

Final Modification Report

GC0141: Compliance Processes and Modelling amendments following 9th August Power Disruption

Overview:

The Government (BEIS) and the Regulator (Ofgem) investigated and reviewed the incident of 9th August 2019 when some 1 million customers lost their electricity supply as a consequence of unexpected losses of generation following a correctly cleared fault event on the Transmission System. The modifications included in these proposals are to address the concerns raised in Action 3 of the Ofgem Report and Action 2 of the BEIS report.

Modification process & timetable

1	Proposal Form 14 March 2020
2	Workgroup Consultation 09 March 2021 – 30 March 2021
3	Workgroup Report 18 May 2022
4	Code Administrator Consultation 06 June 2022 – 08 July 2022
5	Draft Modification Report 20 July 2022
6	Final Modification Report 09 August 2022
7	Implementation Within 10 days of Ofgem Decision

Have 5 minutes? Read our [Executive summary](#)

Have 20 minutes? Read the full [Final Modification Report](#)

Have 30 minutes? Read the full Final SG Modification Report and Annexes.

Status summary: This report has been submitted to the Authority for them to decide whether this change should happen.

Panel recommendation: The Panel has recommended **unanimously/by majority** that the **Proposer's solution / WAGCMX** is implemented.

This modification is expected to have a: **high impact** on Generators and HVDC Interconnector Owners.

Modification drivers: GB Compliance

Governance route This modification has been assessed by a Workgroup and Ofgem will make the decision on whether it should be implemented.

Who can I talk to about the change?

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Executive summary

The modifications included in these proposals are to address the concerns raised in Action 3 of the Ofgem Report and Action 2 of the [BEIS report](#).

What is the issue?

Following the events of 9th August 2019, the National Grid ESO (NGESO) has been actioned to, in consultation with large Generators and Transmission Owners, “review and improve the compliance testing and modelling processes for new and modified generation connections, particularly for complex systems”¹.

What is the solution and when will it come into effect?

Proposer’s solution:

The modification intends to improve modelling, clarify Fault Ride Through (FRT) compliance requirements and improve the compliance process for complex connections.

Additionally, within the Ofgem report regarding 9th August, concerns were raised by Ofgem that there had been too much reliance on self-certification historically. Therefore, this proposal seeks to add in a requirement that all simulation reports submitted by a Generator to National Grid ESO, to demonstrate compliance, are reviewed by an independent engineer or independent test body prior to submission to National Grid ESO and creates a new section requiring a “Compliance Repeat Plan” for Users to confirm compliance with their Grid Code obligations to National Grid ESO every 5 years.

Implementation date:

The modification is to be implemented 10 working days following the Authority decision.

Summary of alternative solution(s) and implementation date(s):

The WAGCMs are combinations of the following elements:

- Whether an independent engineer is required or not and different thresholds which when exceeded would then require an independent engineer.
- Different methods by which NGESO/TO could share SSTI / SSCI information, whether by sharing models, hosting a study environment or employing a consultant.
- Whether a full specification for RMS & EMT is required or not.
- Different requirements for submitting Compliance Repeat Plans (no requirement, submit material changes only, or submit every 5 years)
- Whether there is a requirement to submit FRT studies for complex connections at the start of the process or not.
- Variations on requirement to provide torsional data (no requirement to provide pre-1st April 2015, all users to provide retrospectively, user provides when asked prior to completion date of 1st April 2015).

Workgroup conclusions: The Workgroup concluded by majority that WAGCM14 better facilitated the Applicable Objectives than the Baseline.

Panel recommendation/determination: The Panel has recommended unanimously/by majority that the Proposer’s solution / WAGCMX is implemented

What is the impact if this change is made?

The proposals will improve consumer value by making compliance and modelling processes more robust reducing the risks of power supply disruptions to customers.

¹ https://www.ofgem.gov.uk/system/files/docs/2020/01/9_august_2019_power_outage_report.pdf

Interactions

Offshore Networks are designed in conjunction with the design of offshore generation projects and are dependent upon the point in time at which an OTSDUW entities transfer assets into the emergent OFTO, or in cases where an OFTO is already in place there will be the need to update STC Section K and STCP19-5 to align with the Grid Code proposals.

What is the issue?

The events of 9th August 2019 unfolded when a transmission circuit faulted, and clearance caused unexpected losses of Users' Plant and Apparatus. The consequence of this high level of generation loss led to the first stage of the low frequency demand disconnection scheme operating, which then led to one million customers losing their electricity supply. The National Grid ESO has been actioned to, in consultation with large Generators and Transmission Owners, to "review and improve the compliance testing and modelling processes for new and modified generation connections, particularly for complex systems". Within the Ofgem report detailed concerns were raised relating to the robustness of the processes for demonstrating compliance of new and long-term Users, lack of independent oversight and the ability to model dynamic behaviour of complex systems. The BEIS report (Action 2) and Ofgem Report (Action 3) stated that the compliance processes and modelling processes for new and modified generation connections, particularly complex arrangements, should be reviewed and improved.

Why change?

