THE DISTRIBUTION CODE OF LICENSED DISTRIBUTION NETWORK OPERATORS OF GREAT BRITAIN

Stage 04: Report to The Authority – [DCRP_18_03_05]

DC0079 Frequency Changes during Large Disturbances and their Impact on the Total System - Phase 2

What stage is this document at?

01 Modification
02 Workgroup Report
03 Draft Modification Report
04 Final Modification Report

The purpose of this document is to assist the Authority in its decision to implement the proposed modifications to the Distribution Code Engineering Recommendations G59 and G83. The proposed modifications were subject to industry consultation in August 2017 and February 2018. During the August Consultation no response was received from manufacturers of type tested plant. As a result a second consultation was undertaken in February 2018 and one response was received from a type tested plant manufacturer. The manufacturer did not object to the proposal but proposed a delay in the implementation date.

Published on: 28/3/2018

Recommendation

It is recommended that modifications be made to Distribution Code and Engineering Recommendations G59 and G83 to mandate type tested generators, commissioned on or after 1 July 2018, to demonstrate stability for appropriate RoCoF and vector shift disturbances. This report recommends:

a) That the rate of change of frequency (RoCoF) criterion used for Loss of Mains protection must be 1Hzs^{-1} with a definite time delay of 500ms.
b) That vector shift protection technique should not be used as Loss of Mains protection for type tested generators and that the generation must not trip for vector shifts of up to 50º.
c) That type-tested generation includes stability tests to prove immunity to RoCoF and vector shift less than the above criteria.

High Impact:
Manufactures of Type Tested Generators may need to re-test their plant to ensure compliance with the requirement.

Medium Impact:

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None identified.

Low Impact:

None identified.

Contents

Any Questions?

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Document Control

Version	Date	Author	Change Reference
0.1	02/03/2018	MK	Draft Report to the Authority
0.2	15/03/2018	MK	Updated post DCRP comments
1.0	28/03/2018	DS	Submit Report to the Authority

1 Executive Summary

1.1 Connection requirements applicable for embedded generation can be split into two categories. The first category concerns plant whose loss of mains (LoM) protection is implemented using discrete relays and the second is where the protection functionality is implemented in the control scheme of type-tested embedded generators, as allowed for in both ERECs G59 and G83.

1.2 The purpose of the type tests is to demonstrate compliance with the LoM functional requirements of these engineering recommendations (although the exact LoM technique to be used is not specified). By satisfying the test conditions in the relevant annex of ERECs G59 and G83 the generating plant can be considered to be approved for connection to a public distribution system.

1.3 During the September 2017 DC0079[1] industry consultation, two options were put forward in section 4.36 of that consultation document. Option 1 was only aimed at plant whose LoM is implemented in discrete protection relays. This option required that plant commissioning on or after 1 February 2018 should not use vector shift protection and should use a RoCoF relay set to 1Hzs^{-1} with a 500ms time delay. This option was approved by the Authority on 15 December 2017.

1.4 The second option had included requir~~ed~~ing type tested embedded generators to demonstrate immunity to vector shift and RoCoF disturbances. The workgroup proposed that plant should be able to ride through faults whose vector shift could be up 50°or RoCoF of up to 1Hzs^{-1} with a 500ms time delay.

1.5 The reasons behind these requirements, the current and future challenges faced by the GB System Operator in managing the total system were articulated in the September 2017 DC0079 consultation document.

1.6 No responses were received from manufacturers of type tested embedded generators on these immunity requirements. The workgroup concluded that there was a need to further engage with these manufacturers before option 2 above could be implemented. As part of this engagement process, the DCRP wrote an open letter to manufacturers[2] of type-tested plant in an effort to inform and engage them.

1.7 Another open letter[3] was written by the workgroup redefining the vector shift immunity requirement taking into account post consultation feedback from manufacturers. The immunity as initially proposed in the September consultation document was open to interpretation and would have encroached on to fault ride through requirements which the workgroup felt would be better handled through the proposed expert group being initiated by National Grid to review the overall approach to transmission fault ride through. As a result the workgroup revised the requirement to single simple ±50° vector shift immunity, ie changing

[1] https://www.nationalgrid.com/sites/default/files/documents/GC0079%20%20%20Industry%20Consultation%20Document.pdf

[2] http://www.dcode.org.uk/assets/uploads/171014_open_letter_VS_301017.pdf

[3] http://www.dcode.org.uk/assets/uploads/171128_DCode_open_letter_VS_part_2b_issued_131217.pdf

from the 6° specified in ERECs G59 and G83.

