Workgroup Consultation

GC0151:

Grid Code Compliance with Fault Ride Through Requirements

Overview: A letter issued by the ESO on 7th May 2021 and a presentation to be made to the 27th May 2021 GCRP have identified concerns about demonstrating compliance with the Fault Ride Through Requirements in the Grid Code. This proposal seeks to apply a workable, non-discriminatory, legally compliant solution based on Good Industry Practice to address this significant operational concern in an expedited manner.

Modification process & timetable

1. **Proposal Form**
   23 June 2021
2. **Workgroup Consultation**
   30 July 2021 – 16 August 2021
3. **Workgroup Report**
   01 September 2021
4. **Code Administrator Consultation**
   09 September 2021 – 23 September 2021
5. **Draft Modification Report**
   05 October 2021
6. **Final Modification Report**
   07 October 2021
7. **Implementation**
   One working day after Authority Decision

Have 5 minutes? Read our Executive summary

Have 20 minutes? Read the full Workgroup Consultation

Have 30 minutes? Read the full Workgroup Consultation and Annexes.

Status summary: The Workgroup are seeking your views on the work completed to date to form the final solution(s) to the issue raised.

This modification is expected to have a: High impact on Generators, Transmission System Operators, Interconnectors, Transmission Owners, Distribution Owners

Modification drivers: Efficiency, EU Compliance, GB Compliance, Harmonisation, System Operability, System Security, Transparency

Governance route	Urgent modification to proceed under a timetable agreed by the Authority (with an Authority decision)	
Who can I talk to about the change?	**Proposer:** Garth Graham garth.graham@sse.com 01738 456000	**Code Administrator Chair**: Nisar Ahmed Nisar.Ahmed@nationalgrideso.com Phone: 07773 043068
How do I respond?	Send your response proforma to grid.code@nationalgrideso.com **by 5pm** on **16 August 2021.**	

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Executive summary

A letter issued by the ESO on 7th May 2021 to stakeholders and a presentation to be made to the 27th May 2021 Grid Code Review Panel (GCRP) have identified concerns about demonstrating compliance with the Fault Ride Through Requirements in the Grid Code.

What is the issue?

This proposal seeks to apply a workable, non-discriminatory, legally compliant solution based on Good Industry Practice to address this significant operational concern in an expedited manner.

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

Proposer's solution: To codify a solution in the Grid Code which will:

- 1) Be placing Users (and in particular Generators) in compliance of a relevant **legal requirement**;
- 2) Have minimal **commercial impact** on Users and consumers;
- 3) Have a positive effect on the safety and **security of the electricity system;**
- 4) Apply a **reasonable timing** obligation on all stakeholders;
- 5) Apply a **non-discriminatory process** to all stakeholders; and
- 6) Ensure and **enhance transparency** of the FRT situation in GB

Implementation date: This modification is to be implemented one working day, following the Authority decision.

Summary of potential alternative solution(s) and implementation date(s):
The ESO have developed a draft alternative which can be found in Annex 9. This alternative emphasises what was set out in the open letter written by NGESO; reminding Users of their requirements under the Grid Code and that the inability of Users to ride through 'normal' faults on the NETS is a serious risk to system security. NGESO needs to have the ability to manage fault ride through (FRT) non-compliances quickly and effectively.

What is the impact if this change is made?

This change will have a High impact on Generators, Transmission System Operators, Interconnectors, Transmission Owners, Distribution Owners.

Interactions

This modification has potential interactions with REMIT Article 5 obligations and ACER Guidance.

What is the issue?

The ESO's Head of Networks wrote to stakeholders on 7th May 2021 about "Grid Code Compliance with Fault Ride Through Requirements".

Fault Ride Through (FRT) is defined in the Grid Code as:

> "*The capability of Power Generating Modules (including DC Connected Power Park Modules) and HVDC Systems to be able to remain connected to the System and operate through periods of low voltage at the Grid Entry Point or User System Entry Point caused by secured faults*."

In that letter it set out three actions and; in the Appendix to that letter; an interim process that the ESO was proposing be applied by them on Users and Network Operators. Subsequently, following as we understand meetings on 10th June 2021 with stakeholders (Energy UK in the morning and the wind community in the afternoon) the ESO issued on 16th June 2021 (as part of the papers for the 24th June 2021 GCRP meeting) a short presentation which *seems* to set out amendments to the (7th May) interim process that the ESO was proposing be applied by them on Users and Network Operators.
These steps by the ESO have, inadvertently, given rise to concerns, by stakeholders, that if they were to follow this uncodified 'voluntary'[1] ESO interim process this would:

1) Be placing Users (and in particular Generators) in breach of a relevant **legal requirement**;
2) Have a significant **commercial impact** on Users and consumers;
3) Have a significant impact on the safety and **security of the electricity system;**
4) Apply an **unreasonable timing** obligation on some stakeholders;
5) Apply a **discriminatory process** to some stakeholders; and
6) Not ensure and **enhance transparency** of the FRT situation in GB.

Therefore, a codified process is required to ensure legal compliance and certainty whilst maintaining security of supply and minimising the significant commercial impact on stakeholders as well as providing a reasonably timed, non-discriminatory process and enhanced transparency for stakeholders.

1) Legal Compliance

It is highly relevant, when considering the ESO's proposed interim process, to note that generators that voluntarily reduce their MEL to zero[2] (or to an undefined 'safe[3] level'[4]) whilst investigating the root cause of any FRT related issue would be at risk of being

[1] The ESO's 7th May 2021 letter and the 24th June 2021 GCRP presentation strongly infers that the ESO expects and requires Users (and Network Operators) to comply with the ESO's proposed interim process. This infers a 'voluntary' in name only approach for stakeholders – you are *damned if you do* (to suffer legal compliance and commercial impacts) and *damned if you don't* (to be vilified by the ESO - and possibly BEIS and Ofgem? - for not having followed the interim process).
[2] As noted in the 24th June 2021 GCRP presentation and elaborated in items 3 and 4 of Appendix 1 in the 7th May 2021 ESO letter [3] "*If this cannot be confirmed, the relevant Generator, HVDC System and Network asset(s) should remain out of operation*." [emphasis added]" [4] "*If there is a potential compliance issue, the ESO expectation is that the Generator, HVDC System, Network asset(s) should remain out of operation until a resolution is in place*." [emphasis added]
[3] It is not clear here to what the ESO is referring: 'safe' for the system only? 'safe' for the User(s) only? 'safe' for both the system and the User(s)?
[4] As per the first bullet point on slide 3 of the ESO's June GCRP presentation "*Users are asked to restrict their output until a FRT issue is ruled out (either MEL to zero or to a safe level)*" [emphasis added]

deemed to have physically withheld generation capacity, potentially in breach of the REMIT[5] Article (5) prohibition of market manipulation.
This risk would be higher in scenarios where, during the period of reduced output, the system experiences a period of very tight generation margins.

1.1) ACER Guidance

When considering compliance with REMIT Article (5), it is necessary to take into account the 20th November 2020 (5th edition) version of ACER's guidance[6] on REMIT and in particular section 6.4.1 ('*Examples of the various types of practice which could constitute market manipulation*') of which item (i) is directly relevant to the ESO's proposed approach with respect to the FRT interim process, namely:

i) "Actions undertaken by persons that artificially cause prices to be at a level not justified by market forces of supply and demand (including actual availability of production, storage or transportation capacity)

Manipulative capacity withholding occurs, for example, when a market participant with the relative ability to influence the price or the interplay of supply and demand of a wholesale energy product, decides, without justification, not to offer or to economically withhold the available production, storage or transportation capacity on the market. This includes the unduly limiting of infrastructure or transmission capacities, resulting in prices that likely do not reflect the fair and competitive interplay of supply and demand.
In particular, electricity generation capacity withholding refers to the practice of keeping available generation capacity from being competitively offered on the wholesale electricity market, even though offering it competitively would lead to profitable transactions at the prevailing market prices. Electricity generation capacity withholding can occur in two ways, namely via economic withholding32 [footnote 32 Actions undertaken to offer available generation capacity at prices which are above the market price and do not reflect the marginal cost (including opportunity cost) of the market participant's asset, which results in the related wholesale energy product not being traded or related asset not being dispatched] or physical withholding33 [footnote 33: Actions undertaken in the form of not offering the available generation capacity at any price.]. Electricity generation capacity withholding may be performed by one or more market participants34[7], acting independently or in collaboration. REMIT applies to electricity generation capacity withholding irrespective of whether competition law (also) applies. Electricity generation capacity withholding does not automatically amount to a breach of Article 5 of REMIT. A case-by-case analysis that takes into account the circumstances and specificities of the market35[8] is therefore needed. REMIT does not prohibit prices to be high, provided that they reflect a fair and competitive interplay between supply and demand.
The following approach, based on two concurrent elements, can assess whether a behaviour involving electricity generation capacity withholding amounts to a breach of Article 5 of REMIT in view of the market manipulation criteria as defined in Article 2(2) of REMIT36[9]. The first element to assess is whether the market participant concerned

[5] Further details on REMIT can be found on the Ofgem website at: https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/remit-and-wholesale-market-integrity?sort=publication_date
[6] https://extranet.acer.europa.eu/en/remit/Documents/5th-Edition-ACER-Guidance-updated.pdf
[7] Footnote 34 "For example, producer or storage asset owners."
[8] Footnote 35 "For example, there are different timeframes and types of market places to be taken into account."
[9] Footnote 36 "E.g., and not limited to, setting prices at an artificial level"

is able, in the case specific circumstances, to influence the price or the interplay of supply and demand of a wholesale energy product by engaging in such behaviour37[10]. The second element to assess is whether the market participant has no legitimate technical, regulatory38[11] and/or economic39[12], justification for its behaviour when it does not offer its available generation capacity or has offered it above marginal cost.40[13] In case of intent, any action involving capacity withholding, even beyond the issuing of orders to trade or the entering into transactions, can amount to an attempt to manipulate the market." [emphasis added]

1.2) Conclusion on Legal Compliance

For the reasons set out above, and in order to give legal certainty as regards compliance with the REMIT Article 5 obligations, it is necessary to proceed with a code modification to ensure that generators are able to both follow a process set out in regulation in the circumstances described by the ESO and also be certain as to what a 'safe level' is.