Considering the events of 9th August 2019, National Grid ESO has identified the following areas of the Grid Code which may be considered as defective:

i) Since the Grid Code was modified in June 2005 through modification (H/04) to cover convertor-based technology (including HVDC plant) there has been a huge growth of this type of plant and apparatus connected to the transmission system with increasingly complex connection arrangements. Past Grid Code modifications ([GC077](#)) relating to the submission of shaft data from new Synchronous Generation to allow torsional interactions (SSTI) to be studied have been found to be causing delays to the connection of new power sources as data is needed from existing Generators.

The current Grid Code obligations for supplying controller/converter dynamic modelling information are also considered inadequate to ensure secure operation of the power system particularly regarding convertor base technology phenomena such as Sub Synchronous Controller Interactions (SSCI). The Grid Code modification [GC0100](#) also assigned responsibilities to Users to carry out studies for these interactions (see ECC.6.3.17) prior to connection which requires National Grid ESO to share modelling information; a requirement which is currently not included in the Grid Code.

ii) Defining Users' obligations to ride through fault events on the transmission system and to remain in operation after a fault clearance is considered to be lacking clarity.

iii) While Users consider each minor modification to their Plant and Apparatus in isolation, it may not be apparent that the overall performance of the Plant and Apparatus has changed over its lifetime as a result of the accumulation of these small changes. The consequence is that older plant may not perform as expected when subjected to one of the rare severe events which can occur on the transmission system and the models used by National Grid ESO may no longer be accurate as a result.

iv) Convertor based technologies are often installed in complex networks which may be subject to different configurations during commissioning and the lifetime of the site when individual plant items are out of service. The Grid Code does not specifically require Users to study and demonstrate that connection arrangements across all intended operating conditions of those networks comply with fault ride through requirements.

v) Concerns were raised by Ofgem that there was no independent compliance testing or verification in a couple of key examples associated with the 9th August event.

What is the solution?

Proposer's solution

(i) Improvement to Model Submission - PC

Remove the wording relating to a Completion Date of 01 April 2015 in the wording of PC.A.5.3.2(g) to require all synchronous Generators to supply Shaft Stiffness data to allow Sub Synchronous Torsional Interaction studies to be carried out. Add a sentence to allow this information to be shared with other relevant Users (e.g. HVDC Converter stations, large converter-based wind farms) to enable the User to carry out such studies.

Add a new section (PC.A.9) to give detailed RMS and EMT Model requirements including scope, technical description, performance, validation, documentation and sharing. This is consistent with recent updates to modelling practices internationally (e.g. Australia, Ireland) based on power disruption incidents.

(ii) Clarify wording on Fault Ride Through

To add further clarity on the interpretation of FRT requirements, it is proposed to add a new sentence on the first paragraph of the CC Fault Ride Through compliance requirement. This new sentence explains the circumstance of how long the Generator or HVDC System would be expected to remain connected and stable after a transmission fault. The format of the ECC is different hence a change of words in three clauses is required.

National Grid ESO is proposing the following areas of Grid Code for possible modification:

- The Planning Code should be updated to require shaft data from all Synchronous Generation connected to the transmission network. Although National Grid ESO recognises that there will need to be a time period to be agreed with the Company for Users to collect and supply this information, it is envisaged this period will be no longer than 2 years after this Grid Code modification comes into force. The Planning Code should also be updated to specify the plant and apparatus models to be submitted to National Grid ESO.
- The Planning code should be updated to clarify the format of the model information required (Root Mean Square (RMS) and Electromagnetic Time domain (EMT)) required for all HVDC and generation connected to the transmission network, and for other large generation. This includes (for RMS models) use of industry standard software model templates with site specific parameters as options, with a requirement for these to be shared with relevant Users and (for EMT) details of how the models may be shared to enable industry to perform necessary studies while protecting intellectual property rights. Where required, the User shall also provide replica and/or suitable Real Time Dynamic Simulator models; the requirements details will be specified in the Bilateral Connection Agreement
- Update the wording of the Connection Conditions and European Connection Conditions describing Fault Ride Through to ensure the requirements apply during and after a fault.
- Update the Compliance and European Compliance Processes sections of the Grid Code to oblige Users to confirm their Plant and Apparatus is compliant at regular (5 year) intervals during the life of the asset. This is consistent with European legislation "Requirements for Generators" (Article 41 paragraph 2) for regular re-evaluation of User compliance with the Grid Code.

Update the Compliance and European Compliance Processes simulation sections of the Grid Code (CP & ECP) to oblige Users with complex networks to discuss with

the company early during the compliance process any additional simulation requirements to cover for reasonably anticipated operating conditions.

- Update the Compliance Processes simulation sections of the Grid Code (CP & ECP) to require Users to have the simulation studies reviewed by an independent engineer or test body prior to submission to National Grid ESO. The obligations for compliance and assessment of compliance remain with the User and National Grid ESO (or Offshore Transmission Operator if applicable) respectively.

Workgroup considerations

The Workgroup convened 14 times to discuss the perceived issues, detail the scope of the proposed defect, devise potential solutions and assess the proposal in terms of the Applicable Grid Code Objectives.

The Workgroup held their Workgroup Consultation between 19 February and 19 March 2021 relating to the Original proposal and received 13 responses. A summary and the full detail of the responses can be found in the Annex 4.

