Modification proposal:	**Distribution Code: DC0079 Frequency Changes during Large Disturbances and their Impact on the Total System (Phase 4)**		
Decision:	The Authority[1] has decided to approve[2] this modification		
Target audience:	Distribution licensees, Distribution Code Review Panel, distribution network users and other interested parties		
Date of publication:	5 August 2019	Implementation date:	1 September 2019

Background

Electricity Distribution Licence holders are required by Standard Licence Condition (SLC) 20 of their licences to have in force, implement, and comply with the Distribution Code. SLC 21 imposes a duty on licence holders to review and, where appropriate, seek our approval for modification of the Distribution Code so as to better achieve the requirements of SLC 21. The Distribution Network Operators (DNOs) may propose changes to the Distribution Code and initiate work on a review of the Code through the Distribution Code Review Panel (DCRP).

The Energy Networks Association's (ENA) Engineering Recommendations G59 (ER G59) provide recommendations for the connection of distributed generation >16A per phase connected to distribution electricity networks. ER G59 is referenced in Annex 1 of the Distribution Code and is incorporated within the Distribution Code as part of the Code's technical requirements. Therefore, any change to ER G59 constitutes a change to the Distribution Code and has to be approved by us. The current version of ER G59, ER G59/3-6, came into effect in June 2019[3].

Drivers for the proposed changes to ER G59/3-6

This decision is the fourth in a series of modifications focused on Distributed Generators' (DG) Loss of Mains (LoM) protection equipment and their impact on whole system operation.

The principal issue the electricity system faces is a reduction in system inertia. This impacts how quickly system frequency can change in the event of a disturbance. System inertia levels have reduced in the last decade to a level where significant costs are incurred to ensure that system inertia is kept above certain thresholds to avoid detrimental effects. These costs are passed through to Balancing Services Use of System (BSUoS) customers but ultimately all system costs are passed through to consumers through bills.

In 2014[4], we approved a recommendation to modify the Rate of Change of Frequency (RoCoF) settings for existing distributed generation >5MW. This was as a result of RoCoF constraint costs increasing and the expectation that they would continue to increase.

[1] References to the "Authority", "Ofgem", "we" and "our" are used interchangeably in this document. The Authority refers to GEMA, the Gas and Electricity Markets Authority. The Office of Gas and Electricity Markets (Ofgem) supports GEMA in its day to day work. This decision is made by or on behalf of GEMA.
[2] This document is notice of the reasons for this decision as required by section 49A of the Electricity Act 1989.
[3] http://www.dcode.org.uk/annexes/
[4] https://www.ofgem.gov.uk/publications-and-updates/changes-distribution-code-and-engineering-recommendation-g59-frequency-changes-during-large-disturbances-and-their-impact-total-system

In 2017[5] we approved a modification to change the RoCoF settings for all new non-type-tested generators <5MW, bringing them into line with the requirements of the 2014 decision. The 2017 decision also removed Vector Shift (VS) as a suitable form of LoM protection for new non-type-tested generators. This was as a result of findings that VS protection is prone to mal-operation and can lead to a significant risk on system operation that the Electricity System Operator (ESO) is unable to manage. In 2018[6] we approved a modification to align type tested generator requirements with the 2017 modification after additional consultation with affected parties.

As these modifications did not change RoCoF settings on existing generators <5MW and did not remove VS from the system as a whole, action is needed to remove the risks these two forms of protection impose on the system. Protection settings on existing generators continue to limit the RoCoF that can be permitted in operating the system due to the volume of affected DG installed pre-2017. This requires a significant volume of ESO actions when system inertia is low to avoid breaching this limit. These actions impose costs on consumers[7].

Aligning RoCoF settings across new and existing generation such that it is consistent with the previous modifications (as set out above) would allow higher system RoCoF and a reduction in the constraint costs currently incurred to limit system RoCoF. Alongside this, removing VS protection from the system would improve the resilience of the system to spurious tripping and possible wide scale impacts created by VS mal-operation.

DC0079 underwent industry consultation through July and August 2018.

The modification proposal

This modification proposal is the fourth and final from a long-standing workgroup (WG). Originally founded to progress GC0035, the first WG meeting was in June 2013 and the last concluded in January 2019.

DC0079 was initially raised as Grid Code modification GC0079[8]. However, on 1 October 2017 this modification was superseded by DC0079. This changed as a result of changes to the Grid Code governance arrangements and was passed to the Distribution Code Review Panel for management.

The modification proposes changing the RoCoF settings for all existing <5MW generators connected to the Distribution system. This would bring them into line with the existing requirements for all new generators. This modification also proposes to remove VS as a suitable form of LoM protection from all sizes of existing generators connected to the Distribution System.

A summary of the proposal is as follows:

- That where RoCoF protection relays are used as part of LoM protection, the applied setting will be $1Hzs^{-1}$ with a definite time delay of 500ms.