2) Significant commercial impact on Users and consumers

If Users were to follow the ESO's proposed interim process, it is not clear, following the 24th June 2021 GCRP update, as to whether they should go to zero output (as per the 7th May letter which stipulates a generator 'remaining out of operation' in item 3[14] and item 4[15] of Appendix 1) or a 'safe level' (as per 24th June 2021GCRP update).
However, if they were to go to, and maintain, till the situation is resolved to the ESO's satisfaction (as per Appendix 1 item 3 and item 4), a zero-output level this would amount to a significant commercial impact on Users.
This also needs to be considered in the context of the User being effectively treated, according to the ESO's interim process, as being 'guilty until proven innocent', even though (i) they will, in the case of a FON, have proven to the ESO's satisfaction Grid Code Compliance and (ii) in the case of a fault where there is an over-voltage situation the generator may actually be *required* to trip off according to Grid Code requirement CC[16].6.3.15.3. – so rather than being non-compliant if they tripped off, they would actually be non-compliant if they did not trip off (in that situation).
Absent (a) the necessary technical information from the ESO as to what occurred on the NETS, and, (b) time to investigate the route cause; it will be difficult for the User to determine, within two hours, that non-compliance with the Grid Code has arisen and thus avoid going to zero output or an undefined 'safe level' with the associated significant commercial impact.

[10] Footnote 37 "For example, but not limited to, being a 'pivotal supplier' i.e., a power supplier whose capacity must be used to meet peak demand and whose capacity exceeds the market's supply margin."
[11] Footnote 38 "For instance, in situation of force majeure or localised transmission constraints. The validity of reasons for unavailability of a power plant could be assessed against the 'would be' behaviour of a competitive market participant."
[12] Footnote 39 "I.e. opportunity costs. Opportunity costs represent the expected value of the most valuable choice that was not taken. In wholesale electricity markets, this can, for example, represent producing at a different point in time for energy-limited generation assets, e.g. reservoir hydropower units, or producing in a different sequential market for capacity-limited generation assets."
[13] Footnote 40 "ACER is committed to provide further clarifying guidance with respect to justifications mentioned in Section 6.4.1.(i)"
[14] "*If this cannot be confirmed, the relevant Generator, HVDC System and Network asset(s) should remain out of operation*." [emphasis added]
[15] "*If there is a potential compliance issue, the ESO expectation is that the Generator, HVDC System, Network asset(s) should remain out of operation until a resolution is in place*." [emphasis added]
[16] And its ECC equivalent.

Notwithstanding the above, if Users (be that one or more generators or one or more interconnectors) or Network Operator(s) were to hold their plant and apparatus (including network assets) to zero output or a 'safe level' this could, particularly at times of market tightness (such as a winter peak or, as with the Bank Holidays in spring 2020, summer troughs), lead to additional, higher cost and actions needing to be taken by the ESO to maintain system balance.
This in turn could lead to a significant commercial impact on Suppliers and, over time, to higher costs for end consumers.

3) Significant impact on the safety and security of the electricity system

As noted under (2) above, if Users (be that one or more generators or one or more interconnectors) or Network Owners were to hold their plant and apparatus (including network assets) to zero output or a 'safe level' this could, particularly at times of market tightness (such as a winter peak or, as with the Bank Holiday's in spring 2020, summer troughs) lead to shortages of available plant and apparatus (including network assets) necessary to safely and securely operate the NETS. This, in turn, could significantly impact on the safety and security of the electricity system in GB.

4) Unreasonable timing obligation on some stakeholders

Notwithstanding the above, the ESO is proposing, with the interim process, to not provide stakeholders with a realistic timeframe for them to:

(i) Carry out an initial investigation; and
(ii) Perform the enduring investigation as, for example, was seen following the 9th August 2019 event in terms of how long Orsted and RWE had to report to ESO in that case, which, it be could argue sets 'Good Industry Practice' in terms of FRT reporting to the ESO.

In our view, in the event of a trip coincident with a system fault, more detail is required from the ESO and then more time is required for the User or Network Operator to investigate the situation with their plant or apparatus (including network assets).
We elaborate further on this in the 'What is the proposed solution' section below.

5) Apply a discriminatory process to some stakeholders

According to the ESO's 7th May 2021 interim process, as detailed in Appendix 1, a number of materially different (and, in our view, discriminatory) approaches are inadvertently proposed to be applied by the ESO where an FRT event occurs.
For example, the opening sentence of Appendix 1 sets out that the:

> "*ESO expects to follow the below steps to manage the system security risk following an unexpected generation loss/de-load coincided with a normally cleared transmission fault*." [emphasis added]

This is reinforced by the wording on slide 3 of the ESO's presentation to the 24th June 2021 GCRP meeting which states the:

> "*ESO's expectations of Us*ers"

Notwithstanding the references to HVDC Systems and Network Operators etc., elsewhere in Appendix 1, this suggests that the ESO only actually intend that its interim

process be applied to generators and not, for example, to interconnectors or Network Operators.
If so this would, in our view, be discriminatory.
Another example is shown in item 4[17] of Appendix 1 where a User (but not a Network Operator) has to respond to the SIR from the ESO within two hours, whilst the Network Operator "*must respond as soon as reasonably practicable*".
Depending on the timing of the event be that, for example, on a Friday morning, like the 5th September 2003 event or a Thursday evening or Friday evening like the 28th August 2003 and the 9th August 2019 events[18] could mean that many or few staff are available either on-site or off-site for the User or Network Operator to provide the technical analysis etc., in order to determine the situation with the plant or apparatus (including network assets) and report back accordingly to the ESO.
In the case of the Network Operator, as they only have to respond as soon as reasonably practicable, they will be able to respond, timing wise, differently on, say, a Friday morning (like 5th September 2003) compared to a Friday evening (like 9th August 2019) or over the weekend or a Bank Holiday; whereas a User (such as a generator or interconnector) will not.
As such this, in our view, is discriminatory.

6) Ensure and enhance transparency of the FRT situation in GB

In respect of ensuring transparency of matters pertaining to FRT we are mindful that following the decision by the Authority to approve modification GC0105[19], that the ESO has, to date, yet to issue the Grid Code Review Panel with a report of the ESO's progress towards reporting of voltage transients as it is required under OC3.4.1(c)[20].
In addition to ensuring compliance with existing transparency requirements relating to FRT, we also believe that further enhancements; to the transparency requirements relating to FRT; are now required to be codified within the Grid Code in light of the concerns the ESO has raised in its 7th May 2021 letter and the 24th June 2021 GCRP presentation to ensure that Users, Network Operators, the ESO and Ofgem are fully aware of what is required of them and other parties.

6.1) Safe Limit

In its presentation to the 24th June 2021 GCRP meeting, the ESO has made reference to "*Users are asked to restrict their output until a FRT issue is ruled out (either MEL to zero or to a safe level)*". [emphasis added]
However, as noted under (1) 'Legal Compliance' above, there is no transparency (for Users or Network Operators or Ofgem) of what the ESO is referring to.

[17] "*For any SIR request, in line with Grid Code OC10.4.1.4 and STCP 03-1 Section 3.2.9, the User will have 2 hours to respond and Network Operators must respond as soon as reasonably practicable with a preliminary report into the loss of output.* "
[18] Further details on the two 2003 incidents can be found in the Ofgem report https://www.ofgem.gov.uk/ofgem-publications/37681/sectoralinvestigations-36.pdf
[19] https://www.nationalgrideso.com/document/169821/download
[20] OC3.4.1 (c): "*The Company shall prepare and submit to the Grid Code Review Panel monthly a report titled the System Incidents Report, which shall contain" … "An outline of progress towards reporting events and associated data on the National Electricity Transmission System including: (i) three phase faults; (ii) three phase to earth faults; phase to phase faults; (iv) phase to earth faults; (v) the associated voltage dips – durations and spreads; over-voltages; (vii) under-voltages; (viii) voltage dips of >50%; and (ix) lightning strikes.*"

Is it, for example, (i) 'safe' for the system only; or (ii) 'safe' for the User(s) and / or Network Operator(s) only; or (iii) 'safe' for the system, the User(s) and / or the Network Operator(s)?
Given this uncertainty, we believe it important for Users, Network Operators, the ESO and Ofgem that there is transparency (in the form of it being set out in the Grid Code, having been approved by Ofgem, via this Modification proposal) of what the 'safe level' is along with when (and when not) it applies.
We elaborate further; in the 'What is the proposed solution' section below; what for the purposes of plant and apparatus (including network assets) could be considered as being a 'safe level' in our view.

6.2) Historic fault information
There is a lack of transparency for stakeholders of the historic fault data in GB and therefore, we propose that the ESO be obliged (in the Grid Code) to provide the industry with historic fault data (i.e. timestamped records of voltage dips at GSPs or key nodes) that would enable Users (and Network Operators) to check for any unexpected changes in station output (or network asset performance) that could signify an apparent FRT compliance issue.
The provision of this data by the ESO and the subsequent checking by the User (or Network Operator) of any unexpected changes in station output (or network asset performance) would provide significant confidence that a User's site (or network asset) was compliant and would be far more meaningful than, for example, a one-off confirmation letter.
Given that this is historical data that already exists and given the importance that the ESO attached to this matter (as witnessed, for example, by the statements in the 7th May 2021 letter itself) we would expect that the ESO would wish to make this historic fault data available to stakeholders with the utmost alacrity (and thus perhaps ahead of the change needing to be codified).