Original Proposal – High Level Summary

The Original proposal suggested a number of separate changes to the Grid Code for the industry to consider against the BEIS/Ofgem actions to make the compliance and modelling processes for generation more robust. In summary the five solution areas are:

1. To improve the robustness of the modelling process – the proposal added requirements for Users to provide RMS and EMT models in the software used by the NGESO/TO for dynamic simulations. This included scope, technical description, performance, validation, documentation and confidentiality. The proposal includes sharing modelling information with other relevant Users (e.g. HVDC Converter stations, large converter-based wind farms) to allow interaction studies to be completed prior to connection.
2. To improve Generator understanding of the Fault Ride Through obligations, the description of Fault Ride Through requirement is modified.
3. To improve the robustness of large wind farms during the commissioning process the scope of Fault Ride Through simulations carried out prior to connection for large/complex wind farms and HVDC is enhanced to include alternative running arrangements.
4. To improve the robustness of lifetime compliance of Users with older plant, a new section “Compliance Repeat Plan” is proposed to be added within the Grid Code for Users to confirm compliance with their obligations to National Grid ESO every 5 years.
5. To address concerns raised by Ofgem that there is insufficient independent involvement in the compliance process, add in a requirement that all simulation reports are reviewed by an independent engineer or independent test body prior to submission to National Grid ESO. The proposal explains the scope and extent of the independent engineer’s responsibilities.

Approach taken to assessing workgroup feedback on the Original Proposal

The Workgroup discussed comments provided on the legal text for both [GC0138](#) and this modification.

Consideration of the Proposer’s solution

It was noted by the Workgroup that there were some crossovers with **GC0138** and that certain elements of discussions in regard to this modification may be better placed under **GC0138**. The two modifications were assessed by the same Workgroup but were decoupled following Panel guidance on 30 September 2021.

The legal text for the Original Solution is included in Annex 2 of this report.

The discussions were primarily centered around seven key topic areas within the proposal as follows:

- Independent Engineer solutions
- Sharing for SSCI/SSTI Studies
- RMS and EMT Modelling
- Fault Ride Through definition
- Compliance repeat plan
- Enhanced Fault Ride Through studies
- Provision of torsional/shaft data from older plant

The following sections provides a high-level outline of the key discussions relating to these topic areas:

Independent Engineer Verification

In the Original solution put forward by the Proposer, the additional requirement for Independent Engineer verification was included. The Proposer believes that the additional requirement for Independent Engineer verification as part of this modification goes some way to ensuring the future robustness of arrangements going forwards. The Workgroup however raised concerns about the logistics and cost of the change to industry. Some concerns were raised regarding the additional risk it may add such as increasing compliance turnaround timelines and how to agree on who qualifies for the role, as well as discussions regarding the level of value it could add.

Ofgem gave an update on their thinking on the requirements for an Independent Engineer Verification prior to the Workgroup consultation. Some Workgroup members felt that it would be difficult to find appropriate independent resources and that the cost of doing so would be significant. The general feedback from the majority of the Workgroup was that there was no requirement nor distinct benefit in utilising an Independent Engineer. It was suggested that National Grid ESO would benefit from having more in-house resources available who can then review and suitably challenge the studies. Ofgem's proposal was that the Workgroup should propose some possible solutions which could demonstrate a more enhanced, robust and a more economical process for their consideration.

The feedback and comments provided by the Workgroup held the view that any such review process could include suitable individuals who are not directly involved in the design of the project, but not necessarily independent of the company.

The Workgroup raised a number of alternatives principally limiting the application to larger more complex projects. This view is reflective of that held by some Workgroup members that whilst the robustness of the process is key, the need for an Independent Engineer as proposed is too onerous and that the suggested benefits would not be realised.

Sharing for SSCI / SSTI Studies

The Workgroup discussed sub-synchronous control interaction (SSCI) and sub-synchronous torsional interaction (SSTI) simulation data availability. This data is required to assess potential risk to plant e.g. offshore developers typically require data from other

users for risk mitigation purposes during planning phases. Discussion suggested that National Grid ESO should conduct screening on oscillatory frequencies to check appropriateness before requesting such torsional data for existing plant, as it can be difficult and expensive to obtain. Additionally, the risk is typically only applicable to large converter-based plant.

As described within GC077 and GSR018, frequency domain screening methods may be used to define modes of interaction against which frequency domain impedance across a users devices' operation or mechanical damping (actual or typical) may be used within a network "small-signal" analysis to narrow down conditions of risk, or demonstrate the absence of risk associated with SSCI and SSTI phenomena ahead of time domain analysis. This screening, whilst highly valuable in relation to this modification discussion, was not the focus of the priorities driving it, and it was considered that the extent of additional code drafting and process standardisation needed to incorporate this within the modification would unnecessarily delay and complicate its delivery. As a result, without recourse to such screening time domain studies alone can define and manage the risks present - which requires specific detailed modelling data from another users plant. The Workgroup notes the potential value of taking forward a separate modification specifically on screening techniques at a later stage to support delivery of interaction studies and in relation to other matters of simulation.

The Proposer clarified that while National Grid ESO is responsible for carrying out screening studies and should be able to identify operational risk of interactions, National Grid ESO is not resourced to carry out studies to design controllers to ensure avoidance of such interactions. As a result, the Proposer included several options within the draft legal text for consideration by the Workgroup to ensure appropriate options to consider how best to obtain this data.

