

Modification proposal:	GSR018/GC0077: Sub-Synchronous Oscillations (SSO)		
Decision:	The Authority ¹ directs ² that the proposed modification to the Grid Code be made The Authority approves the proposed changes to the National Electricity Transmission System Security and Quality of Supply Standards		
Target audience:	National Grid Electricity Transmission PLC, transmission licensees, the Grid Code Review Panel, Grid Code users and other interested parties		
Date of publication:	7 March 2017	Implementation date:	As set out below

Background

Sub-Synchronous Oscillations (SSO) are power system oscillations at frequencies less than the power frequency, 50 Hz, caused by interaction between certain equipment on the National Electricity Transmission System (NETS). SSO modes always exist in a power system, but in most cases the oscillations arising from these modes are of low magnitude and are adequately damped. Poorly or negatively damped SSO, considered 'Unacceptable SSO', could have significant implications for the NETS by causing significant damage or failure to generator shaft systems; reducing the lifetime of the generator shaft and imposing health and safety risks on personnel. They may also result in high voltages and currents that may damage the electrical components of Generating Units. Unacceptable SSO may arise from modes of oscillation associated with interactions between: Generating Unit(s) and Series Compensation; Generating Unit(s) and the control systems of High Voltage Direct Current (HVDC) Converters or between different control systems.

The Grid Code and the NETS Security and Quality of Supply Standards (NETS SQSS) do not explicitly specify that Transmission Licensees are required to ensure that no User equipment is subjected to Unacceptable SSO. It is the view of Transmission Licensees that these requirements are implicit through the principles of the System Instability criteria of the NETS SQSS. However, this is unclear to some Users who are also seeking clarity of the accountabilities in relation to the mitigation of Unacceptable SSO.

GSR018/GC0077 seeks to modify the NETS SQSS and the Grid Code to include SSO related provisions and clarify the associated accountabilities.

The modification proposal

GSR018/GC0077 arose from an issue paper (pp13/54) submitted to the Grid Code Review Panel in August 2013 requesting that the Grid Code is modified to ensure that Series Compensation equipment does not cause Sub Synchronous Resonance issues. As a result of this issue paper GC0077 was raised by National Grid Electricity Transmission (NGET). GC0077 was discussed at the NETS SQSS Review Panel in April 2014. Following this a joint Grid Code and SQSS workgroup was established (the GSR018: Sub-Synchronous Oscillations workgroup) to advise on any modifications required to the NETS SQSS and the Grid Code to ensure that User's Plant and Apparatus are not subject to Unacceptable SSO conditions. In particular, the workgroup was tasked to determine the need to include SSO provisions in the NETS SQSS, types of SSO to be considered, SSO definitions and the criteria to which SSO be assessed.

¹ References to the "Authority", "Ofgem", "we" and "our" are used interchangeably in this document. The Authority refers to GEMA, the Gas and Electricity Markets Authority. The Office of Gas and Electricity Markets (Ofgem) supports GEMA in its day to day work. This decision is made by or on behalf of GEMA.

² This document is notice of the reasons for this decision as required by section 49A of the Electricity Act 1989.

The Workgroup discussed the consequences of operating a system with Unacceptable SSO and concluded that the potential damage to plant, loss of revenue, and risks to personnel required that these risks should be appropriately mitigated. Currently, all SSO risks have arisen from Transmission Licensees' equipment, Series Compensation and HVDC links and have been mitigated through the design of this equipment. This required liaison between Transmission Licensees and Users, which took place on an ad-hoc basis and is not subject to any specific Grid Code or Connecton and Use of System Code (CUSC)³ clauses (other than PC.A.7 of the Grid Code, which allows NGET to request additional data). This modification proposal aims to address this lack of clarity and standardise the criteria that Transmission Licensees will need to meet when securing the system against SSO.

To determine the NETS SQSS requirements, the workgroup used the requirements for System Instability as a template. They consider that in respect of the System Instability criteria, the existing set of secured events strike the right balance between the probability of these events taking place, the cost associated with securing the system against them and the consequences of a contingency that causes System Instability. However, they identified that the NETS SQSS definition for System Instability does not differentiate between electromechanical oscillation modes associated with SSO and other phenomena. To address this, the workgroup recommended that explicit definitions of SSO and Unacceptable SSO were required for the System Instability criteria to be met. They also highlighted that SSO conditions associated with a Generator operating below its rated output are not covered by the NETS SQSS. To address this, the workgroup propose that Transmission Licensees need to study SSO at the loading condition that corresponds to the most onerous SSO risk.