6.3) Real-time post-event data
It has come to our attention that when an FRT event occurs in Ireland that the system operator, EirGrid, provides to stakeholders, within 24 hours, the minimum retained / maximum voltage and duration associated with that event. This is not something that occurs in GB.
In our view, the ESO should be obliged (within the Grid Code) to provide to Users and Network Operators the waveform data (or at least the minimum retained / maximum voltage and duration) following any Fault Ride Through incident on the NETS in a timely manner, as EirGrid does.
This will allow Users and Network Operators to investigate and resolve the fault (if one has occurred on their equipment/asset(s)) and thus, in our view, is the starting point for the timeframe for reporting back to the ESO on matters pertaining to FRT compliance.
We also note that following the introduction of GC0105, the Grid Code now requires the ESO to report to the Panel its progress with reporting voltage transients[20].
In respect of items 6.2 and 6.3 above, we are also mindful of the current Ofgem consultation[21] on the publication of data by Network Operators (including, in this case the

[21] Further details on Ofgem's consultation can be found at: https://www.ofgem.gov.uk/publications-and-updates/consultation-data-best-practice-guidance-and-digitalisation-strategy-and-action-plan-guidance

ESO) where the emphasis on justification would switch from a presumption of not publishing (unless justified as to why to publish) to a presumption of publication (unless having justified why not).
For the avoidance of doubt, we believe that our proposed approach, in this Modification proposal, as regards data publication by the ESO in respect of both 'Historic fault information' and 'Real time post event data' conforms with the Ofgem's intentions (as set out in its consultation).

6.4) After event reporting
It is important that lessons learnt from FRT events in terms of the impacts etc., on User or Network Operator plant or apparatus (including network assets) are shared with stakeholders as, for example, happened after the 9th August 2019 event where information on the lessons learnt by the two transmission connected generators was shared with the wider stakeholder community to ensure, collectively as well as individually, that steps were taken to learn from what went 'right' or 'wrong' on the day. Therefore, in our view, the ESO should be obliged (within the Grid Code) to make available, in a timely manner, to Users and Network Operators any lessons learnt information that is provide to the ESO by any User(s) and / or Network Operator(s) after an FRT event.

6.5) Dynamic Largest infeed loss
There is currently no visibility to Users of the dynamic largest infeed loss that is being applied by the ESO to operate the NETS. Whilst it has been generally set to 1,320MW there are, we understand, periods of time, such as when inertia is low, where the level has dropped to circa 800MW. There is little real time visibility to stakeholders of this.
In our view, as we set out in 'What is the proposed solution' below, and in order to support system security it is appropriate for the ESO to be obliged (in the Grid Code) to provide the industry (via the BMRS?) with the current largest infeed loss level at any moment in time that the ESO is operating the NETS to. [22]

Why change?

As set out above in 'What is the issue' there is a need to change the Grid Code with respect to the process followed by Users, Network Operators and the ESO in the event of a Fault Ride Through occurrence where a User's site or Network Operator's asset(s) coincidently trips/de-loads.

This is to ensure that Users, Network Operators and the ESO have clarity and legal certainty as to the steps/actions etc., they need to take if an FRT event and coincident trip/de-load occurred.
This will:

1) Be placing Users (and in particular Generators) in compliance of a relevant **legal requirement**;
2) Have minimal **commercial impact** on Users and consumers;
3) Have a positive effect on the safety and **security of the electricity system;**

[22] During the Workgroup deliberations it came to light that the Largest Infeed Loss information is publicly available and it was noted by the Proposer and the Workgroup

4) Apply a **reasonable timing** obligation on all stakeholders;
5) Apply a **non-discriminatory process** to all stakeholders; and
6) Ensure and **enhance transparency** of the FRT situation in GB.

Therefore, a codified process is required to ensure legal compliance and certainty whilst maintain security of supply and minimising the significant commercial impact on stakeholders as well as providing a reasonably timed, non-discriminatory process and enhancing transparency for stakeholders and that is why this change to the Grid Code should be made.

What is the solution?

Proposer's solution

1) **Response in the event of an apparent trip/de-load coincident with a system fault**

In the event of a User site[23] or Network Operator asset trip/de-load *coincident with a system fault*, data is required from the ESO to help the User or Network Operator investigate the problem and time is required for the User or Network Operator to investigate the root cause of the trip/de-load.
Therefore, we propose the following process applies:

1. Where User's site or Network Asset TEC/ asset capability is < 100 MW; no immediate export limitation would be immediately applied but the User or Network Operator would have three months from the date of submission of waveform data by NGESO to investigate and if necessary, resolve the cause of any non-compliance.
2. Where Users' sites or Network Asset TEC/ asset capability is > 100 MW:

    a. Where the User or Network Operator is in receipt of an **ION**: a MW export constraint would be applied immediately to a level of either:
        i) 70% of the *station* TEC/ asset capability; or
        ii) the prevailing largest infeed limit (whichever is lowest)

    Note – the export limit will not be reduced below 100 MW (i.e a User with 130 MW would only be constrained to 100 MW)
    The User or Network Operator would have 3 months from the date of submission of waveform data by NGESO to investigate and if necessary, resolve the cause of any non-compliance.

    b. Where the User or Network Operator is in receipt of a **FON**: no immediate export limitation would be immediately applied but the User or Network Operator would have three months from the date of submission of waveform data by NGESO to investigate and if necessary, resolve the cause of any non-compliance

    c. Where the User or Network Operator is in receipt of a **LON**:
        i. if the reason for the LON relates to equipment changes that could reasonably be expected to affect the FRT performance (e.g. a generator replacement or software update that fundamentally changes the FRT capability or protection settings that are tighter

[23] This could, for example, be a power station or an interconnector in the form of plant and / or apparatus.

than were applied previously) then the User or Network Operator would be managed as for an ION (see (a) above).

ii. For all other reasons (e.g. a software upgrade that only affects a windfarm's central control unit) the User or Network Operator would be managed as for a User or Network Operator in receipt of a FON.

3. For **any** User or Network Operator: if the cause of the FRT non-compliance is not resolved after three months from issue of the waveform data by NGESO, the User or Network Operator would have to constrain the station TEC/ asset capability to 50% until the non-compliance was resolved

Justification for this process:

- **Three Months to Investigate**
  The existing LON process permits generators/interconnectors up to two years to rectify grid compliance issues. We recognise this is unnecessarily long for a User or Network Operator to correct a fault that could present a risk to the system but in our experience[24] three months is the minimum reasonable time that User or Network Operator would need to complete the tasks that would be expected to fully investigate the fault, namely:
  - gather relevant SCADA error logs and protection settings
  - obtain system fault level data at the time of the fault
  - if required, commission consultants to provide the necessary modelling services to model generator/interconnector/network asset controls
  - repeat required FRT modelling scenarios
  - Implement any setting changes

- **100 MW Threshold**
  The degree of constraint that should be applied is clearly dependent on the impact repeated FRT failures of a generator/interconnector/network asset could have on the wider system which in turn depends on the User's Transmission Entry Capacity or Network Operator's asset capability.

  The FRT requirements apply to interconnectors and all 'Large' generators, i.e those above 10 MW in the north of Scotland but do not apply to many distribution connected generators < 50 MW in England and Wales.

  Therefore, for simplicity we propose the Licence threshold of 100 MW is used since this was chosen to imply that below this level the User's asset (or, by inference, Network Operator's asset) would not have a significant impact on the system.

- **Degree of Forced Constraint: Lowest of 70% TEC or Largest Infeed Limit**
  The sudden loss of a large User (or large network asset) will erode frequency response the ESO holds to cater for the loss of a normal infeed. The larger the User's site (or network asset(s)), the greater the risk that the response holding could be eroded and therefore it could be argued that some action is needed to mitigate the potential risk that the generator (or interconnector or Network Operator) could be non-compliant and could trip again, in effect requiring the ESO to hold 'extra' response at a cost that would be passed through to BSUOS and the end customer.

[24] As well as by reference to the time permitted following the 9th August 2019 event.

However, there is also the possibility:

- the User's site (or Network Operator asset) had received a FON (i.e deemed by the ESO to have satisfactorily demonstrated Grid Code FRT compliance) and the resulting investigation shows it had tripped for valid reasons but the investigation takes several days/weeks to conclude (e.g > 50% turbines unavailable, network over-voltages, repeated network faults). Imposing a hasty constraint on a User site that it turns out is (and was at the time of the event in question) Grid Code FRT compliant could put the User at risk of infringing REMIT Article 5 obligations and would be unreasonable given that the User may have operated for many years without issue and the balance of probability is that they are Grid Code FRT compliant.

  Conversely, a User (or Network Operator) in receipt of an ION is likely to be for a new generator or interconnector (or new network asset) with limited operational history and has by definition not demonstrated to the ESO's satisfaction full compliance; including Grid Code FRT compliance. Therefore the balance of probability suggests that it is possible the User's site (or Network Operator's asset) could be non-compliant and some export limitation is justified.
- Any forced outage of an in-merit generator or interconnector (or forced outage of network assets) will lead to higher costs to the end customer. Where this applies to a large generator (e.g one with a low CfD) or interconnector or substantial network asset this could add significantly to balancing costs and/or erode system margins creating other system security risks
- On many windfarms, operating at a reduced output should improve the FRT capability such that, even though a windfarm may not be compliant *at full output*, the additional 'headroom' obtained from operating at a lower output (such as 70%) will increase the likelihood of a non-compliant windfarm (if that is actually the case) riding through faults.
- If the constrained User is a windfarm then by setting the windfarm to Frequency Sensitive Mode (FSM) rather than applying a fixed MW, the 'headroom' could be used to obtain additional frequency response, which while it cannot be fully relied upon, would be fast-acting and would generally be expected to contribute to the stability of the system in the event of a fault of another User site or Network Operator asset.

In summary, a forced constraint to a maximum of 70% of the station's TEC / network asset capability or Largest Infeed Limit (whichever is lower) for a User or Network Operator in receipt of an ION seems a reasonable compromise between the cost of holding additional response due to a potential FRT non-compliance and the cost impact on the User or Network Operator and end consumers from unnecessarily constraining a User site or Network Operator asset.

We expect these parameters, and particularly the process of notifying the user of the value of the largest infeed limit, will be the subject of Workgroup discussions.