Some Workgroup members questioned whether the ESO is not discharging their License's responsibility to Users when asking them to perform SSTI and CI studies in a wider portion of the SO network - which is not under the control of the User. Other SOs perform such studies themselves and provide Users with ranges of operability for their assets to avoid issues in the main network. Some Workgroup members believed that such an approach should also be considered in the UK and whether it would better meet the Grid Code objectives of this modification.

Provision of Torsional/Shaft Data from Older Plant - PC.A.5.3

The Workgroup discussed in detail the requirement for shaft data from older synchronous plant necessary for ensuring that there is no risk of damage from SSTI. The Workgroup agreed that such data was essential in absence of the aforementioned screening process being available. It was noted that the Original proposal was that all existing Generators should supply the information, but this was not favoured by owners of older plant who felt this applied an inappropriate burden on plant which might never be at risk of torsional interaction.

An alternative has been raised by the Proposer for provision of data when required after screening studies by ESO/TO. This makes the requirement clear but only requires older plant to supply the information when there is a need driven by changes in the network giving rise to the risk of torsional interactions. In the unlikely event that an existing Generator proves unable to procure the data for their plant this would require a derogation request in the same manner as other inabilities to comply with the Grid Code. Some Workgroup members raised a concern that under such circumstances, the studies would be missing potentially pertinent data and therefore would not guarantee no negative impact

on other parties. The Workgroup members also discussed that in circumstances where reasonable data is not available, there should be a discussion with National Grid ESO on how the study scope is to be revised.

RMS and EMT Model Submission (PC.A.9)

The Workgroup spent significant amount of time considering the P.C.A.9 modelling requirements both Root Mean Square (RMS) and Electromagnetic Transient (EMT) models. This included discussions around the current use of both model types and suitability moving forwards. The benefits of both models were discussed in terms of implications on further development of this modification. A subgroup was formed to discuss this issue specifically. The Proposer considered this element of the solution and adopted most of the technical model specification content in the legal text of the original proposal. The drafting on model confidentiality and sharing was significantly amended and investigation of CUSC provisions completed to the satisfaction of the Workgroup.

The Workgroup generally agreed to use of RMS and EMT models. The Workgroup members questioned when sufficient information is to be provided and how it would apply to older sites with different connection dates or where information may not be obtainable. In response, the Proposer directed the workgroup to **PC.A.5.3.2** and **PC.A.5.4.2** which only require the information outlined in **PC.A.9** for new or modified sites.

The Workgroup generally supported using RMS wind farm models (based on international standards) to offset some of the concerns over sensitivity of manufacturer-specific information. The Proposer amended the emphasis within the drafting of **PC.A.9.3.4** towards using international standard models (e.g. IEC/WECC/IEEE models commonly available in proprietary software). While submission would be in these standard international formats, the parameterisation should be appropriate for the connection site and not generic to bring the model performance in line with the real plant (within the inherent accuracy limitations of RMS models). Provisions for verification and validation of models are included in the modification. The use of models to standard recognised structures also facilitates computerised exchange of the controller models. The Workgroup had concerns that international standard models for some HVDC systems which can be more “bespoke” were less developed so may be more difficult to bring in line with real plant performance. This may also be true for other technologies emerging at the transmission level such as batteries and solar farms. However, as with wind generation, as technology progresses in deployment standard models are expected to appear.

Discussions around what level of detail the User has to provide with respect to “Sufficient information” and when it will be provided by the User to allow for The Company to redevelop User-defined RMS models (as opposed to industry standard models) in the event of future software environment changes or version updates took place. It was noted that where a User-defined RMS model is provided this needs to be open with visible transfer block diagrams to be considered “sufficient”.

The NGESO and TO Representatives re-iterated concerns that RMS models should be suitable to run in large network studies without extending simulation run times. This means that high speed (small time constant) and complex control functions should be simplified to larger time constant representations applicable to 50Hz RMS modelling framework. The Proposer noted that any RMS models which would call on external or encrypted data cannot be used due to inherent risk to control centre operations.

The Workgroup discussed confidentiality concerns relating to manufacturers’ intellectual property, particularly regarding EMT models where very detailed representations of control

systems are included. The Proposer provided alternative wording of **PC.A.9.9.2** to allow the Workgroup to consider encryption of EMT models with associated documentation on the functionality included in the model. Subsequently the Proposer agreed that encryption would be incorporated in the legal text of the original proposal. The NGESO/TO would publish a guidance document on the circumstances in which EMT models would be used and would specify some criteria and acceptable compilers to ensure compatibility in an extended network context.²

The User community on the Workgroup raised concerns over data provision from the NGESO/TO required to allow new connectees to ensure no unwanted interactions e.g. SSTI/SSCI would occur as a result of their connection. Of primary concern was the risk of an EMT model from 'manufacturer A' being shared through a User to 'manufacturer B' and manufacturer B gaining knowledge of manufacturer A's technology and consequently a competitive advantage. The proposal has been modified to allow encryption of EMT models to protect intellectual property and specific clauses added restricting any User in receipt of a model to only use it for the stated purpose, restricting internal use and deletion with confirmation of deletion to the National Grid ESO. The Workgroup was presented with the confidentiality requirements of the CUSC noting all Users are bound to this. The National Grid ESO may sign a standard National Grid ESO confidentiality agreement aligned to the CUSC provisions with a manufacturer where the manufacturer wishes to share models direct with the National Grid ESO using Manufacture Data and Performance Report in lieu of the standard submission route via the User. Management of sharing of models received either direct from the User or from Manufacture Data and Performance Report will be on the same basis under CUSC/Grid Code confidentiality provisions. Given the very large numbers of sites, users and manufacturers involved it is impractical and too administratively burdensome to have a system where confidentiality is managed by individual non-disclosure agreements between NGESO/TO/manufacturer/User, each with bespoke conditions. The proposal does not prevent the use of NGESO/TO protected environments for Users to conduct the studies however at present the technological methods which might be used are not widely adopted.