1.8 Tests carried out by Strathclyde and summarised in section 3.2 of the "Testing LV PV Inverters Stability during Voltage Magnitude and Vector Shift Disturbances[4]" report concluded that all commercially available inverters, within their sample, passed the ±50º vector shift type test which the workgroup is proposing in this report even though the current immunity requirement is lower. Recognising that this test was for a limited sample and that plant connected in the future may not exhibit the same characteristics, the workgroup concluded this requirement is adopted to ensure that the risk of inadvertent tripping of generating plant does not increase further as new generation plant is connected to the system.

1.9 A second consultation[5] targeting manufacturers of type-tested plant was undertaken in February 2018. One response was received from an inverter manufacturer. The manufacturer did not object to the proposed changes. The manufacturer did suggest that implementation be deferred to May 2019 when the RfG changes come into force. The manufacturer also raised a technical point that is not necessarily correct or obvious and is also best dealt with in the proposed expert group referred to in 1.7 above.

1.10 This report is proposing to modify EREC G59, and EREC G83 to ensure that all type tested generation commissioned on or after 1 July 2018 should demonstrate stability for appropriate RoCoF and vector shift disturbances as specified in Annexes 2, 3, 4 and 5 of this report.

1.11 The workgroup believes that its terms of reference have not yet been completely discharged and will continue to pursue other issues within its terms of reference, including retrospective application of these and other requirement, on the same subject, already approved by the Authority.

1.12 As the next scheduled meeting of the DCRP is not until 5 April and the need to meet 1 July implementation date the Code Administrator sought agreement from the Panel by circulating a formal request via email. This email request was sent out to the Panel on 14 March with a return date of 21 March for any objections. Subsequently there were no objections and as such the Panel therefore agrees that the changes contained in modification report should be recommended by the DNOs to the Authority.

[4] Strathclyde Report : See annex 6 circulated with this report
[5] http://www.dcode.org.uk/consultations/open-consultations/

2 Purpose & Scope of the Workgroup

2.1 The Frequency Changes during Large Disturbances and their impact on the Total System Workgroup was established by the Grid Code Review Panel (GCRP) and Distribution Code Review Panel (DCRP) in 2012.

2.2 The reasons and background for the formation of the workgroup are covered in Chapter 3 (Workgroup discussion) of the Phase 1, GC0035 document to the Authority available on National Grid's website. Further to this, the same workgroup was reconstituted under GC0079 and then DC0079 with the aim of extending the recommendations of GC0035 to embedded generation with a registered capacity less than 5MW.

2.3 The following are the workgroup objectives relevant to this workgroup recommendation:

2.3.1 To deliver proposals concerning RoCoF based protection on embedded generators with a registered capacity of less than 5MW.

2.3.2 To investigate and recommend on the suitability of VS protection as an alternative to RoCoF, taking into account its possible unsuitability for transmission fault ride through requirements.

Terms of Reference

2.4 Terms of Reference can be found in Annex 1

Timescales

2.5 The DC0079 workgroup held a sequence of over 42 meetings, the first on 14 June 2013 with the most recent meeting being on 27 February 2018.

3 Why Change?

System Inertia

3.1 The volatility of system inertia, the causes, impacts, and mitigation measures have been extensively articulated in the GC0035[6] and GC0079[7] reports to the Authority. This has resulted in:

a) The relaxation of RoCoF setting from 0.125 Hzs^{-1} to 1 Hzs^{-1} with a 500ms time delay for all embedded generation whose registration capacity is 5MW and above.

b) The requirement to set RoCoF to 1 Hzs^{-1} with a 500ms time delay for installations whose registered capacity is below 5MW and whose commissioning date is on or after 1 February 2018

c) The banning of the use of vector shift relay protection as loss of mains protection for all embedded generation whose commissioning date is on or after 1 February 2018

3.2 Analysis of the generation mix in the Future Energy Scenario[8] (FES) 2017 report suggests that the system inertia will continue to decrease over the next 20 years. Fig 1 shows the inertia probability density for selected years up to 2027. This decrease, along with the anticipated increase in the largest infeed loss, will increase the balancing and services cost.