We, as the Proposer, believe:

1. By taking a pragmatic and 'risk-based approach' to the likelihood of a non-compliance, this process strikes the right balance between ensuring the

security of the system whilst also minimising the cost to Users or Network Operator and the consumer.

2. It also provides certainty to all Users and Network Operators (as well as the ESO and Ofgem) of what is required such that they (as well as the ESO and Ofgem) can be confident they are meeting their licence obligations.
3. It uses existing established processes in the Grid Code; if the issue of a FON cannot be relied upon to have confidence of a User's site or Network Operator's asset FRT capability then it suggests there could be a defect in the application of the Compliance process. Similarly, it highlights that until a FON is issued, the User or Network Operator is at risk of potential restrictions in its output/operation – which may in turn, encourage Users and Network Operators to complete the ION stage more quickly than has historically been the case.

2) **Further Clarity on Voltage Protection Settings**

Whilst the Grid Code defines in detail the FRT requirements for voltage dips, it is silent on the need for Users or Network Operators to remain connected for transient over-voltages, particularly those that are expected to occur after the clearance of a fault. Therefore it's possible, for example, that currently a generator or interconnector may successfully ride through a voltage dip, but trip when the fault is cleared as the resulting over-voltage transient is sufficiently high or sustained that it could trigger over-voltage protection that would ordinarily be expected to be fitted by the User (or Network Operator) to protect their equipment.

As it currently stands, the Grid Code is silent on what over-voltage settings are permissible that would not conflict with requirement to ride through faults and in particular the over-voltage that could be expected upon fault clearance.

Similarly, it is also possible a User site or Network Operator asset could ride through a low-voltage fault but incorrectly configured protection settings result in the User site or Network Operator asset(s) tripping or de-loading.

To provide further clarity to Users and Network Operators, it is proposed that wording along the following lines would be added to Section CC.6.3.15.3 and ECC.6.3.15.10 ('Other Fault Ride Through Requirements'):

- Users and Network Operators shall ensure voltage sensitive relays installed to protect the User's plant and / or apparatus or Network Operator's asset are configured such that they will not prevent correct operation of the Fault-Ride-Through capability of the User's equipment (or Network Operator's assets) against the relevant Voltage-Time curves. For example,
    - Over-voltage protection shall be configured to be insensitive to transient over-voltages of at least 1.20pu for at least 0.5 seconds.
    - Under-voltage protection shall be configured to be insensitive for transient under-voltages of below 0.8pu for at least 3 seconds

Note – appropriate values or wording to be agreed by the Workgroup with support from the ESO.

The Proposer believes that by providing this clarity and communicating this change to the industry that:

1. Users and Network Operators can proactively check their settings to confirm that they do not conflict with the minimum Fault-Ride-Through requirements

2. By enabling Users and Network Operators to be pro-active, would ensure a more resilient and robust system by reducing the likelihood of FRT non-compliance.

Workgroup considerations

The Workgroup convened 4 times to discuss the perceived issue, detail the scope of the proposed defect, devise potential solutions and assess the proposal in terms of the Applicable Code Objectives.

A Workgroup member provided information on the historical context that is relevant to GC0151 to the Workgroup. Originally when the Electricity Supply Industry was privatised, and the new code processes introduced; including the Grid Code(s); there were no codified requirements for any User's plant or apparatus to be capable of Fault Ride Through (FRT) in either the Scottish Grid Code or the England and Wales Grid Code. Similarly, there were no codified FRT requirements included in the GB Grid Code when the British Electricity Transmission & Trading Arrangements BETTA were introduced in 2005.

However, at this time all the TOs and System Operators (which included the predecessor body to the ESO today) were becoming concerned that the growing introduction of non-synchronous Power Park Modules were eroding system security by replacing existing synchronous generators which were believed to have good inherent FRT capabilities. To evaluate these concerns FRT was included in modifications H/04 and SA/2004, which were primarily introducing new requirements for non-synchronous Power Park Modules, however whilst the main aim of the modification was to introduce requirements for non-synchronous units in-order to appear even-handed FRT requirements for synchronous units were also added. The modification was introduced into the GB Grid Code on the 1 June 2005 as per the Authority's Decision Letter dated 27 May 2005[ref 1]. As well as applying these new FRT requirements to new units some requirements were also applied retrospectively to existing units as discussed in the Impact Assessment sections 6.4 & 6.5 of the Authority's consultation[ref 2] issued on the 17 January 2005 and the responses[ref 3]. However, in these letters it is clear that it is not the intention to introduce unachievable requirements to existing Users and these will be addressed as required.

Whilst all these requirements were codified into the Connection Conditions ('CC') section CC.6.3.15 of the Grid Code and have been subject to a number of minor modifications since June 2005 the next big change to the FRT requirements in GB were introduced by the EU Network Codes. Specifically, the new FRT obligations in the EU Requirement for Generators (RfG) and HVDC Network Codes were introduced into the Grid Code in a new section called European Connection Conditions (ECC) for new plants installed after around 2018 with FRT being specifically dealt with in section ECC.6.3.15.

These requirements are all currently in force and require Users to be compliant with Fault Ride Through (FRT) which is defined in the Grid Code as:

> "*The capability of Power Generating Modules (including DC Connected Power Park Modules) and HVDC Systems to be able to remain connected to the System and operate through periods of low voltage at the Grid Entry Point or User System Entry Point caused by secured faults*."

In general, FRT requires that should a plant be capable of continuing to operate through a 3-phase short circuit applied at its connection point for a period of 140ms then removed. The reason this condition has been adopted is it is considered to be the theoretical worse event that a unit could be subjected too and hence should be capable of withstanding any normal voltage dips occurring on the transmission system. It should be bourn in mind that these events are particularly stressful for the User's Plant and / or Apparatus. In terms of a synchronous generator when a 3-phase short circuit is applied to the connection point(s) the current flowing in the generator is significantly increased resulting in the mechanical forces on the generator and turbine will significantly increase with the generator trying to pull itself out of its foundations. Equally the power transmission torque down the turbine train increases significantly causing large forces down the machine. The current assessment of compliance is wholly based on simulation studies to confirm the unit will stay electrical stable with the system and not pole slip and although the significant mechanical force which in-principle have been assessed during design they may never have been applied. In general terms older units may never actually have been required to perform these assessments; even if they have this is only based on modelling, and it is not a guarantee that the unit will actually perform as anticipated. In general units may have operated for years with no issues but this might be due to the proximity of the fault - as long as the fault is far enough away the unit may be capable of riding though distant faults.

Unlike synchronous generators most non-synchronous technologies use current limiters to keep mechanical forces lower, however as they require a source AC voltage signal to operate, the longer they are unable to see the mains supply the harder it is for the control system to maintain in synchronism. Again, compliance is only assessed on the bases of model simulations these are only as good as the models and again may not actually be capable of local faults.

Following the initial concerns in 2004 and the introduction of the FRT requirements in 2005 the GB system has generally operated acceptably, until the 9 August 2019 when two unit simultaneously failed to ride through a fault and resulted in demand disconnection. This has again raised concerns with the ESO about the failure of Units to FRT and for some reason this situation appears to be getting worse with the number of units failing to ride though increasing concerns about system security.

Consideration of the proposer's solution

The Proposer has identified three core aspects of the solution, these are:

- (i) Time to investigate;
- (ii) MW Threshold; and
- (iii) Degree of forced constraint

Time to investigate

- Proposer's view: Proposer is suggesting that the User or Network Operator should have 12 weeks from the date of submission of the voltage waveform data by the ESO to investigate and if necessary, resolve the cause of any non-compliance to enable correct investigations to be carried out in a timely manner.
- ESO view: ESO Workgroup member stated that Users have a responsibility to explain a sudden unexpected loss of output when requested. *OC5.4.2* does not have clear timelines to manage unexpected generation losses. This could be

modified with the agreement of industry to better manage system risks. Thus, the ESO would like to engage with Users to understand their concerns and to formulate a better process.

- Workgroup view: Workgroup members affirmed that the current timeline is too short to investigate, make relevant contacts and review information required to make informed decisions.

MW Threshold

- Proposer's view: Currently, the FRT requirements apply to interconnectors, HVDC systems and all 'Large' generators, i.e. those above 10 MW in the north of Scotland but do not apply to many distribution connected generators < 50 MW in England and Wales. Hence, the Proposer is suggesting the Licence threshold of 100 MW is used since this was chosen to imply that below this level the User's asset (or, by inference, Network Operator's asset) would not have a significant impact on the system.

Degree of forced constraint

- Proposer's view: Proposer suggests that a forced constraint to a maximum of 70% of the station's TEC / network asset capability or Largest Infeed Limit (whichever is lower) for a User or Network Operator in receipt of an ION seems a reasonable compromise between the cost of holding additional response due to a potential FRT non-compliance and the cost impact on the User or Network Operator and end consumers from unnecessarily constraining a User site or Network Operator asset whilst taking into account that technical the risk of a further FRT event resulting in a similar trip/de-load is significantly reduced where a asset is operating at substantially below its maximum output.

Voltage Protection Setting

- Proposer's view: Proposer states that the Grid Code is silent on the need for Users or Network Operators to remain connected for transient over-voltages, particularly those that are expected to occur after the clearance of a fault. Also, the Grid Code is silent on what over-voltage settings are permissible that would not conflict with requirement to ride through faults and in particular the over-voltage that could be expected upon fault clearance. Thus, the Proposer's suggestion is as follows:
    - wording along the following lines would be added to Section CC.6.3.15.3 and ECC.6.3.15.10 ('Other Fault Ride Through Requirements'): Users and Network Operators shall ensure voltage sensitive relays installed to protect the User's plant and / or apparatus or Network Operator's asset are configured such that they will not prevent correct operation of the Fault-Ride-Through capability of the User's equipment (or Network Operator's assets) against the relevant Voltage-Time curves.
- Workgroup view: Workgroup members expressed concerns about the insufficiency of the Grid Code provisions in this area claiming that it is ambiguous and unclear. Workgroup members also addressed concerns about the lack of sufficiency of voltage data stating that data relating to voltage on grid/voltage traces should not be confidential, but rather it should be publicly available in a public domain except where there is case to not publish. In Ireland there is an auto email to subscribe to

a list that sends out voltage info of faults. The Proposer noted that recent events highlighted by the ESO had identified that an FRT event in one part of GB could manifest itself some 250 miles / 400 kms away. The Proposer noted that without timely visibility of this information; from the ESO to Users; that an interconnector or generator at, say, Medway in Kent, would be none the wiser of an FRT event which occurred at, say, Heysham in Lancashire and could not therefore be expected to take that event into account when considering how they deal with FRT events on the network. Conversely, by making this information more widely available, this would, in the view of the Proposer, allow all relevant stakeholders to examine if / how their asset(s) had performed during the FRT event for which data was being report by the ESO.