Further consideration of discussion on facilitating SSTI/SSCI studies is recorded in Annex 5 of this report.

Fault Ride Through Definition (Connection Conditions/ECC)

Workgroup members held several discussions regarding repeatability requirements in terms of how many faults plant should be able to ride through whilst remaining connected and stable; in what timeframe and how soon they should return to normal operation immediately after fault recovery. Queries on how to define 'immediately after' a fault were raised by several Workgroup members. After several iterations with the Workgroup members, the Proposer revised the drafting of these clauses to clarify further.

Another Grid Code Workgroup [GC0155](#) has been set up to consider further clarification of the Fault Ride Through requirements. Some Workgroup members believed that the FRT definition should be assessed in more detail by the GC0155 Workgroup.

Enhanced Fault Ride Through Studies (ECP)

Discussions around the requirements for Fault Ride Through Simulations indicated that the Workgroup felt they were too open ended. As a result, the Proposer made amendments to the scope of **ECP.A.3.5.3** stating that the **Generator** and **The Company** will agree on the nature of the content/studies prior to simulations commencing.

² Any guidance note would not be reviewed by public consultation

The proposer also added the specific provisions relating to complex HDVC systems within ECP.A.3.5.5 to ensure more appropriate requirements for a wider range of technologies.

Compliance Repeat Plan

The Proposer suggested an enhanced robust compliance plan to ensure regular reviews of the Generator Compliance status are conducted and submitted by Users on an ongoing basis every five years. Workgroup discussions and subsequent feedback outlined concerns over the requirement to re-validate simulation studies for every five years. Some Workgroup members felt repeat testing should be based only on scenarios where National Grid ESO highlights issues. Several Workgroup members felt that the Compliance Repeat Plan should not be made mandatory, as this would impact revenue for the Plant Operator without appropriate consideration of necessity e.g. whether material changes have occurred in the previous five years. Further to workgroup feedback, the Proposer agreed that the National Grid ESO will notify the provider with a six-month reminder to ensure compliance is met within the five-year requirement to ensure ample notice for preparation and delivery.

The majority of the Workgroup agreed that the simulation studies are a part of the Compliance Process and not the Planning Code Data. The majority also agreed that significant material changes of Users' plant which may impact operational capabilities and/or compliance should be notified to the ESO, and that continuing self-certification is the correct way forward, noting that if the network has changed then it is the ESO's responsibility to assess the network accordingly.

The Proposer also clarified the requirements clearly restrict the scope to re-submission of the data outlined in the Planning Code and the Data Registration Code rather than full simulations and tests present in the Compliance Processes/European Compliance Processes. The proposer also made it clear that the Independent Engineer review requirement is not intended to apply to the Compliance Repeat Plan.

The Workgroup raised concerns around the practical implementation as there will be a considerable number of power stations which have been operating for more than five years since the initial compliance was confirmed. The Proposer agreed that the National Grid ESO should provide guidance on how the dates for older stations confirming continued compliance should be managed and spread so that portfolio users (and ESO) do not face an impractical influx of work.

The Original Solution details the proposal for the Compliance Repeat Plan. An alternative suggestion was raised only requiring information to be submitted when substantive changes have occurred. The National Grid ESO's view is that it is the Users responsibility to maintain the data for their Plant and Apparatus so there should not be significant problems in resubmitting the planning code data to ensure that the National Grid ESO is in receipt of a complete and up to date set of information notwithstanding the User's obligation to advise the National Grid ESO of any updates as soon as reasonably practical.

Alignment of Signed Connection Agreements

The Workgroup noted that Users over the past two years have been requested to sign Connection Agreements which include specific requirements for Users on model submission and SSTI/CI studies: these requirements were introduced by National Grid ESO in the Connection Agreement templates available on an interim basis to address the issues discussed in relation to this modification, until it is completed. Once the proposed Grid Code changes are approved by the Authority, the Grid Code will take precedence

over the Bilateral Agreement for connections after the activation date included in the Planning Code. Users with connection dates prior to the activation date have been asked to provide the required models to allow the NGESO/TO to fulfil their obligations prior to the activation date. The basis of the models specified in the Bilateral Agreements should reflect the proposals in the proposed PC.A.9. The Workgroup members recommended that all currently signed Connection Agreements with such requirements should be aligned with the updated Grid Code, if Users want to do so. This updating process should not require a Modification Application submission but, should be addressed via an Agreement to Vary.

Sub-group discussions on elements of solution

Variations on the following elements of the solution were discussed; Independent Engineer verification, Modelling, and Interactions. These topics were allocated out as sub-group discussions with meetings held separately to Workgroup discussions. Further detail of the key discussions within the three subgroups and their Terms of Reference can be found in Annex 5.