[5] https://www.ofgem.gov.uk/publications-and-updates/dc0079-frequency-changes-during-large-disturbances-and-their-impact-total-system
[6] https://www.ofgem.gov.uk/system/files/docs/2018/05/dc0079_d.pdf
[7] The ENA have held stakeholder events which explain the issues this modification proposal seeks to address: http://www.energynetworks.org/assets/files/Accelerated%20Loss%20of%20Mains%20Protection%20Change%20Programme%20-%20Stakeholder%20event%20.pdf
[8] http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0035-GC0079/

The Office of Gas and Electricity Markets
10 South Colonnade, Canary Wharf, London, E14 4PU **Tel** 020 7901 7000
www.ofgem.gov.uk

- That VS protection technique will be removed where it is in use as LoM protection.
- Any existing over-frequency setting relays still set at 50.5Hz will, if possible, be changed to 52.0Hz.

Constraint costs as a result of RoCoF management were £143.6m for the financial year 2018/19[9]. This was significantly above expectations and was not included in the WG's cost benefit analysis (CBA) as it used forecast values significantly below this. The WG CBA forecasts a positive net present value two years after change completion based on lower constraint costs. We understand that there is broad industry consensus that without this modification, constraint costs will increase as the system changes with more non-synchronous generation commissioning and older synchronous generators decommissioning.

Distribution Code Review Panel (DCRP)[10] comments and licensee recommendation

At the DCRP Panel meeting on 7 February 2019, a majority of the DCRP considered that the modification proposal would better facilitate the Distribution Code objectives (a) and (b) and therefore recommended its approval. The Distribution Network licensees recommended that modifications are made to the Distribution Code and EREC G59/3-4.

Our decision

We have considered the issues raised by the modification proposal and in the Final Report received on 26 February 2019. We have considered and taken into account the responses to the consultation on the modification proposal which are included in the Final Report[11]. We have concluded that:

- implementation of the modification proposal will better facilitate the achievement of the applicable objectives of the Distribution Code;[12] and
- approving the modification is consistent with our principal objective and statutory duties.[13]

[9] https://www.nationalgrideso.com/document/142956/download
[10] The DCRP is established in accordance with SLC 21 of the Electricity Distribution Licence.
[11] Distribution Code proposals, final reports and representations can be viewed at: http://www.dcode.org.uk/areas-of-work/ and http://www.dcode.org.uk/consultations/
[12] As set out in Standard Condition SLC 21.4 of the Electricity Distribution Licence available at: https://epr.ofgem.gov.uk//Content/Documents/Electricity%20Distribution%20Consolidated%20Standard%20Licence%20Conditions%20-%20Current%20Version.pdf
[13] The Authority's statutory duties are wider than matters which the Panel and licensees must take into consideration and are largely provided for in statute, principally in this case the Electricity Act 1989.

The Office of Gas and Electricity Markets
10 South Colonnade, Canary Wharf, London, E14 4PU **Tel** 020 7901 7000
www.ofgem.gov.uk

Reasons for our decision

We consider this modification proposal will better facilitate Distribution Code objectives (a), (b), is consistent with our principal objective and statutory duties and has a neutral impact on the other Distribution Code objectives.

This is the fourth in a series of related decisions and as such they share a large degree of commonality in terms of the basis for our decision. Our 2014 decision laid out the requirement for the changes of RoCoF settings for existing generators above 5MW, whilst our 2017 decision laid out the requirement for new non-type-tested generators <5MW and the removal of VS as a means of LoM protection for new DG.

(a) permit the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity

We consider the extension of changing existing RoCoF settings to all non-type tested DG >50kW is necessary. It is needed to improve the stability and robustness of the electricity system. The management of the risk presented by RoCoF protection by the ESO is currently complex, costly and potentially inefficient. Changing the LoM protection settings for existing generators will reduce the risk management complexity, therefore reducing overall system risk. The existing generators affected are connected to the distribution system, and a change to ER G59 represents an efficient way to implement the change.

Post change, the ESO will continue to manage RoCoF but the LoM settings proposed will allow the ESO greater latitude with regard to the potential system RoCoF rates. The flexibility provided should allow the ESO to reduce the constraints associated with RoCoF, accommodate larger generating units and interconnectors, and increase volumes of DG and interconnections, many of which are asynchronous in nature.

We consider that system RoCoF has the potential to increase significantly, due to reduced system inertia and an increase in the largest infeed loss. This will increase the cost and complexity of avoiding inadvertent operation of DG protection that could otherwise result in widespread shut down of DG across the system. It is rational and reasonable to complete the process started in 2014 by extending the changes to all relevantly affected DG; given the benefit of relaxing system RoCoF limits cannot be realised until a large proportion of affected installed capacity is changed. A strong and stable whole system is a fundamental requirement on which any efficient, co-ordinated and economical distribution system can be created.