Consideration of other options

Security and Supply

ESO stated that they have an obligation to make all parties/network assets – Generator, Interconnector, Network Operators etc aware and up to date where there is a reported FRT risk, and everyone connected to the system has an obligation to ensure system security and integrity.

Workgroup members discussed that what the key thing is finding an agreed method to protect the system such that ESO can make their concerns and complaints known to Generators or Interconnectors of Networks and that those parties can respond in a timely manner to the ESO's concerns.

The Workgroup reiterated that a trip/de-load co-incident with when an FRT event occurs may give rise to both an over and / or under voltage situation and that, depending upon which of these it is (and the duration) that an asset would be fully in compliance with the Grid Code in tripping off or de-loading whilst in a different set of circumstances it would not. It therefore would take much more time that the two hours set out in the ESO's 7th May 2021 letter to fully investigate what had happened and determine what, if anything, needed to be done to correct the situation. The Proposer also noted that there was already a process within the Grid Code (as summarised in "*CP.A.1.4 Illustrative Compliance Process for Ongoing Compliance*"[25]) where the ESO (or User) identifies plant and / or apparatus as not meeting Grid Code (or BCA) obligations. The Proposer noted that with GC0151 Original, where the ESO finds non-compliance with a party's FRT obligations that a non-discriminatory approach will be applied to all parties; be they a Network owner, Interconnectors, Generators and, if relevant, Demand.

Managing System Risk

A Workgroup member raised issues of the accuracy of the model predicting FRT failure and the level of support to be given by Users when there is a failure and the necessity of validating the model and methods. Workgroup members explained that validation of an asset's FRT compliance may be achieved through site-testing and simulation, type testing, validating turbine (5MW threshold) and factory acceptance testing.

[25] This can be found on page 18 of the 'Compliance Process' section of the Grid Code at: https://www.nationalgrideso.com/document/33916/download

Other Issues with Existing Fault Ride Through (FRT) Text

It was highlight by a Workgroup member that whilst carrying out a review of FRT compliance, as requested by the letter of the 7 May 2021, that a number of other issues were found with the existing legal text within the Grid Code relating to FRT. These issues suggested that there might be technical compliance issues due to the current drafting of the Grid Code and other issues dealing with the understanding of the current legal text. In an attempt to encourage discussion and a way forward with these issues a strawman of potentially improved legal text was put forward by a Workgroup member and is attached in appendix 8. Whilst this area is still under discussion and the Proposer is currently think about adopting this into their original proposal and hence views are sought from industry about the merits or potentially issues of this strawman. The following sections detail the thinking behind this strawman proposal.

Clarification of Fault Ride Through Requirement

Currently the way CC.6.3.15(a)(i) is written it deals both with a plant capability and actions to be taken during a fault but does not clearly distinguish between both leading to confusion. It is suggested that the current CC.6.3.5(a)(i) is split into two section one dealing with the required capability CC.6.3.15(a)(i)(a) and a second section CC.6.3.15(a)(i)(b) dealing with actions to be taken during a fault. Note originally it was thought adding a new section and renumbering the following sections would work but this had significant knock-on effects with renumbering.

Plant Capabilities

The new section CC.6.3.15(a)(i)(a) will only deal with plant capabilities by clarifying that the has to be capable of riding through the worst fault that the network could impose on the plant which is a 3-phase short circuit at the connection point which lasts for 140ms as shown in figure 1 below. To achieve this the words “be design to” will be added to section CC.6.3.15(a)(i)(a) as can be seen in the legal text in appendix *.

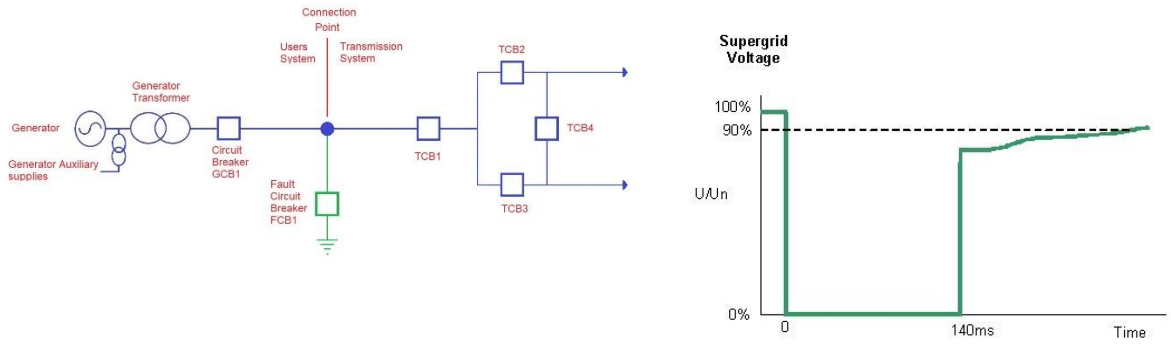

Figure showing theoretical worse case fault which plant has to be capable of riding though

Operating Requirements During a Fault

The new section CC.6.3.15(a)(i)(b) shall be deal with the actions to be taken in the event that a fault occurs firstly by requiring that plants ride through faults in the transmission

system which can be cleared but transmission system circuit breaker as shown in figure 2 below and by adding the following text as the introduction to the section

> (b) Each **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant and Apparatus** shall remain transiently stable and connected to the **System** without tripping of any **Generating Unit**, **DC Converter** or **Power Park Module** and / or any constituent **Power Park Unit**, **OTSDUW Plant and Apparatus**, and for **Plant and Apparatus** installed on or after 1 December 2017, reactive compensation equipment, for any balanced and unbalanced fault where subjected to a voltage dip at the **Connection Point** where the voltage remains either on or within the envelope shown in figure CC.6.3.15(a)(i)(a) except where:

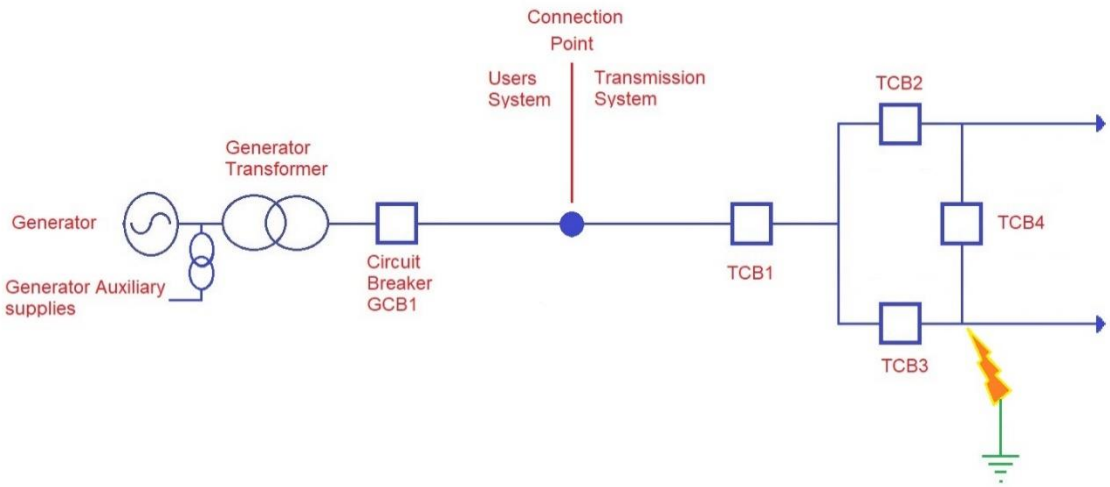

Figure 2 showing a fault which can be cleared by transmission system breakers TCB3 & 4

Whilst the induction to this section deals with plants riding through faults as it is currently drafted in the Grid Code, it is not clear what is supposed to happen where the plant's circuit breaker has to open to clear the fault. There are concerns that the current text could be interpreted that the plant has to remain connected feeding the fault for 140ms which could lead to dangerous situations. In discussion with the ESO it is quite clear that is not their expectation, and that plant should trip this these circumstances. It is proposed that the following subclauses are added to clarify each situation where tripping is permitted.

