/or 6.3 as applicable.

3.4 The proposed changes to the Grid Code are within CC.6.1 and will therefore affect Transmission Owners.

3.5 The text required to give effect to the proposal is contained in Annex 2 of this industry consultation.

National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS)

3.6 The criteria applied to the design and specification of SCC devices and HVDC convertors by Transmission Licensees is consistent with the criteria in the SQSS applied to system stability. It may be appropriate to add criteria to the SQSS to deal specifically with sub-synchronous issues. The SQSS Review Panel intend to develop and progress proposals which, if progressed, would be subject to industry consultation and Authority approval [4].

[4] Information on the SQSS Panel, including its governance framework, can be found here:

http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/SQSS/Panel-information/

4 Impact & Assessment

Impact on the Grid Code

4.1 GC0077 requires amendments to the following parts of the Grid Code:

- Connection Conditions (CC)

4.2 The text required to give effect to the proposal is contained in Annex 2 of this document.

Impact on National Electricity Transmission System (NETS)

4.3 The proposed modification will ensure that sub-synchronous oscillation risks for Users of the National Electricity Transmission System can be mitigated appropriately.

Impact on Grid Code Users

4.4 The proposed modification will ensure that management of sub-synchronous oscillation risks will be clear to Transmission Users.

Impact on Greenhouse Gas emissions

4.5 The proposed modification will have no impact on Greenhouse Gas emissions.

Assessment against Grid Code Objectives

4.6 National Grid considers that GC0077 would better facilitate the Grid Code objectives:

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

The proposed modification will provide additional clarity and assurance for Users on the mitigation of Sub-Synchronous Resonance and Sub-Synchronous Torsional Interaction effects on the National Electricity Transmission System.

(ii) to facilitate competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);

Improved transparency and clarity on the management of SSR mitigation may prevent distortion of competition in generation. For example, without this a generator may be forced to shut down or implement additional protection measures.

(iii) subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole; and

Improved transparency and clarity of the management of SSR mitigation measures may promote security and efficiency of generation as they will facilitate the efficient deployment of series compensators, increasing transfer capability without affecting security of supply

(iv) to efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.

The proposal is neutral on this objective.

Impact on industry documents

4.7 The proposed modification may require criteria to be added to the NETS SQSS to deal specifically with sub-synchronous oscillation. This will be progressed by the SQSS Review Panel and the implementation of any changes will be subject to industry consultation and Authority approval.

4.8 The proposed modification does not impact on the STC. However, as Section D, Paragraph 2.2.6 of the STC, stipulates that Transmission Owners are obligated to ensure their Transmission System complies with the minimum technical, design and operational criteria and performance requirements set out or referred to in Connection Conditions (CC) 6.1, 6.2, 6.3 and 6.4 and in Planning Code 6.2 and/or 6.3 as applicable, the proposed changes to the Grid Code will affect Transmission Owners.

Implementation

4.9 National Grid proposes that, should the proposals be approved, the proposed changes be implemented 10 business days after an Authority decision.

5 Consultation Responses

5.1 Views are invited upon the proposals outlined in this consultation, which should be received by 15 August 2014.

Your formal responses may be emailed to:

Grid.Code@nationalgrid.com

5.2 Responses are invited to the following questions:

(i) Do you believe the proposals provide sufficient clarity and transparency to Transmission Users on how Sub-synchronous Resonance, Sub-synchronous Torsional Interaction and related phenomena will be managed where Transmission Licensees are installing new equipment?

(ii) Have you identified any adverse, perhaps unintended, consequences of the proposals? If so what are they, and how should the proposals be improved?

(iii) Do you support the proposed implementation approach?

(iv) Do you believe that GC0077 better facilitates the appropriate Grid Code objectives?

5.3 If you wish to submit a confidential response please note the following:

(i) Information provided in response to this consultation will be published on National Grid's website unless the response is clearly marked "Private & Confidential", we will contact you to establish the extent of the confidentiality. A response marked "Private and Confidential" will be disclosed to the Authority in full but, unless agreed otherwise, will not be shared with the Grid Code Review Panel or the industry and may therefore not influence the debate to the same extent as a non confidential response.

(ii) Please note an automatic confidentiality disclaimer generated by your IT System will not in itself, mean that your response is treated as if it had been marked "Private and Confidential".