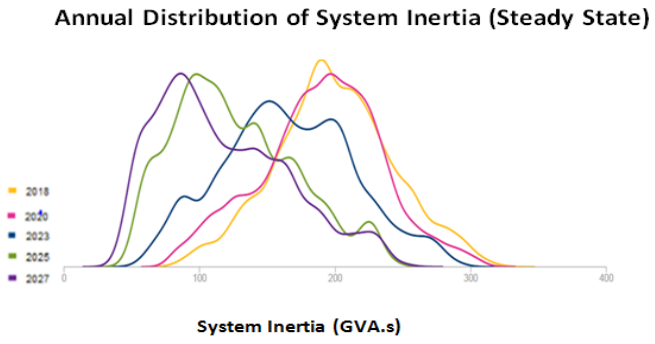

Fig 1 System inertia distribution

Vector shift Issues

3.3 Inadvertent tripping of vector shift protection as a result of secured events on the transmission system continues to impose a major challenge to the GB System Operator. The September 2017 industry consultation report, referenced in section 1.3 of this report, articulated the problems associated with VS protection. One incident mentioned in the same report is the 22 May 2016 single phase transmission circuit fault that resulted in a significant number of embedded generation plants

[6] http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0035-GC0079/

[7] http://www.dcode.org.uk/assets/uploads/Report_To_the_Authorityv3_1.pdf

[8] http://fes.nationalgrid.com/media/1253/final-fes-2017-updated-interactive-pdf-44-amended.pdf

tripping as a result of the operation of VS protection. This event resulted in a loss of infeed and a bigger frequency excursion than otherwise anticipated. Data from simulations and phase measurement units showed that the vector shift at the point of fault was greater than 50°.

3.4 Further similar incidents have occurred and Table 1 below shows a summary of some of these events.

Date	Fault Location	Estimated Capacity tripped[MW]	Vector shift (location: 400kV)
10/07/2017	Bramford – Sizewell No. 4 400kV circuit	330	36° (Bramford)
17/07/2017	Kensal Green Reserve Busbar 1	550	21° (Beddington)
21/05/2017	Littlebrook Circuit Breaker X140	280	9° (Canterbury)

Table 1 Vector Shift during transmission incidents

3.5 Information from the DNOs, on faults in Table 1, indicated that the loss of embedded generation was as a result of vector shift protection operation.

3.6 These events, among others, support the need to stop using vector shift protection for future embedded generators to prevent them from inadvertent tripping.

Increase in the number of type tested connections.

3.7 The majority of type tested generators are of the Photovoltaic (PV) type. Based on the Feed in Tariff report[9] it can be seen that approximately 35 000(approximately 4% of total) sites were connected in 2017. Fig 2 shows the number of type tested connection per year from 2012.

[9] https://www.gov.uk/government/statistics/solar-photovoltaics-deployment

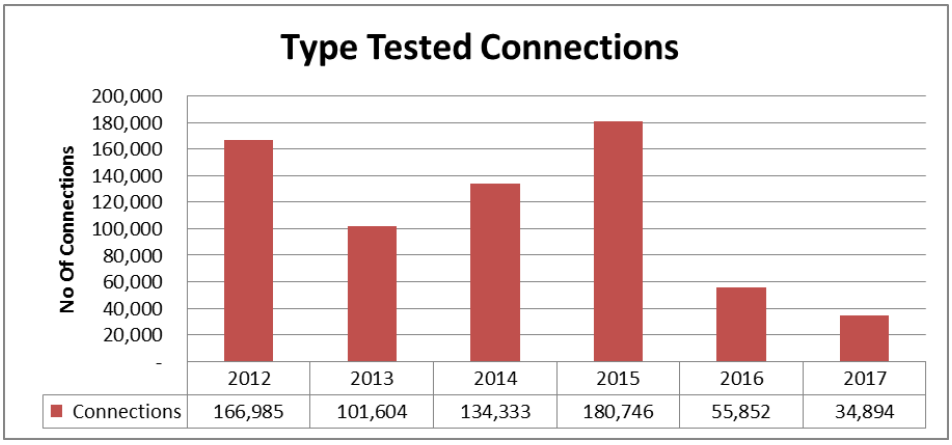

Fig 2 Type tested plant connection per annum

3.7.1 Though there appears to be a downward trend in the number of connections per year, the number of connections is still quite significant. PV connections are likely to continue in future based on the forecast in the FES. The risk of inadvertent tripping could increase if more and more generators with low vector shift immunity level are being installed. To reduce this risk the workgroup is proposing a higher level of immunity.