Workgroup consultation summary

The Workgroup held their Workgroup Consultation between 19 February and 19 March 2021 and received 13 responses. A summary as well as the full responses can be found in Annex 4.

Overall – respondents were mostly supportive of the principles of the proposed changes and the need for enhanced robustness of compliance processes, with some key concerns in the following areas:

- The Independent Engineer proposal received concerns in several areas, such as cost implications and additional administrative burden slowing existing processes down further. Several Workgroup members felt it would add complexity and introduce further ambiguity in accountability without sufficiently clear benefits to the compliance process. Queries were raised regarding what qualifications would render someone competent for the role, who would regulate their activities, and what their specific liabilities would be. Some respondents also felt that the IE role should only apply to future sites rather than existing connected parties.
- Fault Ride Through changes requiring a thirty-minute period of sustained and stable connection post-fault do not sufficiently account for subsequent trips relating to operational safety matters. Also “fault” should be more clearly defined.
- The Compliance Repeat Plan as proposed led to some views that it would create additional administrative burden, and that the scope should be reconsidered in terms of whether it should require reassessment of all applicable compliance matters or whether the scope could be discussed and agreed with the National Grid ESO on a more bespoke basis each time. Queries were also raised over how to implement it in the immediacy without bottlenecks of “backed up” checks potentially leading to Limited Operational Notifications.
- The question of responsibility for interaction studies resulted in majority views that this should be the National Grid ESO’s responsibility given their access to relevant models.

- Concerns over sharing of EMT models and implications for IP protection and general confidentiality, due to the potential for reverse-engineering even of black boxed models.

Post-consultation discussion

The Workgroup considered the seven key elements of the solution separately. In four of the seven elements, variations on that element were considered as well as comparison to the Original solution and baseline (current) Grid Code. For the other elements, the Original solution was compared with the baseline Grid Code.

- Independent Engineer solutions (Original, baseline and two variations)
- Methodology for SSCI/SSTI Studies (Original, baseline and three variations)
- RMS and EMT Modelling (Original and baseline)
- Fault Ride Through definition (Original and baseline)
- Compliance repeat plan Studies (Original, baseline and one variation)
- Enhanced Fault Ride Through studies (Original and baseline)
- Provision of torsional/shaft data from older plant (Original, baseline and one variation)

The Workgroup voted on each solution element in isolation. This enabled them to see what the majority of the Workgroup agree with on each element of the solution, and these were put forward as WACGMs. The majority combinations are WACGM1 and WACGM14 (there was a split vote in regard to provision of torsional/shaft data).

The vote on each solution element is provided in Annex 6a.

The Workgroup found it challenging to put forward discrete Alternative solutions which combine the seven elements considered by this modification. At the Grid Code Panel on 31 March 2022, the Panel asked the Workgroup to consider whether any aspects of the modification could be de-scoped to help to refine the solutions. Two aspects were discussed:

- The Workgroup considered whether the Independent Engineer aspect was still required, given that BEIS and Ofgem had recently published their response to the Future of the System Operator Consultation, and one Workgroup member suggested that the ESO will be required to carry out the Independent Engineer role as part of their duties anyway. The Proposer felt that it is too early to discuss what the FSO responsibilities would be at this time, and therefore there was no change made to this aspect of the modification.
- The Workgroup considered whether the Fault Ride Through requirements aspect could be taken from this modification and instead considered within [GC0155](#) 'Clarification of Fault Ride Through Technical Requirements'. The Proposer believed that aspect this is fundamental in terms of what the modification is looking to address as a result of the 9th August 2019 power disruption, and therefore no change was made to this aspect.

WACGMs

Workgroup members each put forward the combination of the seven elements which they felt best facilitated the Grid Code Objectives. These, as well as the majority combinations (WACGM1 and WACGM14) became Workgroup Alternative Grid Code Modifications. The WACGM forms can be found in Annex 7.

Baseline							
Original							
Solution	Independent Engineer	Sharing for SSTI / SSCI	RMS & EMT Models	Fault Ride Through Definition & Retrospective Requirements	Compliance Repeat Plan	Enhanced FRT Studies	Torsional Data
Baseline	No requirement for IE	No requirement on NGENSO/TO to share models	No specification required	No time duration or respective requirements	No requirement to submit compliance statement and DRC Schedules	No requirement to agree additional studies for complex connections at start of process	No requirement to provide torsional data with completion date before 1st April 2015
Original	Requirement for IE	NGESO /TO share models as required	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 1	No requirement for IE	NGESO /TO share models as required	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 2	No requirement for IE	NGESO /TO share models as required	Specification of RMS & EMT model (fully encrypted)	No time duration or respective requirements	No requirement to submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	User provides data when asked prior to a completion date of 1st April 2015
WAGCM 3	Requirement for IE	NGESO/TO host study environment with remote access	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 4	No requirement for IE	NGESO or TO Employ a Consultant who	Specification of RMS & EMT model	Adds a time duration & retrospective	Every 5 years Users submit compliance	No requirement to agree additional	User provides data when asked prior to a