GCR018 proposes to modify the NETS SQSS to:

- Include definitions for SSO and Unacceptable SSO.
- Specify within Sections 2, 4, 5, 7 and 9 that following a secured event, there shall be no Unacceptable SSO.
- Specify within Sections 2 and 7 that in relation to the power plant under consideration, SSO criteria should be met when the Generating Unit is operating at the output level where it is most vulnerable to SSO.

No changes are proposed to the way secured events are defined and applied to the background conditions specified in Section 4, or to the background conditions for plants other than the plant under consideration specified in Section 2 and Section 7, as the workgroup considered these are sufficient.

The workgroup consider there to be three broad methods to mitigate Unacceptable SSO covering both design and operational timescales:

1. Designing Transmission or User plant such that they are equipped with the appropriate measures to mitigate the risks of Unacceptable SSO under the scenarios dictated by the proposed modifications to the NETS SQSS.
2. De-synchronising Generating Units that could interact with Transmission plant causing Unacceptable SSO conditions when the Transmission Plant is in service.
3. Taking the Transmission Plant that could interact with Generating Units causing Unacceptable SSO conditions out of service when the relevant Generating Units are operational.

The workgroup articulated the likely costs and effectiveness of each method, concluding that in general option 1 is the most cost effective. They noted that for infrequent system conditions option 2 may be economical, and that for SSO risks that are limited to very short periods option 3 could be cost effective. The workgroup recommend that each SSO

³ Available at <http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/CUSC/The-CUSC/>

risk be assessed on a case by case basis in order to determine the most economical mitigation solution.

GC0077 proposes to modify the Grid Code to:

- Specify that NGET is required to ensure that no User's plant is subjected to Unacceptable Sub-Synchronous Oscillations in accordance with the relevant Licence Standards.
- State that where there is a need, NGET may set some site specific requirements related to damping or mitigation of Sub-Synchronous Oscillations on Users.

Industry Consultation

An Industry Consultation was published on 11 April 2016. Five responses were received, four respondents were fully supportive of the change proposed. One respondent agreed with the modifications proposed to the NETS SQSS and the Grid Code. However the response raised concerns about how these requirements are planned to be met for connections of new Users' Plant, highlighting that SSO mitigation works on User equipment classed as User Works are charged differently to Enabling Works.

NGET noted that a new Synchronous Generating Unit that interacts with existing Transmission Plant is the source of the Unacceptable Sub-Synchronous Oscillations when viewed in the context of a new connection. Through discussion, the workgroup concluded that each SSO risk be assessed on a case by case basis in order to determine the most economical mitigation solution at as early a stage as possible; at the Connection Application stage for new Users, and via a Modification Notification for existing users. NGET note that works required to ensure no Unacceptable SSO exist will be classified as User Works, site specific requirements, Transmission Reinforcement Works or any third party works and will be funded in accordance with the established arrangements and practices within the CUSC.

NGET's recommendation

NGET recommend that the NETS SQSS and Grid Code are changed to include the modifications proposed in GSR018/GC0077. The workgroup consider the modification proposal clarifies the accountabilities in terms of management of Sub-Synchronous Oscillations on the Transmission System, giving Users comfort that their plant will not be exposed to material risks. They also consider it to ensure that the risks are managed using the most coordinated, economic, and efficient means.

Send back

NGET originally submitted GCR018/GC0077 to us for decision on 22 August 2016. We sent GCR018/GC0077 back to NGET on 27 September 2016 because the Final Report did not provide clear evidence of consideration and comparison of the costs of the consequences of unacceptable SSOs nor the cost of mitigating the SSO risks as required as a result of the proposed modification⁴. NGET subsequently updated GCR018/GC0077 to include clear articulation of the potential consequences of Unacceptable SSO as well as presenting a range of SSO mitigation options and their indicative costs, and resubmitted the proposal to us for decision.

⁴ <https://www.ofgem.gov.uk/publications-and-updates/authority-decision-send-back-final-report-gc0077-sub-synchronous-oscillations-ss0>

GSR018

Decision notice

This letter sets out the Authority's reasons and decision to approve the proposed changes to the NETS SQSS. We have concluded that:

- implementation of the modification proposal will better facilitate the achievement of the objectives of the SQSS⁵; and
- approving the modification is consistent with our principal objective and statutory duties⁶.