4 Workgroup Discussions

4.1 The workgroup discussions and conclusions were fully documented in the previous DNOs' report to the Authority on DC0079, dated 27 October 2017. This report was based on the consultation that ran from 7 August to 1 September 2017

4.2 This current stage of the DC0079 report is forward looking and is proposed to cover only type-tested embedded generators with a commissioning date on or after 1 July 2018. The workgroup recommends that type-tested plant should stay connected for:

a) A transmission fault which may result in a 50º vector shift at the generator's plant terminals.

b) A RoCoF of up to $1Hzs^{-1}$ with a 500ms time delay.

4.3 This current proposal is in pursuit of option 2 described in the September 2017 consultation document.

4.4 Option 1 of the September consultation was approved by the Authority on 15 December 2017 and its recommendation came into effect from 1 February 2018.

4.5 The workgroup concluded, after the first consultation, that a further engagement with-type tested manufacturers was necessary as they had not responded to the consultation.

4.6 The DCRP wrote two open letters to type tested manufacturers as part of the engagement process notifying them of the proposed changes to the immunity requirement. In response some manufacturers indicated that they have seen the letters, and other manufacturers had discussions with the workgroup, from which the workgroup believes there is generally a low level of concern amongst manufacturers in terms of the difficulty of meeting the proposed tests.

4.7 A second consultation was held in February 2018 from which one response was received. Details of the response are covered in section 5 of this report.

Vector shift and Frequency studies: PNDC Reports -Strathclyde

4.8 In parallel to engaging manufacturers, National Grid, on behalf of the workgroup, commissioned the Power Network Demonstration Centre (PNDC) from Strathclyde University to analyse the behaviour of small scale invertors. This analysis aimed to assess the consequences of subjecting the inverter to a vector shift of up to ±60° at various loading levels and various levels of retained voltage. The results of this analysis are as follows:

a) All inverters tested passed the vector shift type test of ±50° at nominal voltage and loading.

b) For a retained voltage below 80%, the results were less consistent as only some of the inverters connected tripped and the others reduced their output.

4.9 A similar study to analyse the behaviour of inverters when subjected to rate of change of frequency and vector shift events was documented in a report titled ''Experimental Evaluation of PV Inverter Performance

during Islanding and Frequency Disturbance Conditions[10]'' produced by the PNDC. The conclusion was that:

a) All inverters remained stable to a rate of change of frequency event of 1Hzs^{-1} and a vector shift of 6° (as specified during that time)

b) Some inverters experience a reduced power output during events. This is similar to 4.8 (b)

4.10 From the two PNDC reports and the low level of concern amongst manufacturers, the workgroup recommends that vector shift and RoCoF immunity levels be changed.

4.11 On findings relating to inverter behaviour during faults, the workgroup suggests that this could be further investigated under a separate workgroup as a package with fault ride through requirements. The issue of low system voltages during faults was investigated under RfG with a proposal to establish an expert workgroup with an objective of using virtual synchronous machines (VSM) as a source of reactive current during faults and thus improve the overall voltage performance of the transmission and distribution system. National Grid is in the process of setting up an expert group to review these issues.

[10] https://www.nationalgrid.com/sites/default/files/documents/8589936354-UoS%20Inverter%20Testing%20Final%20Report%20-%20December%202015.pdf

Summary of the ERECs G83 and G59 modification

4.12 Section 5.3.3 of EREC G83 Annex 4 **(Frequency Drift and Step Change Stability Test**) requires Small Scale Embedded Generators (SSEG) to carry out stability type tests to ensure plant remains stable under normal network operations which is frequently changing due to continuous unbalance of load and generation or when subjected to a step change due to the loss of a network component, which does not result in islanding. In order to meet this requirement and avoid unnecessary tripping of these generators, the workgroup proposes that these machines be type tested at:

4.12.1 A rate of change of frequency for the test that is marginally less than $1Hzs^{-1}$ with a 500ms time delay (see section 5.3.1 Table 1 of Annex 4).