		sees network data	(fully encrypted)	requirements	statement and DRC Schedules	studies for complex connections at start of process	completion date of 1st April 2015
WAGCM 5	No requirement for IE	NGESO/TO share models as required	Specification of RMS & EMT model (fully encrypted)	No time duration or respective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	User provides data when asked prior to a completion date of 1st April 2015
WAGCM 6	No requirement for IE	NGESO/TO share models as required	No specification required	No time duration or respective requirements	Submit material changes from submission made to achieve FON	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 7	No requirement for IE	NGESO/TO share models as required	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Submit material changes from submission made to achieve FON	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 8	No requirement for IE	NGESO/TO share models as required	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	No requirement to submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	User provides data when asked prior to a completion date of 1st April 2015
WAGCM 9	Min threshold 100MW before IE required	NGESO/TO share models as required	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 10	Min threshold 100MW before IE required	No requirement on NGESO/TO to share models	Specification of RMS & EMT model (fully encrypted)	No time duration or respective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	All Users provide torsional data (retrospective)
WAGCM 11	Min threshold 100MW (inc of	User employs a Consultant who	Specification of RMS & EMT model	Adds a time duration & retrospective	Submit material changes from	Additional studies for complex	User provides data when asked prior

	Users at LON status or material change) before IE required	sees network data & carries out the studies	(fully encrypted)	requirements	submission made to achieve FON	connections agreed at start of process	to a completion date of 1st April 2015
WAGCM 12	Min threshold 100MW (inc of Users at LON status or material change) before IE required	User employs a Consultant who sees network data & carries out the studies	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Every 5 years Users submit compliance statement and DRC Schedules	No requirement to agree additional studies for complex connections at start of process	User provides data when asked prior to a completion date of 1st April 2015
WAGCM 13	No requirement for IE	NGESO /TO host study environment with remote access	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Submit material changes from submission made to achieve FON	Additional studies for complex connections agreed at start of process	User provides data when asked prior to a completion date of 1st April 2015
WAGCM 14	No requirement for IE	NGESO/TO share models as required	Specification of RMS & EMT model (fully encrypted)	Adds a time duration & retrospective requirements	Every 5 years Users submit compliance statement and DRC Schedules	Additional studies for complex connections agreed at start of process	User provides data when asked prior to a completion date of 1st April 2015

Legal text

The legal text for this modification can be found in Annex 2.

What is the impact of this change?

Workgroup vote

The Workgroup met on 5 May 2022 to agree that the Terms of Reference had been met and carry out their Workgroup vote. 13-14 Workgroup members voted (note one Workgroup member abstained from voting on 13 of the WAGCMs). The full Workgroup vote can be found in Annex 8.

Option	Number of voters that voted this option as better than the Baseline	Number of voters
Original	5	14
WAGCM1	4	14
WAGCM2	5	13
WAGCM3	4	13
WAGCM4	4	13

WAGCM5	5	13
WAGCM6	2	13
WAGCM7	3	13
WAGCM8	4	13
WAGCM9	5	13
WAGCM10	5	13
WAGCM11	5	13
WACGM12	5	13
WACGM13	5	13
WACGM14	7	13

Code Administrator Consultation summary

The Code Administrator Consultation was issued on the 06 June 2022 closed on 08 July 2022 and received 5 responses. A summary of the responses can be found in the table below, and the full responses can be found in Annex 9.

Code Administrator Consultation summary	
Question	
Do you believe that the GC0141 Original Proposal or WAGCM1-14 better facilitates the Applicable Grid Code Objectives?	There was no clear preference on solutions shown from the Code Administrator Consultation responses.
Do you support the proposed implementation approach?	Most respondents were supportive of the implementation approach.
Do you have any other comments?	<p>Issues highlighted:</p> <ul style="list-style-type: none"> - 'No requirement for an independent engineer' with the exception that the proposed new mandatory requirement to provide shaft data from all existing synchronous power stations for new developments to carry out SSI studies, should not be a cost for the existing synchronous power station. - One respondent believed requirement for an independent should be up to the User - seeing as they are obliged to demonstrate compliance. They also raised concerns about what constitutes as "suitably qualified". - Lack of clarity with how the revised CC 6.3.15 applies to existing LEEMPS. One respondent interpreted that PC.A.9 does not apply to LEEMPS. - Concerns about solutions which place retrospective obligations on existing Users.

	<ul style="list-style-type: none"> - Safety concern regarding the added requirement that a Unit must stay connected for 30 minutes following a fault or disturbance. - Complex modification made up of 7 elements - respondent concerns that by combining the 7 elements this has created artificial linkages between the different aspects of the modification. - Regarding RMS and EMT models, a concern was shared regarding intellectual property rights. - Torsional data not always available for older plants. Respondent suggested where risk of SSTI has been identified, the data should be provided at the expense of the requester.
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Legal text issues raised in the consultation

A respondent stated that the revised CC 6.3.15 will apply to any existing LEEMPS and it will not be reasonable to impose these new fault ride through requirements retrospectively to LEEMPS. There is no explanation in the consultation of how these new requirements can be achieved with existing plant and on this basis the proposed new text in CC.6.3.15 should not be implemented.

Also, the respondent expressed that as the DNOs will need to implement the new PC.A.5.3.2 – which means implementing PC.A.9, but as PC.A.9 does not include any embedded plant within its scope, it is unclear whether NGENSO will or will not expect these models from LEEMPS.