Reasons for our decision

We consider GSR018 better facilitates NETS SQSS objectives i, ii and iii and has a neutral impact on the other objective.

(i) facilitate the planning, development and maintenance of an efficient, coordinated and economical system of electricity transmission, and the operation of that system in an efficient, economic and coordinated manner;

The modification proposal clarifies the criteria that Transmission Licensees will need to meet when securing the system against SSO. It also clarifies the scenarios that will be considered in both design and operational timescales. This clarification should better facilitate the planning, development and maintenance of an efficient, coordinated and economical NETS.

(ii) ensure an appropriate level of security and quality of supply and safe operation of the National Electricity Transmission System;

The modification proposal seeks to ensure that the NETS will be secured against Unacceptable SSO for the same events that it is secured against for System Instability, thereby seeking to ensure that no User's equipment is subject to SSO risks for all secured events. This is appropriate as failing to secure the system against Unacceptable SSO could lead to generator shaft system damage or failure and poses health and safety risks to personnel.

(iii) facilitate effective competition in the generation and supply of electricity, and (so far as consistent therewith) facilitating such competition in the distribution of electricity; and

By making explicit reference to SSO, the modification proposal provides Users with assurances that their Plant will not be subject to Unacceptable SSO risk. This removes a potential barrier to connect to the NETS, thereby facilitating competition in the generation of electricity.

Implementation and future work

In this letter we have set out our decision to approve the changes to the SQSS proposed in GSR018. For these changes to take effect we will need to modify the relevant conditions of the electricity transmission licence so they refer to the new version of the SQSS. As this modification is not time-critical we have not yet issued a statutory consultation to modify the licences. We will be doing this at an appropriate stage in the future, such as when we issue a decision on other SQSS modifications.

⁵ The SQSS Governance Framework <http://www2.nationalgrid.com/uk/industry-information/electricity-codes/sqss/panel-information/>

⁶ The Authority's statutory duties are wider than matters which NGET must take into consideration and are detailed mainly in the Electricity Act 1989 as amended.

GC0077

Our decision

We have considered the issues raised by the modification proposal and in the Final Report dated 30 January 2017. We have considered and taken into account the responses to NGET's consultation on the modification proposal, which are included in the Final Report⁷. We have concluded that:

- implementation of the modification proposal will better facilitate the achievement of the objectives of the Grid Code;⁸ and
- approving the modification is consistent with the our principal objective and statutory duties.

Reasons for our decision

We consider this modification proposal will better facilitate Grid Code objectives i, ii and iii and has a neutral impact on the other objectives.

(i) to permit the development, maintenance and operation of an efficient, co-ordinated and economical system for the transmission of electricity

The workgroup demonstrated, by providing indicative costs of SSO mitigation measures, that it may be economical to modify or design User plant rather than Transmission plant to manage SSO. The modification provides NGET with the means to enforce SSO related site specific requirements on Transmission System Users where required. The modification meets this objective by facilitating a more co-ordinated and economical NETS.

(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)

The modification makes explicit the requirement for Transmission Licensees to develop, and NGET to operate, a Transmission System that is free from Unacceptable SSO, under all credible scenarios. This provides Users with assurance that their Plant will not be subject to Unacceptable SSO risk and therefore removes a potential barrier to connect to the NETS, thereby facilitating competition in the generation of electricity

(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

The modification proposal clarifies the criteria that Transmission Licensees will need to meet when securing the system against SSO. It also clarifies the scenarios that will be considered in both design and operational timescales. This clarification should better facilitate this Grid Code objective.

⁷ Grid Code proposals, final reports and representations can be viewed on NGET's website at: <http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/>

⁸ As set out in Standard Condition C14(1)(b) of NGET's Transmission Licence, available at: <https://epr.ofgem.gov.uk/>

Decision notice

In accordance with Standard Condition C14 of NGET's Transmission Licence, the Authority hereby directs that Grid Code modification proposal GC0077 'Sub-Synchronous Oscillations (SSO)' be made and that the Grid Code is modified as set out in the report submitted to the Authority.

We direct that GC0077 is implemented on 21 March 2017.

Min Zhu**Associate Partner, Analysis**

Signed on behalf of the Authority and authorised for that purpose