Grid Code Review Panel

Suppression of Sub Synchronous Resonance from Series Compensators

Date Raised: 14 Aug 2013

GCRP Ref: pp13/54[1]

A Panel Paper by John Morris

EDF Energy

Summary

Relevant Transmission Licensees are in the process of procuring Series Capacitive Compensation (SCC) equipment to increase boundary power transfer capability. It is known that such devices can cause sub-synchronous resonance at frequencies that can interact with the natural torsional modes of synchronous generators. To avoid potential damage to synchronous generating units it is proposed that the Grid Code requires such installations to employ damping to remove the risk of unwanted interactions.

Users Impacted

High

Medium

Transmission Owners, System Operator, Generators

Low

Description & Background

A power system comprises a number of elements, many of which comprising of mechanical, electrical, electromechanical and electronic systems. All of these elements, when connected within the total power system, will have resonant oscillatory modes at a range of frequencies. These resonances can be excited by disturbances to the system, such as routine switching events or sudden changes in demand. Most oscillations are harmless and short lived because of the effective damping inherent within the system. However, under exceptional circumstances these oscillations can grow in magnitude, and if not controlled, cause plant damage or system instability.

The rotating shaft system of a turbine generating unit has inherent torsional oscillation frequencies which are determined by its large inertia masses and the interconnected shaft system. If the associated frequencies reflected at the terminals of the generator are close to the characteristic frequencies of the connected electrical power system and insufficiently damped, there will be unfavourable interaction between the two systems. The problem generally lies in the sub-synchronous frequency range (frequencies below 50Hz) as those in the super-synchronous range tend to be well-damped.

The high speed active controls deployed in a number of power system technologies, including High Voltage Direct Current (HVDC) equipment, have the potential to exacerbate sub-synchronous oscillations by providing negative damping. Equally, if explicitly designed to do so, they can provide positive damping and mitigate any risks of adverse oscillatory effects occurring.

Changes to the transmission network configuration will have the impact of changing the resonant modes of the overall power system. Series Capacitive Compensation (SCC) has

[1] The Code Administrator will provide the paper reference following submission to National Grid.

been identified as a key tool in maximising the transfer capability of the current overhead line network across Great Britain, with the potential advantage of reducing the infrastructure required. However the negative impact of SCC's is the potentially significant impact on resonant frequencies.

The application of HVDC technology on the transmission system will grow significantly over the next few years alongside the deployment of SCC solutions. There is therefore a current need to consider subsynchronous resonance on a regular and ongoing basis. New provisions have recently been incorporated into the Grid Code to specify the information required from synchronous generators to allow sub-synchronous resonance to be assessed. (GC0040 was approved for implementation on 19 August 2013)

The Grid Code currently places a duty on DC Converters not to cause a subsynchronous resonance problem on the Total System, CC6.3.16(a), but makes no reference to Series Capacitive Compensation installations.

Proposed Solution

It is proposed that the Grid Code is modified to require Relevant Transmission Licensees to provide sub-synchronous resonance damping control facilities to series capacitive compensation installations installed on the transmission system whenever it occurs in the range that could cause unwanted interactions with synchronous generating units.

Assessment against Grid Code Objectives

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

The deployment of SCC's can facilitate increased power transfer across transmission boundaries and can be engineered to avoid putting synchronous generating units at risk from SSR.

(ii) to facilitate competition in the generation and supply of electricity (and without limiting the foregoing, to facilitate the national electricity transmission system being made available to persons authorised to supply or generate electricity on terms which neither prevent nor restrict competition in the supply or generation of electricity);

By ensuring that wherever SCC's are deployed in the transmission system local generation is not exposed to the risk of SSR interactions.

(iii) subject to sub-paragraphs (i) and (ii), to promote the security and efficiency of the electricity generation, transmission and distribution systems in the national electricity transmission system operator area taken as a whole; and

Without certainty of SSR damping from SCC's some generators may be required to install monitoring and this may require consideration of shutting plant down to remove the risk of damage.

(iv) to efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity Regulation and any relevant legally binding decisions of the European Commission and/or the Agency.

It is a matter of discrimination if HVDC owners are required to avoid causing SSR interactions but RTL's have no such requirement for SCC's

Impact & Assessment
Impact on the National Electricity Transmission System (NETS) Yes positively by ensuring the security of supply is maintained. ***Impact on Greenhouse Gas Emissions*** No ***Impact on core industry documents*** Grid Code connection conditions ***Impact on other industry documents*** No

Supporting Documentation
Have you attached any supporting documentation No If Yes, please provide the title of the attachment:

Recommendation
The Grid Code Review Panel is invited to: Progress this issue to Industry Consultation

Document Guidance

This proforma is used to raise an issue at the Grid Code Review Panel, as well as providing an initial assessment. An issue can be anything that a party would like to raise and does not have to result in a modification to the Grid Code or creation of a Working Group.

