

Modification proposal:	<b>Distribution Code:</b> DC0079 - Frequency Changes during Large Disturbances and their Impact on the Total System		
Decision:	The Authority <sup>1</sup> has decided to approve <sup>2</sup> this modification		
Target audience:	Distribution licensees, Distribution Code Review Panel, distribution network users and other interested parties		
Date of publication:	15 December 2017	Implementation date:	1 February 2018

## 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 Recommendation G59 (ER G59) provides recommendations for the connection of distributed generation >16A per phase connected in parallel with the public electricity network. 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, ER G59/3-2, came into effect in September 2015.

### *Drivers for the proposed changes to ER G59/3-2*

ER G59 outlines the type of Loss of Mains (LoM) protection required by distributed generation to connect to the public electricity network. Two types of protection currently permitted include Vector Shift (VS) and Rate of Change of Frequency (RoCoF). Existing protection settings create a limit on the RoCoF that can be permitted in operating the system. This requires significant System Operator (SO) actions when system inertia is low to avoid breaching this limit, which imposes costs on consumers. Increasing this limit requires the RoCoF settings to be changed to allow a reduction in these costs.

We made a previous decision<sup>3</sup> in 2014 that RoCoF settings for existing distributed generation >5MW should be changed. DC0079 is part of a scheme to realign the RoCoF limit constraint. Our 2014 decision describes the technical challenges being faced by the SO with regards to reducing system inertia and the costs this imposes on the system.

DC0079 also addresses an issue with the use of VS protection. The principle of VS protection operation is based on the assumption that the disconnection of a generator and the local network from the main distribution network will result in a change of the phase angle of the voltage waveform in the islanded system. VS relays monitor the change of the phase angle between two successive cycles and if it exceeds the pre-defined threshold, the relay disconnects the generator from the network. The present VS thresholds stated in ER G59 are 6° or 12°. On a number of occasions it has been

<sup>1</sup> 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.

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

<sup>3</sup> <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>

suspected that a transmission system fault that did not result in islanding, resulted in the inadvertent tripping of the generators by triggering their VS protection. A definite event was recorded on 22 May 2016 following a transmission single circuit fault. Further investigation of this event showed that a significant number of distributed generators (>400MW in total) had tripped as a result of the operation of the VS protection. This event resulted in a loss of infeed and a frequency excursion that was larger than should have occurred for such a fault. Modelling has been carried out for a number of areas on the transmission system that show, for certain types of faults the VS observed at the distribution system can be significantly beyond the ER G59 VS limits thus resulting in widespread operation of the LoM protection.

Because of these events, a series of studies of VS relay operation was undertaken, to identify their effectiveness<sup>4</sup>. The studies show that VS relays are, in general, ineffective at detecting the existence of an island therefore they do not perform their function as expected.

Depending on the location and nature of a fault that may trigger a VS event, the SO is potentially unable to protect against such a large loss of infeed. An example could be a fault that results in the loss of a major generator or interconnector triggering a further loss of distributed generation due to VS.

#### *Industry consultation process*

A consultation opened on 7 August 2017 and closed 1 September 2017. Email notification of this consultation was sent to industry stakeholders and published on the Distribution Code website<sup>5</sup>.

The consultation included two options for implementation of the LoM setting change and stability tests, technical details of the modification are included in the modification proposal section of this letter:

Option 1 - Limited to discrete relay protection only. As such, type tested generation under ER G59 would not be affected.

Option 2 –Involves applying new protection settings and stability tests to all embedded generators, including type tested generating plant.

ER G59 includes settings for both type tested and non-type tested equipment. Type tested equipment is equipment that has been tested by the manufacturer or a third party to ensure that the design meets the requirements of ER G59 e.g PV behind an inverter. For non-type tested equipment, further tests are required at commissioning and are handled individually.

In total, six responses were submitted by industry stakeholders with four from DNOs and two from generators. All submissions were in favour of the working group's (WG) recommendation, which was Option 2.

As none of the respondents to the formal consultation were manufacturers of type tested equipment the WG considered that additional direct stakeholder engagement was necessary. As a result, 39 inverter manufacturers were contacted. Of these, six responded to the direct communication with two requesting time to undertake repeat type testing for Option 2 including RoCoF and VS stability immunity up to 50° on type tested equipment. As a result of this and concerns the WG had with the responses they received, they changed their recommendation to Option 1 for this modification proposal.

---

<sup>4</sup> By the University of Strathclyde. These are available on the Distribution Code website.

<sup>5</sup> <http://dcode.org.uk/consultations.html>

The WG have stated that further work needs to be carried out to address LoM settings and stability testing of type tested equipment and that this may result in further modifications to ER G59, ER G83 and the Distribution Code.

### **The modification proposal**

This modification is the second from a long standing WG. Originally founded as GC0035 the first WG meeting was 14 June 2013, there have been 37 meetings with the most recent being 26 September 2017. The WG has not yet fully discharged the terms of reference and further modification proposals are expected.

DC0079 was initially raised as Grid Code modification (GC) 0079.<sup>6</sup> However, on 1 October 2017 this modification was superseded by DC0079.