We also consider the removal of VS protection, as a whole, from the distribution system is justified. VS protection has proven to be ineffective at detecting faults leading to electrically islanded conditions and is highly susceptible to mal-operation for transient faults on the transmission system. There have been a number of documented incidents where large volumes of DG have tripped for transient transmission faults. If these had been coincidental with a loss of transmission generation infeed, there is the possibility for significant system impact. This creates a risk to the operation of the distribution system and therefore is reasonable to be removed.

We note that this modification could increase the risk of energised island networks on the distribution system. These islands would pose a risk of injury to people near distribution equipment and the risk of damage to synchronous plant. The WG engaged Strathclyde University to carry out a study of the risks associated with the proposed modification. They found that the risk increases but is viewed as being as low as reasonably practicable and they believe it is within the broadly acceptable region of personal risk accepted as

consistent with the Health and Safety at Work Act 1974. Details of the risk assessment can be found attached in the DC0079 Final Report.

Due to the health and safety impact of this modification, we consulted with the Health & Safety Executive (HSE), in accordance with section 3C of the Electricity Act 1989. The HSE have worked with the WG since its inception. In our consultation with the HSE on this modification, they reiterated their position laid out in our 2014 modification approval. They believe that this modification is needed due to the changing nature of the electricity system but stated the following:

1. The effect of the setting change on individual generators would need to be assessed from a health and safety perspective. The HSE stated that this is the responsibility of the relevant duty holder.
2. It is important that the affected generators are made aware of the potential health and safety impact of the setting changes.

The HSE wrote to the DNOs and IDNOs asking them to write to all affected generators to convey the above two points in 2014[14]. The HSE have informed us that this advice is still relevant and current for this modification. They expect network operators to approach this modification in the same way as in 2014.

There were seven respondents to the formal industry consultation including large scale generators, network operators and industry bodies representing small scale synchronous generators. The consultation format used by the DCRP did not disaggregate each of the objectives for respondents to give their views on. Rather they were asked whether the modification better facilitated the objectives of the Code as a whole. In this case all of the respondents were positive towards the code objectives being met. However, it is to be noted that many responses made mention of future savings to the total system or with regards to balancing costs.

As we said in our 2014 modification approval, it is correct to identify these costs savings however they are not related to the relevant objectives for the Distribution Code. These savings are unlikely to affect either objective (a) or (b). However they are relevant to our decision, as set out in the section below on our principal objective.

The Electricity System Operator presented to the Transmission Charging Methodologies Forum a number of times to consult with stakeholders that pay BSUoS[15] to seek to ensure they were aware of the modification consultation.

The changes detailed in the Final Report to LoM protection will result in an improvement in the operation of an efficient, economical and co-ordinated distribution system. Taking all these factors into consideration, overall we consider that the proposal better facilitates Objective (a).

(b) facilitate competition in the generation and supply of electricity

The WG consultation asked whether respondents agreed with a range of questions related to implementation of the proposed changes. The majority of respondents were positive regarding the changes. One respondent queried whether there was an issue with older type

[14] The letter is dated 23 July 2014, a copy can be obtained directly from the HSE.
[15] https://www.nationalgrideso.com/document/134211/download & https://www.nationalgrideso.com/document/143216/download

The Office of Gas and Electricity Markets
10 South Colonnade, Canary Wharf, London, E14 4PU **Tel** 020 7901 7000
www.ofgem.gov.uk

wind turbines being adversely affected by the proposed changes. This objection was withdrawn after discussion with the WG. Another objected based on the impact on small synchronous generators with regards to RoCoF withstand challenges that could damage the generators. The WG has recognised the issues with small synchronous generators and suggests that these risks be actively managed through the implementation plan.

We note the concerns of respondents on the detail for the implementation of this modification. Alongside the Final Report there has been an implementation plan produced. This plan covers many of the concerns that respondents raised, however uncertainty remains regarding implementation costs. The WG addressed this issue by pointing out that this has never been done before and therefore cost certainty is difficult to achieve at this stage. We expect licensees to manage cost uncertainty proactively throughout the entire implementation period.

To ensure value for money and minimisation of costs throughout the programme; a steering board will be created which will consist of key stakeholders including ourselves. The ESO will undertake quarterly cost benefit analysis to determine the effectiveness of the programme and report this to the steering board. Costs will also be reported by DNOs and the ESO throughout to ensure we have oversight of the programme. We will take an active role in ensuring that costs are minimised to consumers.

We consider that the modification would better facilitate Objective (b). It will reduce constraints applied to large in-feeds, associated balancing actions and facilitate the connection of more non-synchronous generation by reducing residual balancing actions being taken by the ESO to manage system RoCoF. We consider that reductions in constraints and balancing actions would improve competition by reducing the need for actions taken by the ESO outside the market. We also consider that facilitating the integration of non-synchronous generation to bring more generation to market is likely to improve competition.