Firstly if the fault is on the generators equipment then the generator shall be required to trip to clear the fault from the transmission system as detailed in the proposed new sections CC.6.3.15(a)(ii)(b)(i) and ECC.6.3.15.8(vi)(i), as follows:-

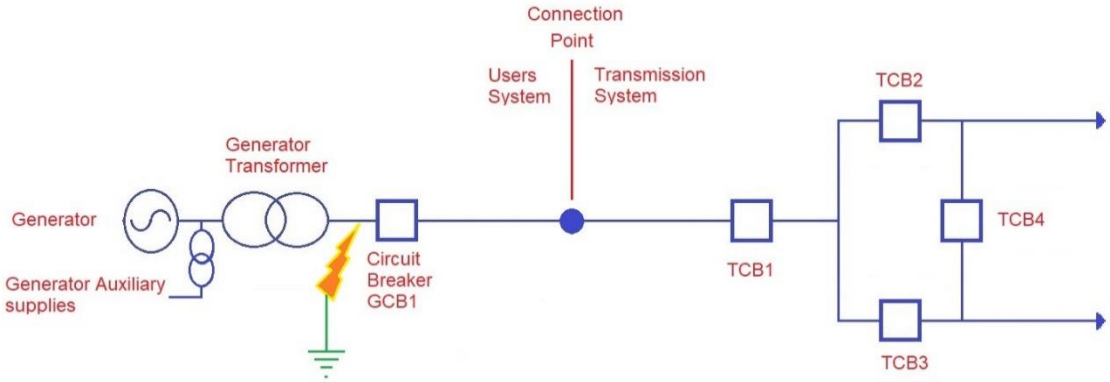

Figure 3 showing a fault which can only be cleared by generator breakers GCB1

the fault is on the **User's System,** when the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant and Apparatus** shall trip to clear the fault from the **Transmission System.** The protection schemes and settings should not jeopardise **Fault Ride Through** performance as specified in CC.6.3.15.1

Secondly if the fault is at a location on the network that means that the fault can only be cleared by operation of both transmission and the generator circuit breaker as shown in figure 4, again the generator will be permitted to trip to clear the fault as detailed in the proposed new section CC.6.3.15(a)(i)(b)(ii) and ECC.6.3.15.8(vi)(ii), as follows:-

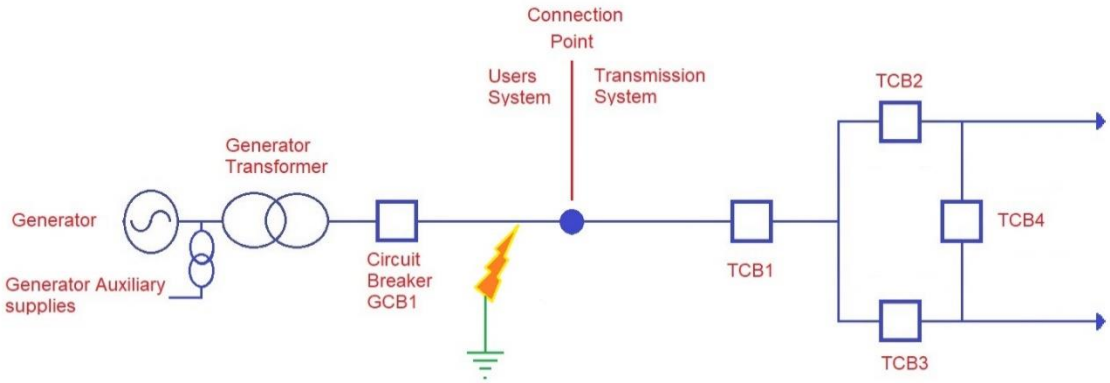

Figure 4 showing a fault which can only be cleared by generator breaker GCB1 & transmission circuit breaker TCB1

the location of the fault means it cannot be fully cleared without tripping the of **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant** shall trip as required.

Thirdly if the fault is at a location on the network that means the generator will become islanded by the operation of the transmission circuit breakers as shown in figure 5 as detailed in the proposed new sections CC.6.3.15(a)(ii)(b)(iii) and ECC.6.3.15.8(vi)(iii), as follows:-

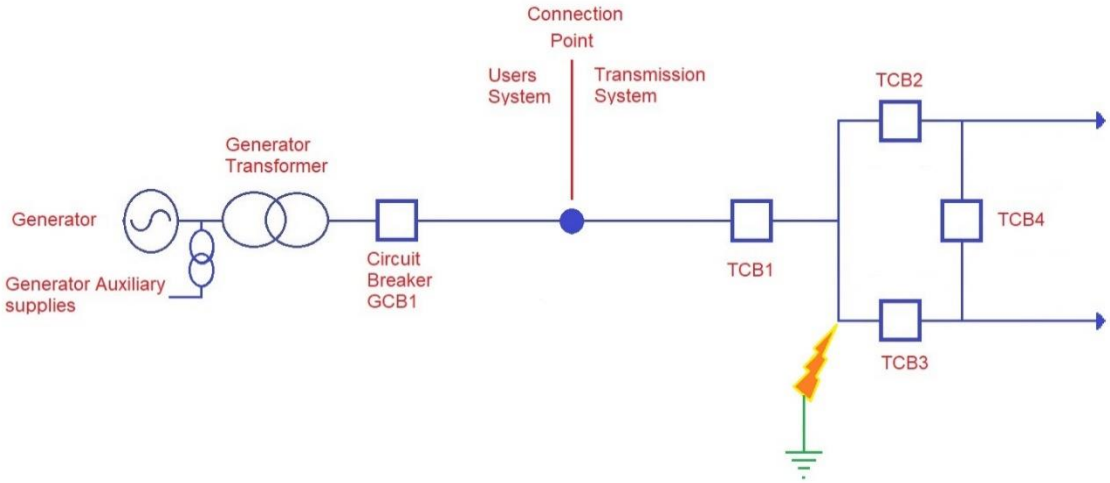

Figure 5 showing a fault which can be cleared by transmission breakers TCB1,2&3, however this results in the generator being islanded from the main transmission system and needs to come off

clearance of the fault results in the **Generating Unit**, **DC Converter**, or **Power Park Module** or **OTSDUW Plant** becoming islanded and disconnected from the **Total System** and not supplying **Customers** (where CC.6.3.7(c)(i) applies), then the **Generating Unit**, **DC Converter**, or **OTSDUW Plants** shall be permitted to trip as required**.**

Also if there were inter-trip arrangements with the TO or ESO in relation to protection schemes or to prevent cascade overloading, etc then plants shall be required to trip as per these arrangements as detailed in the proposed new section CC.6.3.15(a)(i)(b)(iv & v) and ECC.6.3.15.8(vi)(iv & v),as follows:-

the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plant** is part of combined protection scheme with the **Transmission Operator**, then the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plants** shall be permitted to trip as required**.**

the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent

Power Park Unit thereof and **OTSDUW Plant** is part of and intertrip scheme which is switched into service and triggered, then the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plants** shall be permitted to trip as required**.**

As previous described in this report there is an issue relating to what plants are supposed to do in the event that during the fault clearance the voltage at the connection point exceeds the plants overvoltage protection settings. This section of the new text appears to be the correct place to propose the introduction of new legal text and as such the text below is proposed for section CC.6.3.15(i)(b)(vii) and ECC.6.3.15.8(vi)(vii), however the detailed discussion on overvoltage setting was in the previous section.

during the fault clearance the voltage exceeds, the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit,** over-voltage protection setting when the **Generating Unit**, **DC Converter**, or **Power Park Module** and any constituent **Power Park Unit** thereof and **OTSDUW Plants** shall be permitted to trip as required**.**

There is a final section on Offshore transmission already exists and has just been moved as it related to operational actions and not a capability which is basically the original text as detailed in section CC.6.3.15(a)(i)(b)(vi) and ECC.6.3.15.8(vi)(vi).

in the case of an **Offshore Generating Unit**, **Offshore DC Converter** or **Offshore Power Park Module** (including any **Offshore Power Park Unit** thereof) which is connected to an **Offshore Transmission System** which includes a **Transmission DC Converter** as part of that **Offshore Transmission System**, the **Offshore Grid Entry Point** voltage may not indicate the presence of a fault on the **Onshore Transmission System**. The fault will affect the level of **Active Power** that can be transferred to the **Onshore Transmission System** and therefore subject the **Offshore Generating Unit**, **Offshore DC Converter** or **Offshore Power Park Module** (including any **Offshore Power Park Unit** thereof) to a load rejection

Fault Current Injection

The area of the current legal text which technically creates the biggest problem in relation to the ESO's letter of the 7 May 2021 are in sections CC.6.3.15 (a)(ii) and ECC.6.3.15.9.2.1(a)(i) which currently state "for which the voltage at the Grid Entry Point (or Interface Point in the case of OTSDUW Plant and Apparatus) is outside the limits specified in CC.6.1.4, each Generating Unit or Power Park Module or OTSDUW Plant and Apparatus shall generate maximum reactive current ". If this requirement is drawn out on the figure 6 below where the current and voltage must always either be within the green shaded area or on the red line.

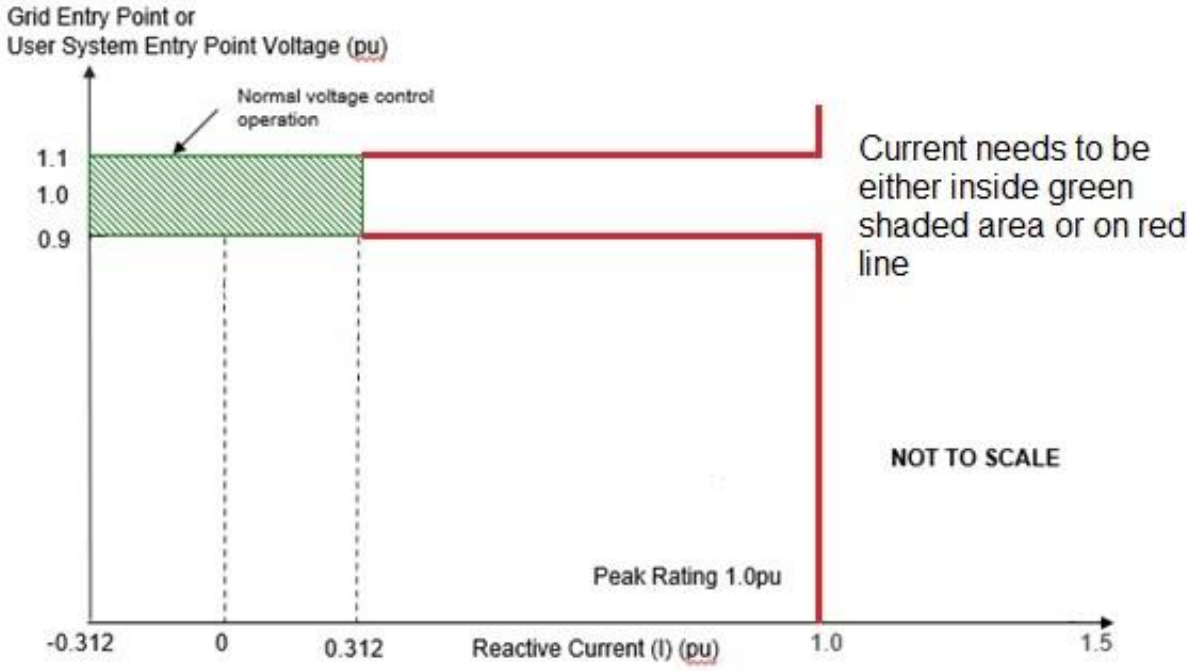

Figure 6 showing an interpretation of the existing legal text requiring the current to either be in the green box or on the red line

This creates a particular problem in relation to the part of the letter which requires Parties to confirm compliance as the Grid Code particularly FRT sections, because as drafted very few plants (if any) actually do this and it has presumably drifted in as a drafting oversight relating to PPM requirements. This issues has previously been identified in the workgroup GC0111 on Fast Fault Current injection and in the GC0137 VSM workgroup and has been fixed for new PPMs, however currently all synchronous generator and older PPM will technically be non-compliant with this FRT requirement as drafted. This issue was dealt with in GC0111 by adding a new figure as shown in figure 7 and changing the text as follows.