Guidance has been provided in square brackets within the document but please contact National Grid, The Code Administrator, with any questions or queries about the proforma at grid.code@nationalgrid.com .

Annex 2 Proposed Legal Text

This section contains the proposed legal text to give effect to the proposals. The proposed new text is in red and is based on Grid Code Issue 5 Revision 6.

CONNECTION CONDITIONS
(CC)

CC.6 TECHNICAL, DESIGN AND OPERATIONAL CRITERIA

CC.6.1 National Electricity Transmission System Performance Characteristics

CC.6.1.1 **NGET** shall ensure that, subject as provided in the **Grid Code**, the **National Electricity Transmission System** complies with the following technical, design and operational criteria in relation to the part of the **National Electricity Transmission System** at the **Connection Site** with a **User** and in the case of **OTSDUW Plant and Apparatus**, a **Transmission Interface Point** (unless otherwise specified in CC.6) although in relation to operational criteria **NGET** may be unable (and will not be required) to comply with this obligation to the extent that there are insufficient **Power Stations** or **User Systems** are not available or **Users** do not comply with **NGET's** instructions or otherwise do not comply with the **Grid Code** and each **User** shall ensure that its **Plant** and **Apparatus** complies with the criteria set out in CC.6.1.5.

Grid Frequency Variations

CC.6.1.2 The **Frequency** of the **National Electricity Transmission System** shall be nominally 50Hz and shall be controlled within the limits of 49.5 - 50.5Hz unless exceptional circumstances prevail.

CC.6.1.3 The **System Frequency** could rise to 52Hz or fall to 47Hz in exceptional circumstances. Design of **User's Plant** and **Apparatus** and **OTSDUW Plant and Apparatus** must enable operation of that **Plant** and **Apparatus** within that range in accordance with the following:

Frequency Range	Requirement
51.5Hz - 52Hz	Operation for a period of at least 15 minutes is required each time the Frequency is above 51.5Hz.
51Hz - 51.5Hz	Operation for a period of at least 90 minutes is required each time the Frequency is above 51Hz.
49.0Hz - 51Hz	Continuous operation is required
47.5Hz - 49.0Hz	Operation for a period of at least 90 minutes is required each time the Frequency is below 49.0Hz.
47Hz - 47.5Hz	Operation for a period of at least 20 seconds is required each time the Frequency is below 47.5Hz.

For the avoidance of doubt, disconnection, by frequency or speed based relays is not permitted within the frequency range 47.5Hz to 51.5Hz, unless agreed with **NGET** in accordance with CC.6.3.12.

Grid Voltage Variations

CC.6.1.4 Subject as provided below, the voltage on the 400kV part of the **National Electricity Transmission System** at each **Connection Site** with a **User** (and in the case of **OTSDUW Plant and Apparatus**, a **Transmission Interface Point**) will normally remain within ±5% of the nominal value unless abnormal conditions prevail. The minimum voltage is -10% and the maximum voltage is +10% unless abnormal conditions prevail, but voltages between +5% and +10% will not last longer than 15 minutes unless abnormal conditions prevail. Voltages on the 275kV and 132kV parts of the **National Electricity Transmission System** at each **Connection Site** with a **User** (and in the case of **OTSDUW Plant and Apparatus**, a **Transmission Interface Point**) will normally remain within the limits ±10% of the nominal value unless abnormal conditions prevail. At nominal **System** voltages below 132kV the voltage of the **National Electricity Transmission System** at each **Connection Site** with a **User** (and in the case of **OTSDUW Plant and Apparatus**, a **Transmission Interface Point**) will normally remain within the limits ±6% of the nominal value unless abnormal conditions prevail. Under fault conditions, voltage may collapse transiently to zero at the point of fault until the fault is cleared. The normal operating ranges of the **National Electricity Transmission System** are summarised below:

National Electricity Transmission System Nominal Voltage	Normal Operating Range
400kV	400kV ±5%
275kV	275kV ±10%
132kV	132kV ±10%

NGET and a **User** may agree greater or lesser variations in voltage to those set out above in relation to a particular **Connection Site**, and insofar as a greater or lesser variation is agreed, the relevant figure set out above shall, in relation to that **User** at the particular **Connection Site**, be replaced by the figure agreed.