4.12.2 A vector shift of up to 50º. This is to ensure that this plant remains connected during secured events on the transmission system which may result in a local vector shift of up to 50 º.

4.13 Section 9.3.7 of EREC G59 (Annex 3) has been modified to, among other things, change the stability limit of type tested generating units from the current ~~±~~±6º to ~~±~~±50º

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Risk Assessment summary

4.14 Several risks were considered during the September 2017 Consultation on vector shift protection. Based on the Strathclyde report ''Assessment of Risks Resulting from the Adjustment of Vector Shift (VS) Based Loss of Mains Protection Settings Phase II''[11] the workgroup agreed with the conclusion that:

4.14.1 VS protection is generally very ineffective, especially for settings of 12° and above. Analysis concluded that when using these higher settings, in an attempt to reduce the risk of inadvertent tripping, generators are disconnected by EREC G59 protection (as opposed to VS) in the majority of islanding situations. This coupled with the absence of real life cases where out-of- phase auto-reclosure has been recorded in the network for the past 25 years led the workgroup to conclude that VS should not be used as LoM protection.

4.14.2 The risk related to accidental electrocution for the LoM option where only EREC G59 voltage and frequency protection are used is estimated at $6.28x\ 10^{-7}$ and therefore lies within what is termed as the "broadly acceptable" region of personal risk accepted as consistent with the Health and Safety at Work Act 1974.

Implementation Costs

4.15 Manufacturers of all type tested generation units under ERECs G83 and G59 are likely to incur re-test costs. As part of the industry consultation, the working group sought manufacturers of type tested generating units' opinion and inputs on the cost implications associated with this option.

[11] https://www.nationalgrid.com/sites/default/files/documents/Appendix%202%20Strathclyde%20Report%202.pdf

4.16 Although only one manufacturer responded directly to the consultation, the manufacturer did not make any comment about cost.

4.17 From other contact with a number of manufacturers they are already engaged in changing, and certifying, the performance of their products to comply with the European RfG network code. They have indicated that making these changes is not an issue, although one or two have suggested aligning the compliance date with that of the RfG compliance date, ie May 2019.

5 Consultation Responses

5.1 The consultation ran from 31 January 2018 to 23 February 2018.

Consultation objective

5.2 The consultation had the specific target of manufacturers of type-tested plant. None had responded formally to the August 2017 consultation. The workgroup sought their opinion on modifications to the Distribution Code as summarised in section 4.12 of this report.

Consultation Responses

5.3 Manufactures of type tested plant did not respond to the first consultation. This resulted in the delay of implementing stability test requirements on type tested plant and the need for a second consultation.

5.4 During the second consultation (February 2018), only one response was received from manufacturers of type tested plant. In that response the manufacturer supported the workgroup proposal to increase the immunity level in order to increase the overall system stability. However they raised the following concerns:

a) That the proposed implementation date of 1 July 2018 be delayed to 27 April 2019. SMA was concerned that further recommendations could be proposed under RfG and were proposing this delay until these are fully implemented under RfG. While the workgroup recognises this, it was concluded that the workgroup‘s proposal could only be the first step towards fulfilling the RfG requirement and did not in any way contradict the RfG requirement.

b) That increasing the vector shift immunity level to 50° at nominal voltage could result in significant saturation of 50Hz transformers and thus trigger the tripping of overcurrent protection. The workgroup recognised this concern but concluded that this could be covered more completely under general fault ride through requirements for transmission faults – as is currently proposed to be explored by a Grid Code expert group. The workgroup also noted that the current type test requirements are not fully specified and the expert group are likely to include this in their considerations.

5.5 Annex 7 shows the detailed response from the manufacturer.

5.6 The workgroup, in discussing this response decided that, as this manufacturer had known from engagement back in November that implementation was proposed during 2018, and given the increasing risks to the system from not making the change, the original date of July 2018 should remain. The workgroup also believes that the technical issues associated with the retained voltages and vector shift during a transmission fault are better dealt with in the expert group proposed by National Grid.