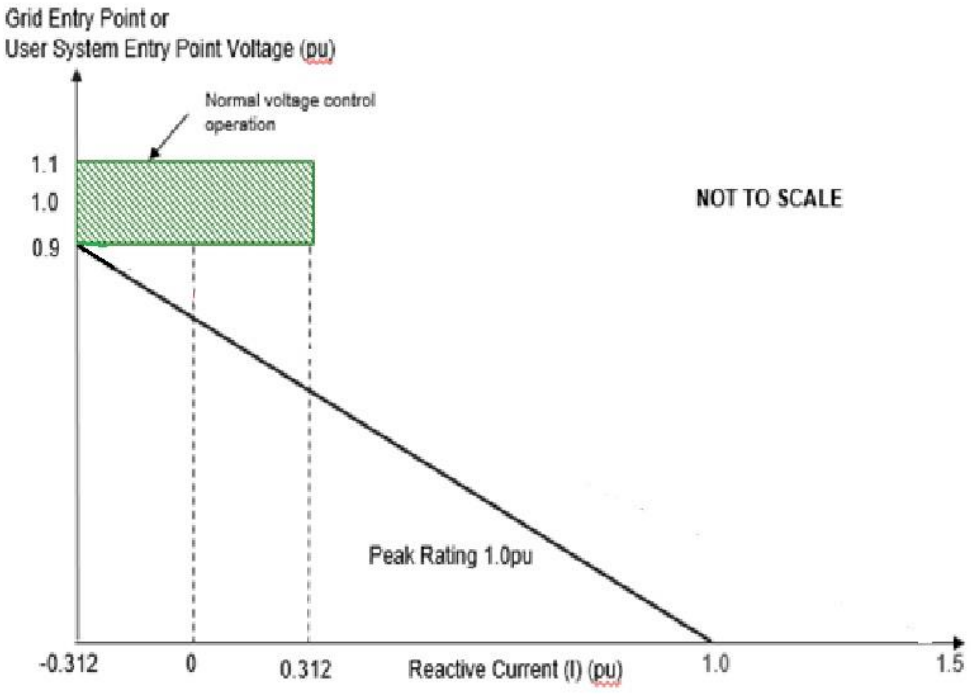

Figure 7 showing the proposed reactive current injection requirements, requiring the current to always remain above the black line

(iv) During the period of the fault as detailed in CC.6.3.15.1 (a) (i) for which the voltage at the **Grid Entry Point** (or **Interface Point** in the case of **OTSDUW Plant and Apparatus**) is outside the limits specified in CC.6.1.4, each **Generating Unit** or **Power Park Module** or **OTSDUW Plant and Apparatus** shall inject a reactive current above the heavy black line shown in Figure CC.6.3.15(b) without exceeding the transient rating limit of the **Generating Unit**, **OTSDUW Plant and Apparatus** or **Power Park Module** and / or any constituent **Power Park Unit** or reactive compensation equipment.

Active Power Requirements

The final area of concern relating to the existing legal text is the minimum active Power requirement after the fault has cleared. Original as drafted the 2005 original as "(or within 0.5 seconds of restoration of the voltage at the **User System Entry Point** to 90% of nominal or greater if **Embedded**), **Active Power** output or in the case of **OTSDUW Plant and Apparatus**, **Active Power** transfer capability, shall be restored to the level available immediately before the fault". Subsequently it has been realised that the real response is oscillatory and not very constant so a modification has added the following words
"- the total Active Energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant
- the oscillations are adequately damped of oscillations"

Whilst this works in principle at higher loads it does create an issue at lower loads if you consider at a real event for a unit operating as a synchronous condenser in figure 8.

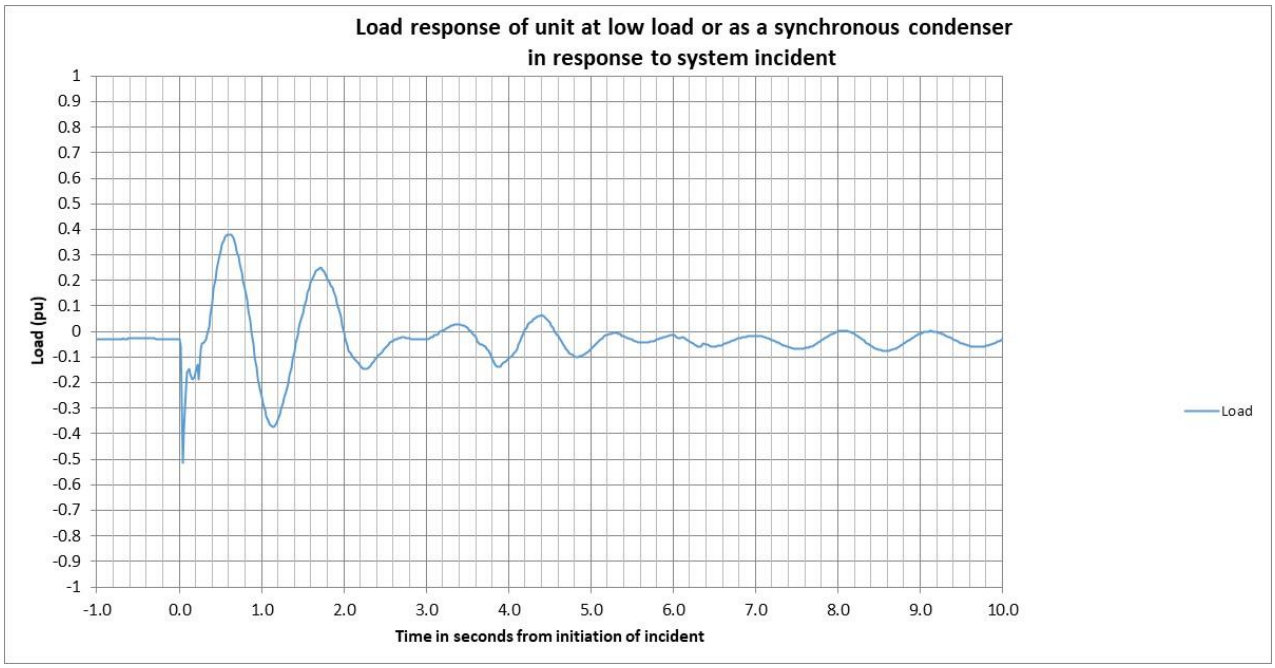

Figure 8 showing a typical active power response of a unit at low load to a fault

If you look at the initial load which is 0.02 pu then 90% of this small number you get a very small number, it is also difficult to see how a sensible compliance assessment can be carried out at these levels and it is hence suggested that the tolerance should be changed to 10% of rated capacity as follows
"Active Power transfer capability, shall be restored to the level available immediately before the fault within plus or minus 10% of the **Rated Capacity"**

Workgroup discussion on Strawman

A workgroup member presented a strawman for the Fault Right Through process, this was discussed with the Workgroup, the following was noted by the Workgroup:

- The Grid Code is ambiguous and vague on practical options that may be taken where for example there is a transient overvoltage. Thus, a pointer to remain connected and not trip off
- ESO provided explanation on older synchronous generators and the design process – generator designed not to pole slip but expected to continue to run. Excitation System functionality specified in BCA determined by ESO/TO dynamic studies of network against System Quality and Supply Standards based on fastest clearance or slowest mains protection.
- In practical terms the ECC voltage profiles have no real difference between transmission and distribution generator network for a transmission fault as the voltage dip on the distribution network is less severe hence "0 volts" on transmission (ECC.6.3.15.6) or "0.1 pu volts" on distribution (ECC.6.3.15.5)
- Referring to one of the slides in the presentation, a Workgroup member remarked that 'Tripping' is a tricky. Caution should be applied as all the largest generators are Type D by size under EU Code but, smaller Type B or C Generators "by size" become Type D if connected to transmission rather than distribution. For transmission voltages all have to meet "0 volts"' FRT. There is need to go into actual texts of the ECC to find allowable voltage limits

- In some instances, Generators will find it hard to know the difference between the fault from their system and outside their system

Lessons learnt

Workgroup members agreed on the merit of sharing lessons learned so that issues may be avoided where possible across the board. The provision by the ESO of a summary report of what happened and how the party / parties involved rectified the issue will be sufficient. However, a Workgroup member added a caution that manufacturers are not usually open to share what has gone wrong, they prefer to contact their customers directly. The Proposer noted that there was no intention with the original to place any obligation to share, for example, intellectual property information but rather; like with aircraft accident reports and the lessons learnt shared with industry after the 9th August 2019 system event; share the broad lessons learnt so that collectively we can all learn from each other and thus better improve how we deal, as a community, with FRT events in the future.