Voltage Waveform Quality

CC.6.1.5 All **Plant** and **Apparatus** connected to the **National Electricity Transmission System**, and that part of the **National Electricity Transmission System** at each **Connection Site** or, in the case of **OTSDUW Plant and Apparatus**, at each **Interface Point**, should be capable of withstanding the following distortions of the voltage waveform in respect of harmonic content and phase unbalance:

(a) Harmonic Content

The **Electromagnetic Compatibility Levels** for harmonic distortion on the **Onshore Transmission System** from all sources under both **Planned Outage** and fault outage conditions, (unless abnormal conditions prevail) shall comply with the levels shown in the tables of Appendix A of **Engineering Recommendation** G5/4. The **Electromagnetic Compatibility Levels** for harmonic distortion on an **Offshore Transmission System** will be defined in relevant **Bilateral Agreements**.

Engineering Recommendation G5/4 contains planning criteria which **NGET** will apply to the connection of non-linear **Load** to the **National Electricity Transmission System**, which may result in harmonic emission limits being specified for these **Loads** in the relevant **Bilateral Agreement**. The application of the planning criteria will take into account the position of existing and prospective **Users' Plant** and **Apparatus** (and **OTSDUW Plant and Apparatus**) in relation to harmonic emissions. **Users** must ensure that connection of distorting loads to their **User Systems** do not cause any harmonic emission limits specified in the **Bilateral Agreement**, or where no such limits are specified, the relevant planning levels specified in **Engineering Recommendation** G5/4 to be exceeded.

(b) Phase Unbalance

Under **Planned Outage** conditions, the maximum **Phase (Voltage) Unbalance** on the **National Electricity Transmission System** should remain, in England and Wales, below 1%, and in Scotland, below 2%, unless abnormal conditions prevail and **Offshore** (or in the case of **OTSDUW**, **OTSDUW Plant and Apparatus**) will be defined in relevant **Bilateral Agreements**.

CC.6.1.6 In England and Wales, under the **Planned Outage** conditions stated in CC.6.1.5(b) infrequent short duration peaks with a maximum value of 2% are permitted for **Phase (Voltage) Unbalance**, subject to the prior agreement of **NGET** under the **Bilateral Agreement** and in relation to **OTSDUW**, the **Construction Agreement**. **NGET** will only agree following a specific assessment of the impact of these levels on **Transmission Apparatus** and other **Users Apparatus** with which it is satisfied.

Voltage Fluctuations

CC.6.1.7 Voltage fluctuations at a **Point of Common Coupling** with a fluctuating **Load** directly connected to the **Onshore Transmission System** shall not exceed:

(a) In England and Wales, 1% of the voltage level for step changes which may occur repetitively. Any large voltage excursions other than step changes may be allowed up to a level of 3% provided that this does not constitute a risk to the **National Electricity Transmission System** or, in **NGET's** view, to the **System** of any **User**. In Scotland, the limits for voltage level step changes are as set out in **Engineering Recommendation** P28.

(b) For voltages above 132kV, **Flicker Severity (Short Term)** of 0.8 Unit and a **Flicker Severity (Long Term)** of 0.6 Unit, for voltages 132kV and below, **Flicker Severity (Short Term)** of 1.0 Unit and a **Flicker Severity (Long Term**) of 0.8 Unit, as set out in **Engineering Recommendation** P28 as current at the **Transfer Date**.

CC.6.1.8 Voltage fluctuations at a **Point of Common Coupling** with a fluctuating **Load** directly connected to an **Offshore Transmission System** (or in the case of **OTSDUW**, **OTSDUW Plant and Apparatus**) shall not exceed the limits set out in the **Bilateral Agreement**.

Sub-synchronous Resonance and Sub-synchronous Torsional Interaction

CC.6.1.9 **NGET** shall ensure that **Users' Plant and Apparatus** will not be subject to unacceptable sub-synchronous oscillation conditions as specified in the relevant **Licence Standards.**

CC.6.1.10 **NGET** shall ensure where necessary, and in consultation with **Transmission Licensees** where required, that any relevant site specific conditions applicable at a **User's Connection Site,** including a description of the sub-synchronous oscillation conditions considered in the application of the relevant **Licence Standards,** are set out in the **User's Bilateral Agreement**.