6 Impact & Assessment

Impact on the Distribution Code

6.1 The workgroup recommends amendments to the Distribution Planning and Connection Code and Engineering Recommendations G59 and G83. It is for noting that once G98 and G99 have been published, they too will need to be updated in the same manner. That will be undertaken as a separate modification process.

6.1.1 The appropriate text for the Distribution Code is contained in Annex 2 and Annex 3 of this document. Note that two versions of the Distribution Code are included. This is because of the parallel consideration of the GC0102 changes. Annex 2 assumes that the authority accepts the GC0102 changes. Annex 3 uses the current D Code as base text – ie which will still be current should the authority not accept GC0102 in the expected time scale. There are no implications for EREC G59 and G83 from the GC0102 consultation.

6.1.2 The appropriate text for EREC G59 is contained in Annex 4 of this document.

6.1.3 The appropriate text for EREC G83 is contained in Annex 5 of this document.

Impact on National Electricity Transmission System (NETS)

6.2 This will result in limiting the total capacity of embedded generation that is at risk of being unnecessarily disconnected from the system by their LoM protection following an event on the transmission system.

Impact on Embedded power stations

6.3 The modification proposed will require type tested embedded generation connected to the system after the agreed implementation date to be type tested at 50° vector shift and a RoCoF of up to $1Hzs^{-1}$ with 500ms time delay immunity level.

Impact on Grid Code Users

6.4 The proposed modification will reduce the risk of embedded generators from tripping as a result of transmission related secure events.

Impact on Greenhouse Gas emissions

6.5 The proposed change will reduce emissions by reducing the number and duration of the occasions where additional fossil-fuelled plant has to run to provide additional inertia to the total system.

Assessment against Distribution Code Objectives

6.6 The workgroup considers that the proposed amendments would better facilitate the Distribution Code objective:

(i) To permit the development, maintenance and operation of an efficient, coordinated and economical system for the distribution of electricity;

LoM will also be more co-ordinated as there are less forms of LoM protection that do not co-ordinate – the protection is more simple and

reliable. The proposal will progressively reduce the risk of undetected islanding and inadvertent generation shutdown as new generation sites connect.

(ii) To facilitate competition in the generation and supply of electricity

The proposal has a neutral impact on this objective.

(iii) Efficiently discharge the obligations imposed upon DNOs by the Distribution Licence and comply with the Regulation (where Regulation has the meaning defined in the Distribution Licence) and any relevant legally binding decision of the European Commission and/or Agency for the Co-operation of Energy Regulators.

The proposal has a neutral impact on this objective.

(iv) Promote efficiency in the implementation and administration of the Distribution Code.

The proposal has a neutral impact on this objective.

Impact on core industry documents

6.7 The proposed modification does not affect any other core industry documents.

Impact on other industry documents

6.8 The proposed modification does not affect any other industry documents.

Implementation

6.9 The workgroup proposes that, should the proposals be taken forward, the proposed changes be implemented with the provisional target of 1 July 2018.

7 Workgroup Recommendations

7.1 This report recommends changes to the EREC G83/2, G59/3-3 and the Distribution Code to ensure that all type tested plant connecting onto the system is compliant with the specified immunity requirements. This should be implemented from 1 July 2018 or such other date as the Authority decrees.

8 Distribution Code Review Panel Recommendation

8.1 As the next scheduled meeting of the DCRP is not until 5 April and the need to meet 1 July implementation date the Code Administrator sought agreement from the Panel by circulating a formal request via email. This email request was sent out to the Panel on 14 March with a return date of 21 March for any objections. Subsequently there were no objections and as such the Panel therefore agrees that the changes contained in modification report should be recommended by the DNOs to the Authority.