Open Data

The Workgroup support greater visibility of system performance information. The Proposer noted that with the original, where an asset was believed to have had a co-incident trip/de-load that they should receive information from the ESO, in a timely manner, of the voltage waveform data from the FRT monitor equipment closes to that asst whilst other users would receive the voltage waveform data from the FRT monitor equipment closes to the fault itself. The Workgroup noted that the provision of this open data will help Generators, Interconnectors and Network Operators to act more proactively. Developers of equipment and academic research will benefit from this open data as well. A Workgroup member raised the need for clarity on whether there will be a required retention policy and what that will look like. The Proposer noted that with the original there would also be an obligation on the ESO to publish historical data associated with FRT events. The Proposer suggested this could go back five or ten years and that allowing the ESO a reasonable period (90 days was suggested) to publish this voltage waveform data; from the FRT monitor equipment closes to the fault itself; would be appropriate.

Interaction with Derogation process

A Workgroup member highlighted at the third Workgroup meeting a possible interaction between the proposed original solution and the existing Grid Code derogation proves. The Proposer and the Workgroup member discussed this off-line and reported back to the Workgroup

Workgroup Alternatives

The ESO has submitted a draft alternative for industry to review. The legal text for this alternative will be developed fully before the Workgroup report is presented to Panel.

This alternative emphasises what was set out in the open letter written by NGESO; reminding Users of their requirements under the Grid Code and that the inability of Users to ride through ‘normal’ faults on the NETS is a serious risk to system security. NGESO needs to have the ability to manage fault ride through (FRT) non-compliances quickly and effectively i.e. in the minutes, hours and days after an apparent ‘non-compliance’ is observed.

If managing this through restricting a User that has failed to ride through a fault is not possible, then either NGESO will incur additional operational costs due to the need to hold more reserves or the likelihood of a risk of disruption to the NETS will increase. Either way, consumers will be impacted.

When NGESO identifies a potential FRT issue, they will notify the User in writing. This may be through the SIR process. The User should then be prepared to immediately take action up to and including restricting their output in agreement with NGESO.

This applies to all the Users required to comply with CC.6.3.15 or ECC.6.3.15 regardless of their size, location, type, operational status (FON, ION or LON) etc.

This alternative also includes for a requirement for NGESO to provide a summary of the fault ride through non-compliances that have occurred to date as immediate learning points for industry and an obligation to provide this information on an enduring basis. The Grid Code will also be updated with an additional obligation to provide the largest infeed loss data at a given time.

Draft legal text

As is often the case, the draft legal text has not been completed in time for the Workgroup Consultation (it will be completed in time for the Workgroup Report to be presented to Panel). At the third Workgroup meeting the Proposer went through a draft of the proposed Business Rules for the original (upon which the Legal Text will then be based) and this can be found in Annex 8.

What is the impact of this change?

Proposer's assessment against Code Objectives

Proposer's assessment against Grid Code Objectives	
Relevant Objective	**Identified impact**
(a) To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity	**Positive** Takes a risk-based approach to managing the cost of constraints from potential FRT non-compliance. Minimises risk of unnecessary constraints being applied to Users or Network Operator that could otherwise lead to higher costs to the end consumers.
(b) Facilitating effective 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	**Neutral** No impact

which neither prevent nor restrict competition in the supply or generation of electricity);	
(c) 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;	**Positive** Places a time-limitation on Users and Network Operators to quickly correct FRT compliance issues.
(d) 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; and	**Positive** Clarifies the action expected by a User in the event their station or Interconnector trips or de-loads coincident with a fault so they can fulfil their REMIT obligations
(e) To promote efficiency in the implementation and administration of the Grid Code arrangements	**Neutral** No impact.

Standard Workgroup consultation question: Do you believe that GC0151 Original proposal better facilitates the Applicable Objectives?

When will this change take place?

Implementation date
Within one Working Day of an Authority decision.

Date decision required by
In light of the ESO's statement[26] in its 7th May 2021 letter, a decision is required as soon as reasonably practicable.

Implementation approach
Changes to systems and processes are expected to be required as clarified; by the Workgroup and in the Business Rules; in due course based on the broad outline of the solution.

Standard Workgroup consultation question: Do you support the implementation approach?

Interactions

☐CUSC ☐BSC ☐STC ☐SQSS

[26] "*An inability of generation, interconnector or Other transmission connected plant and apparatus being able to ride through 'normal' faults on the NETS is a situation that we cannot tolerate and is a serious risk that we need to manage quickly and effectively*." [emphasis added]

☐European Network Codes	☐ EBGL Article 18 T&Cs[27]	☐Other modifications	☒Other

There is an interaction with REMIT.

How to respond

Standard Workgroup consultation questions

1. Do you believe that GC0151 Original proposal better facilitates the Applicable Objectives?
2. Do you support the proposed implementation approach?
3. Do you have any other comments?
4. Do you wish to raise a Workgroup Consultation Alternative request for the Workgroup to consider?

Specific Workgroup consultation questions

5. Do you have any comments on the process to be followed after a suspected fault ride through failure?
6. Do you have any comments on the required sharing by the ESO of largest infeed loss information?
7. Do you have any comments on the sharing of user lessons learned information (including any information from Fault Data/Recorders)?
8. Do you have any comments on the sharing of information by the ESO on faults (with or without identified FRT issues)?
9. The proposal sets out the time to investigate by the User et al. Do you believe this time is appropriate or not? Please provide your rationale.
10. The proposal sets out the MW threshold. Do you believe this is appropriate or not? Please provide your rationale.
11. The proposal sets out the level of the forced constraint. Do you believe this is appropriate or not? Please provide your rationale.
12. Do you believe that the methodology should apply differently to projects in receipt of an ION or a FON?
13. Should the ESO have the ability to constrain a User suspected of FRT failure ahead of further investigation?
14. In respect of the voltage wave form data, should the Grid Code prescribe or not the format in which that data is to be provided? Please provide your rationale.
15. In respect of the constraint limitation to be applied to affected parties, should this be set within a range or a fixed value? If so, what do you believe that to be. Please provide your rationale.
16. Would you agree that a generator should continue to operate if there was a derogation required?

[27] If your modification amends any of the clauses mapped out in Annex GR.B of the Governance Rules section of the Grid Code, it will change the Terms & Conditions relating to Balancing Service Providers. The modification will need to follow the process set out in Article 18 of the European Electricity Balancing Guideline (EBGL – EU Regulation 2017/2195). All Grid Code modifications must be consulted on for 1 month in the Code Administrator Consultation phase, unless they are Urgent modifications which have no impact on EBGL Article 18 T&Cs. N.B. This will also satisfy the requirements of the NCER process.

17. Do you believe that generators operational history should be taken into account when deciding upon the constraint level whilst an investigation is taking place?
18. Do you have any comments on possible Alternative from the ESO as included in the consultation?
19. Do you have any comments on the Strawman document on the FRT process?

The Workgroup is seeking the views of Grid Code Users and other interested parties in relation to the issues noted in this document and specifically in response to the questions above.
Please send your response to grid.code@nationalgrideso.com using the response pro-forma which can be found on the GC0151 modification page.
In accordance with Governance Rules if you wish to raise a Workgroup Consultation Alternative Request please fill in the form which you can find at the above link.

If you wish to submit a confidential response, mark the relevant box on your consultation proforma. Confidential responses will be disclosed to the Authority in full but, unless agreed otherwise, will not be shared with the Panel, Workgroup or the industry and may therefore not influence the debate to the same extent as a non-confidential response.

Acronyms, key terms and reference material

Acronym / key term	Meaning
AC	Alternating Current
BCA	Bilateral Connection Agreement
BSC	Balancing and Settlement Code
BSUOS	Balancing Services Use of System
CfD	Contracts for Difference
CMP	CUSC Modification Proposal
CUSC	Connection and Use of System Code
DC	Direct Current
EBGL	Electricity Balancing Guideline
ECC	European Connection Conditions
ESO	Electricity System Operator
EU	European Union
FON	Final Operational Notification
FRT	Fault Ride Through
GB	Great Britain
GCRP	Grid Code Review Panel
HVDC	High Voltage Direct Current
ION	Interim Operational Notification
LON	Limited Operational Notification
MEL	Maximum Export Limit
MW	Mega Watt
NETS	National Electricity Transmission System
NGESO	National Grid Electricity System Operator
OTSDUW	Offshore Transmission System Development User Works
PPM	Power Park Module
PU	Per Unit

SCADA	Supervisory Control and Data Acquisition
SIR	System Incidence Report
STC	System Operator Transmission Owner Code
SQSS	Security and Quality of Supply Standards
TCB	Transmission Circuit Breaker
TEC	Transmission Entry Capacity
TO	Transmission Owner
T&Cs	Terms and Conditions
VSM	Virtual Synchronous Machine

Reference material

Ref 1 – Decision and direction in relation to consultations H/04, "Grid Code Changes to Incorporate New Generation Technologies and DC Inter-connector (Generic Provisions)" and SA/2004, "Consultation on Technical Requirements for Windfarms"

https://www.ofgem.gov.uk/sites/default/files/docs/2005/05/10870-binder1.pdf

Ref 2 – Consultation on Technical Requirements for Windfarms The Authority's Minded To decision letter and Impact Assessment relating to the Scottish transmission licensees SA/2004 Report to the Authority

https://www.ofgem.gov.uk/sites/default/files/docs/2005/01/9348-0805.pdf

Ref 3 – Grid Code Modification H/04 & SA/2004 Response to OFGEM's consultations 07/05 & 08/05

https://www.ofgem.gov.uk/sites/default/files/docs/2005/05/10873-14205b.pdf

- NGESO's letter of 7th May 2021 "Grid Code Compliance with Fault Ride Through Requirements"
- NGESO's presentation to June 2021 Grid Code Review Panel meeting "Unexpected Generation Failure Management"

Annexes

Annex	Information
Annex 1	Proposal form
Annex 2	Terms of reference
Annex 3a	Urgency Letter to Ofgem
Annex 3b	Urgency Letter to Ofgem – Revised Timetable
Annex 4	Proposer Presentation
Annex 5	ESO Presentation
Annex 6	FRT – Draft Business Rules
Annex 7	Continental Split v2
Annex 8	Fault Ride Through Strawman Legal Text
Annex 9	ESO Draft Alternative