The modification proposes changing the RoCoF settings for all new non-type tested generators <5MW, bringing them into line with the existing requirements for >5MW generators. This modification also proposes to remove VS as a suitable form of LoM protection.

A summary of the proposal is below:

- RoCoF settings changed to 1Hz/s with a definite time delay of 500ms for all new non-type tested generators. Generators commissioned on or after 1 February 2018 would be required to commission with the new setting.
- All non-type tested generators commissioned on or after 1 February 2018 will not be allowed to use VS.
- All non-type-tested generators as part of their LoM technique should demonstrate stability for appropriate RoCoF and VS disturbances. Including immunity to  $\pm 50^\circ$  VS events.

### **Distribution Code Review Panel (DCRP)<sup>7</sup> comments and licensee recommendation**

At the DCRP Panel meeting on 26 October 2017, the DCRP considered that the modification proposal would better facilitate the Distribution Code objectives and therefore recommended its approval.

### **Our decision**

We have considered the issues raised by the modification proposal and in the Final Report submitted to us on 4 December 2017. We have considered and taken into account the responses to the consultation(s) on the modification proposal, which are included in the Final Report.<sup>8</sup> We have concluded that:

- implementation of the modification proposal will better facilitate the achievement of the applicable objectives of the Distribution Code;<sup>9</sup> and

---

<sup>6</sup> Please see <http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0035-GC0079/>

<sup>7</sup> The DCRP is established in accordance with SLC 21 of the Electricity Distribution Licence.

<sup>8</sup> 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/>

<sup>9</sup> 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>

- approving the modification is consistent with our principal objective and statutory duties.<sup>10</sup>

### **Reasons for our decision**

We consider this modification proposal will better facilitate Distribution Code objective (a) and has a neutral impact on the other applicable objectives.

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

This modification is the second in a series that addresses the issue of RoCoF and LoM protection more generally. As set out in our decision on GC0035 in 2014, we consider that changes to the RoCoF settings for all new non-type tested generators covered by ER G59, bringing them into line with the existing requirements for >5MW generators, will increase the stability and robustness of the electricity system. Having a stable and robust overall system is a prerequisite for an efficient, co-ordinated and economical distribution system. DC0079 will reduce the risk of RoCoF LoM protection inadvertently shutting down distributed generation, benefitting the operation of the distribution and total system. We consider that system RoCoF is likely to continue to increase and therefore increased resilience to this, where more economic options are not available, is beneficial.

The WG have shown that VS is not effective at detecting islanding and is more likely than RoCoF to trip for a transmission fault. More effective means of protection, such as RoCoF, are available to generators to use where appropriate. The proposal also arrests the number of generators at risk of VS LoM protection inadvertently tripping thus maintaining the risk to system operation at the same level that the SO has managed to date.

We note that this modification could increase the risk of energised island networks on the distribution system, the 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 does increase but is viewed 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.

Due to the health and safety impact of this modification, we consulted with the HSE, in accordance with section 3C of the Electricity Act 1989. The HSE have worked with the WG and modifications were made to this proposal as a result of HSE's input. HSE's are content with the approach taken in this modification on balancing the electrical risks of islanding against the concomitant risk of loss of infeed to the system.

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

---

<sup>10</sup> 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.

### **Principal objective and other considerations**

We have also considered this modification against our principal objective of protecting consumer interests. This modification should assist in lowering Balancing Services costs, and so lower Balancing Use of System (BSUoS) charges. As BSUoS charges, like other system costs, are ultimately paid for by consumers, we consider that this modification should result in lower costs to consumers. We therefore consider that approving this modification is in accordance with our principal objective.

### **Observations**

We note the comments of the WG that further modifications may be raised to consider whether LoM protection changes should have retrospective effect and to address the issue of type tested generators' settings and testing. Given the challenging nature of potentially changing relay settings for thousands of existing generators not captured by this current proposed modification, it is our view that network licensees should make robust plans to ensure any proposed changes are carried out in a timely and efficient manner. Any future modification in this space will require accompanying implementation plans covering the following areas to provide confidence that any new requirements will be delivered:

- Overall plans detailing how the modification will be implemented and LOM protection changes carried out.
- Identification of responsible parties for ensuring the modification is implemented.
- Stakeholder engagement proposals for the duration of the process.
- Proposals to demonstrate compliance with the modification such that the System Operator can have confidence to utilise a higher system RoCoF.
- Proposals detailing which parties should pay for any protection changes and how this cost will be recovered, if necessary.
- Proposals to incentivise efficient delivery of the modification.

Should any future modification proposals to change the LoM settings be raised, we will scrutinise closely the costs and benefits to individual generators as well as the whole system cost benefit case along with the implementation plan proposals. We note that this issue affects many parties, we encourage the WG to engage with the industry going forward to ensure an optimised solution and plan is formulated.

### **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 submitted to the Authority on 4 December 2017 be made.

**Peter Bingham**  
**Chief Engineer**

Signed on behalf of the Authority and authorised for that purpose