Annex 1 – Workgroup Terms of Reference

i) The workgroup will investigate extending the first stage of work (Phase 1 underGC0035) to cover all distributed generation as Phase 2.

ii) The workgroup will undertake Phase 2 of the work. The context for Phase 2 includes the following considerations:

a) There is a convergence of technical considerations when transmission system faults give rise to both voltage and frequency phenomena. DC0079 is concerned primarily with the frequency effects on the Total System, or on DNO power islands.

b) It is recognised that National Grid will have to develop a formal operating standard in line with the European Codes defining the maximum RoCoF that the total system is secured against. This is an expected consequential requirement of implementing the EU Network Code currently titled "Network Code on Operational Security" in the GB frameworks.

c) There are a number of factors that will prevent generating plant riding through frequency changes. These include both the physical capabilities of electrical and mechanical components, the capability of control systems, and the effects of protection.

d) Generating equipment connected to distribution networks will generally have protection that fulfils two discrete functions. The first is to protect the generating equipment and ancillaries. The second is to provide the required network interface protection, ie as currently required by ERECs G59 or G83.

e) The focus of Phase 2 is to address the risks of unwanted tripping initiated by the network interface protection, but includes considering mitigation of any additional frequency resilience risks arising from generating equipment protection and control.

f) Phase 2 will investigate the suitability of VS shift protection as an alternative to RoCoF, taking into account its possible unsuitability for transmission fault ride through requirements.

iii) Phase 2 will therefore include the following activities:

a) Monitoring the implementation of the protection changes recommended under phase 1.

b) Researching the characteristics (numbers/types etc.) of existing embedded generation of less than 5MW rated capacity including their likely RoCoF withstand capabilities;

c) Researching the characteristics of existing embedded generation of all sizes where the embedded generation is fitted with VS anti-islanding protection.

d) Investigate the likely effect of transmission faults on VS protection techniques, and determine the risk of wide spread DG tripping from VS protection being inappropriately sensitive to transmission faults.

e) Investigating the characteristics of popular/likely inverter technology deployed, particularly in relation to RoCoF withstand capability and island stability;

f) Investigating the characteristics of popular/likely inverter technology deployed in relation to its behaviour in the presence of the voltage phenomena associated with transmission faults;

g) Assessing or modelling the interaction of multiple generators in a DNO power island;

h) Investigating and quantifying the risks to DNO networks and Users of desensitising RoCoF based protection on embedded generators of rated capacity of less than 5MW;

i) Analysing the merit of retrospective application of RoCoF criteria to existing embedded generation of less than 5MW (including comparison with similar programmes in Europe);

j) Considering any other relevant issues in relation to the resilience of the total system in respect of the operating characteristics of small generation;

k) Consider, if appropriate, revised VS protection settings, including any supporting risk assessment analysis;

l) To the extent that revised settings are proposed, create detailed specifications for the application of those revised settings;

m) Consider any other adverse effect on total system operability that existing ERECs G59 and G83 requirements may present, given the changed context since ERECs G59 and G83 were originally introduced, and include any such issues and their mitigation in the drafting and consultation (for example the current and future implications of Black Start on the existing over and under frequency settings);

n) Developing proposals for consultation on any proposed changes to RoCoF and VS protection drawing out the costs, benefits and risk of such a change to present to the GCRP and DCRP. Proposals should include a recommendation of where implementation costs should fall and the most appropriate workgroup for this issue to sit with;

o) Initiating consideration by DNOs of the future management of out-of-phase reclose risk; and

p) Engaging with the Health and Safety Executive (HSE) and all affected parties considering the different stakeholders that will be affected by any proposed changes.

iv) Phase 2 will deliver proposals concerning RoCoF based protection on embedded generators of rated capacity of less than 5MW and concerning VS protection for all embedded generation.

Annex 2 –Legal Text DCode 31 draft (not approved) for RfG

Proposed changes to Dcode are documented in a file called **Annex 2 Legal Text DCode 31 draft (not approved) for RfG** circulated together with this report.

Annex 3 –Legal Text DCode v30 approved

Proposed changes to Dcode are documented in a file **Annex 3 Text DCode v30 approved** circulated together with this report.

Annex 4 – Legal Text for EREC G59

Proposed changes to EREC G59 are documented in a file called **Annex 4 EREC G59_3-3 base text becoming G5_3_4 for DC0079 TT** circulated together with this report.

Annex 5 –Legal Text for EREC G83

Proposed changes to EREC G83 are documented in a file called **Annex 5 ER_G83-2-1 base text becoming G83_3 for DC0079 TT**circulated together with this report.

Annex 6 – Strathclyde Report

Please see report called **Annex 6 Strathclyde Report** circulated together with this report.

Annex 7 – Detailed Consultation Responses

Please see attachment called **Annex 7 Responses to the Consultation** circulated together with this report.