Taking all these factors into consideration, overall we consider that the proposal better facilitates Objective (b).

Principal objective and other considerations

We have also considered this modification against our principal objective of protecting consumer interests. The modification will reduce the risk of inadvertent tripping of DG that uses both VS and RoCoF LoM protection. In both cases there is a risk of cascade failure that could have a significant impact on security of supply. It is in the consumer's interest that these existential threats are removed or managed to a sufficient extent so as to reduce the risk to security of supply.

Once the modification has been fully implemented it will result in lower Balancing Services costs, and so lower BSUoS charges. As BSUoS charges, like other costs, are ultimately paid for by consumers; we consider that this modification will result in lower costs to consumers. We consider that approving this modification is in accordance with our principal objective. As mentioned above the CBA utilised by the WG uses forecast RoCoF constraint costs well below the level experienced in the 2018/19 financial year. The outturn value of which was £143.60m. It is our view that given the 2018/19 costs were significantly above expectations and that if these were included in the WG CBA they would provide an earlier breakeven point and strengthen the justification for this change.

The effect of not approving this modification would be that RoCoF constraint costs would continue to increase, with interconnectors, large generators and renewables becoming increasingly constrained. If we were not to remove the risk of VS mal-operation the ESO

would have limited ability to manage this risk and it could lead to significant impacts on system operation. Neither of these scenarios are acceptable.

Reducing system inertia and increased non-synchronous generation is likely to continue for the foreseeable future. We consider that a modification which facilitates the stable integration of non-synchronous generation benefits consumers as it promotes supply side competition, helps achieve legally binding carbon reduction targets and reduces the likelihood of low frequency demand disconnection relay operation (which results in an involuntary loss of supply to large groups of consumers). We therefore consider that approving this modification is consistent with our principal objective.

Modification implementation plans

We note that the WG have provided details on how these changes will be implemented. Given the complexity and scale of the task being proposed this implementation plan is needed to give comfort that industry will carry out the modification in an appropriate manner.

The WG estimates that the cost of the modification will be at the upper end of their estimates, ~£100m over a 3 year period. This will result in an increase in BSUoS for the duration of the implementation period (this is because the costs will be paid by the wider industry through BSUoS rather than recovered from the generators themselves). However once completed the result will be a significant reduction in RoCoF constraint costs going forward. Detailed implementation costs will only be available once the process is underway, however we are satisfied that the proposed costs have been estimated in an appropriate manner from experience in similar areas and through consultation with relevant industry parties. One aspect of the implementation plan that is significantly different from the 2014 scenario is that, as noted above, costs will be paid for through BSUoS rather than by the generators themselves. Given the scale and scope of the proposed modification and the current relationship between BSUoS and RoCoF constraint costs, we believe this is a reasonable route for funding the modifications.

Industry has been moving forward with preparations in advance of our approval of this modification. We have been informed that a number of actions have occurred prior to acceptance of the modification, these include:

- a number of stakeholder engagement events have occurred since the submission[16]
- establishment of a core project team and relevant structures
- agreement of contractual structure between the Electricity System Operator, Distribution Network Operators/Independent Distribution Network Operators and generators
- creation of a generator information portal
- further research to inform costs for modifications
- agreement of delivery assurance principles including an approach to witness testing and post-event checks.

We believe that these actions show a mature approach towards the challenge faced by industry. However, given the unprecedented nature of this modification in terms of its scale and scope, we believe that industry parties must all fully participate in delivering the

[16] A number of stakeholder events have taken place since submission. A public register of issues raised is available:
http://www.energynetworks.org/assets/files/electricity/engineering/DCRP/DC0079/190623%20ALOM%20Public%20Issues%20Log.pdf

The Office of Gas and Electricity Markets
10 South Colonnade, Canary Wharf, London, E14 4PU **Tel** 020 7901 7000
www.ofgem.gov.uk

required changes as quickly and efficiently as possible. We wrote to all of the Distribution Network Operators' and the Electricity System Operator's CEOs in December 2018 urging them to ensure their full co-operation with the development of the implementation plan. Now the modification has been approved, we expect that they will extend their leadership to this issue along with reasonable and adequate resources to ensure its success.

Decision notice

In accordance with SLC 21.11 of the Electricity Distribution Licence, the Authority hereby directs that the modification to the Distribution Code set out in the Final Report to the Authority received on 26 February 2019 be made.

Peter Bingham
Chief Engineer
Signed on behalf of the Authority and authorised for that purpose

The Office of Gas and Electricity Markets
10 South Colonnade, Canary Wharf, London, E14 4PU **Tel** 020 7901 7000
www.ofgem.gov.uk