Panel recommendation vote

The Panel met on the 28 July 2022 to carry out their recommendation vote. They assessed whether a change should be made to the Grid Code by assessing the proposed change and any alternatives against the Applicable Objectives.

Panel comments on Legal text

Ahead of the vote taking place, the Panel considered the legal text amendments proposed as part of the Code Administrator Consultation and agreed that they were typographical. The changes made can be found in Annex xx.

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Alan Creighton, Network Operator Representative**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						

WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Alastair Frew: Generator**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Christopher Smith: Offshore Transmission Licensee**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						

WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Guy Nicholson: Generator**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **John Harrower: Generator**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						

WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Robert Longden: Supplier**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Rob Wilson: National Grid ESO**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						

WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Roddy Wilson: Onshore Transmission Licensee**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?

Panel Member: **Sigrid Bolik: Generator**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						

WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 1: Does the Original, WAGCM1-14 facilitate the objectives better than the Baseline?
 Panel Member: **Graeme Vincent (on behalf of Steve Cox): Network Operator Representative**

	Better facilitates AO (a)?	Better facilitates AO (b)?	Better facilitates AO (c)?	Better facilitates AO (d)?	Better facilitates AO (e)?	Overall (Y/N)
Original						
WAGCM1						
WAGCM2						
WAGCM3						
WAGCM4						
WAGCM5						
WAGCM6						
WAGCM7						
WAGCM8						
WAGCM9						
WAGCM10						
WAGCM11						
WAGCM12						
WAGCM13						
WAGCM14						
Voting Statement						

Vote 2 – Which option is the best?

Panel Member	BEST Option	this option better facilitate? (if baseline is not applicable)
Alan Creighton		
Alastair Frew		
Christopher Smith		
Guy Nicholson		
John Harrower		
Robert Longden		
Rob Wilson		
Roddy Wilson		
Sigrid Bolik		
Graeme Vincent		

Panel conclusion

The Panel, **unanimously/ by majority recommended/determined** that the Proposer's **solution/WAGCM1-14** should be implemented.

When will this change take place?**Implementation date:**

10 working days after decision.

Date decision required by:

There is no critical date for the implementation of this modification.

Implementation approach:

There will be no impact on systems.

Interactions

- | | | | |
|--|--|---|--------------------------------|
| <input type="checkbox"/> Grid Code | <input type="checkbox"/> BSC | <input checked="" type="checkbox"/> STC | <input type="checkbox"/> SQSS |
| <input type="checkbox"/> European
Network Codes | <input type="checkbox"/> EBR Article 18
T&Cs ³ | <input type="checkbox"/> Other
modifications | <input type="checkbox"/> Other |

Offshore Networks are designed in conjunction with the design of offshore generation so changes to Fault Ride Through definition may require update to STC section K and changes to the scope of studies may require an update to STCP19-5.

Acronyms, key terms and reference material

Acronym / key term	Meaning
Baseline	The code/standard as it is currently
BCA	Bilateral Construction Agreements
BEIS	Department for Business, Energy and Industrial Strategy
CP	Compliance process
CC	Connection Conditions
ECP	European Compliance process
EON	Energisation Operation Notification
ION	Interim Operational Notification
LON	Limited Operational Notification
NGESO	National Grid Electricity System Operator
EMT	Electromagnetic Time domain
FRTS	Fault Ride Through Simulations
HVDC	High Voltage Direct current
RMS	Root Mean Square
SSCI	Sub-synchronous Control Interaction

³ If the modification has an impact on Article 18 T&Cs, it will need to follow the process set out in Article 18 of the Electricity Balancing Regulation (EBR – EU Regulation 2017/2195) – the main aspect of this is that the modification will need to be consulted on for 1 month in the Code Administrator Consultation phase. N.B. This will also satisfy the requirements of the NCER process.

SSTI	Sub-synchronous Torsional Interaction
STC	System Operator Transmission Owner Code
TO	Transmission Owner

Reference material

1. Guidance Notes covering the demonstration of compliance for Power Park Modules, Synchronous Generators and HVDC Interconnectors under both EU Code and GB Code can be found on the National Grid ESO website under Grid Code, Associated Documents:
<https://www.nationalgrideso.com/industry-information/codes/grid-code-old?code-documents=>
2. Commission Regulation (EU) 2016/631 of 14 April 2016 and Commission Regulation (EU) 2016/1447 of 26 August 2016.
<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&from=EN>
<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1447&from=EN>
3. 9th August 2019 Power Outage Report published by Ofgem dated 3rd January 2020.
https://www.ofgem.gov.uk/system/files/docs/2020/01/9_august_2019_power_outage_report.pdf
4. GB Power System disruption on 9 August 2019, Energy Emergencies Executive Committee (E3C) Final Report published by Department for Business, Energy and Industrial Strategy, published January 2020.
<https://www.gov.uk/government/publications/great-britain-power-system-disruption-review>

Annexes

Annex	Information
Annex 1	GC0141 Proposal Form
Annex 2	Legal Text
Annex 3	Terms of Reference
Annex 4	GC0141 Workgroup Consultation Responses
Annex 5	Subgroup discussions and subgroup Terms of Reference
Annex 6a	Superseded Vote
Annex 6b	Superseded WACGM Forms
Annex 7	WAGCM Forms
Annex 8	GC0141 Workgroup Vote
Annex 9	Code Administrator Consultation Responses

