Stage 4: Final Modification Report	At what stage is this document in the process?
# GC0129: ## Updating the Grid Code to use Engineering Recommendation G5/5 - Harmonics	01 Proposal 02 Code Administrator Consultation 03 Draft Final Modification Report 04 Final Modification Report

Purpose of Modification: Engineering Recommendation G5 is being updated to Version 5, this change seeks to align the references to G5 within the Grid Code.

This Final Modification Report has been prepared in accordance with the terms of the Grid Code. An electronic version of this document and all other GC0129 related documentation can be found on the National Grid ESO website via the following link: https://www.nationalgrideso.com/codes/grid-code/modifications/gc0129-updating-grid-code-use-engineering-recommendation-g55

At the Grid Code Review Panel meeting on 29 October 2019, the Panel members unanimously agreed that the Original was better than the baseline and recommended that it should be implemented.

The purpose of this document is to assist the Authority in making its determination on whether to implement GC0129.

Low Impact
National Grid Electricity System Operator, Relevant Transmission Licensees, Distribution Network Owners and Users connecting harmonic sources and/or resonant plant

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Timetable

The Code Administrator recommends the following timetable:

Draft Final Modification Report presented to Panel	21 October 2019
Modification Panel decision	29 October 2019
Final Modification Report issued to the Authority	12 November 2019
Decision implemented in Grid Code	1 March 2020 or 6 months after Ofgem decision, whichever is the later

Any questions?

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Proposer Details

Details of Proposer: (Organisation Name)	National Grid Electricity System Operator
Capacity in which the Grid Code Modification Proposal is being proposed: (e.g. CUSC Party)	The Company
Details of Proposer's Representative: Name: Organisation: Telephone Number: Email Address:	 Philip Smith National Grid ESO 01189 363 522 Philip.Smith4@nationalgrid.com
Details of Representative's Alternate: Name: Organisation: Telephone Number: Email Address:	 Robert Wilson National Grid ESO 07799 656402 Robert.Wilson2@nationalgrideso.com
Attachments (Yes/No): **No**	

Impact on Core Industry Documentation.

Please mark the relevant boxes with an "x" and provide any supporting information

BSC	
CUSC	
STC	**X**
Other	

This modification is being made along with the update to Engineering Recommendation G5 and the corresponding change to the Distribution Code.

1 About this document

This document is the Final Modification Report document that contains the responses received from the Code Administrator Consultation which closed on 11 October 2019.

GC0129 was proposed by National Grid Electricity System Operator and was submitted to the Grid Code Modifications Panel for its consideration on 30 May 2019. The Grid Code Panel unanimously decided to send GC0129 straight to Code Administrator Consultation for 15 Working days once there was sufficient certainty on the corresponding change to the Distribution Code.

Code Administrator Consultation Responses

One response was received to the Code Administrator Consultation. A summary of the response can be found in Section 7 of this document. The respondent agreed that the proposal better facilitates the applicable Grid Code objectives.

Grid Code Review Panel View

The Panel members unanimously agreed that the Original was better than the baseline and recommended that it should be implemented.

This Final Modification Report has been prepared in accordance with the terms of the Grid Code. An electronic copy can be found on the National Grid ESO website: https://www.nationalgrideso.com/codes/grid-code/modifications/gc0129-updating-grid-code-use-engineering-recommendation-g55

2 Original Proposal

Section 2 (Original Proposal) and **Section 3 (Proposer's solution**) are sourced directly from the Proposer and any statements or assertions have not been altered or substantiated/supported or refuted by the Workgroup.

Defect

The Distribution Code Review Panel (DCRP) has recently held a consultation to update Engineering Recommendation (EREC) G5 to issue 5 (G5/5). EREC G5 defines planning levels and compatibility levels for the assessment of voltage distortion from User's equipment and installations with harmonic emission to be connected to transmission systems and distribution networks in the United Kingdom.

The Grid Code references EREC G5 issue 4 (G5/4) in several places; this modification seeks to align the references to G5 to issue 5.

What

EREC G5 has been modified as outlined below, this list is taken from the Distribution Code's Consultation on G5 that was sent on 13 March 2019. Please refer to the 'DCRP/MP/19/03 - EREC G5 Issue 5' tab at http://www.dcode.org.uk/dcode-modifications/2019-modifications/ for any updates made since this date.

Planning and compatibility levels for individual harmonics have been revised, while keeping the planning and compatibility levels for voltage total harmonic distortion (THD) the same as G5 Issue 4 (G5/4). As a result for some harmonics these levels have increased. No planning or compatibility level has decreased compared to G5 Issue 4.

i. *Defining voltage ranges for which the tables of planning and compatibility levels are applicable. These voltage levels have been adapted to align with typical voltages in use in the UK.*
ii. *The planning and compatibility levels are now extended to 5 kHz (the 100th harmonic). The measurement of harmonics above 2.5 kHz is at the discretion of the*

NO (see below for definition) facilitating the connection. It is also recommended to consider the assessment of these harmonics at the discretion of the NO.

iii. *Clearly defining interharmonics and revising interharmonic limits in accordance with IEC 61000-34-30, IEC 61000-4-7 and IEC 61000-2-2.*

iv. *Revising limit for voltage notches in terms of the notch depth and duration.*

v. *Updating the three stages of assessment. G5 Issue 5 similar to its predecessor, Issue 4, has three stages of connection process. These are Stage 1 for connection of equipment to LV, Stage 2 for connection of equipment which failed Stage 1 and any other connection to voltages below 33 kV, and Stage 3 for any other connection.*

vi. *Stage 1 has been completely revised; it is designed for connections at LV. It is designed as a linear process such that assessments are applied in stages and substages. If a substage is passed, then the new user can connect; if the substage is failed, then the next substage of assessment is undertaken. In total there are four substages in Stage 1.*

vii. *Stage 2 has been completely revised; it is designed for connection at voltages below 33 kV and for those new users that have failed Stage 1. It has also been designed as a linear process, such that assessments are applied in substages.*

viii. *A new section has been added to Issue 5 that sets criteria for the connection of resonant plant, such as power factor correction capacitors to LV and voltages up to 11 kV. This ensures that the network background harmonic levels are not amplified excessively.*

ix. *Stage 3 has been completely revised; it is designed for connections above 33 kV and for those new users that have failed Stage 2. The connection process has been clearly outlined.*

x. *In Stage 3, the harmonic limits are based on the apportionment of the harmonic headroom. This is a major difference between G5 Issue 5 and Issue 4.*

xi. *Defining the minimum requirement and format for harmonic specification that NO has to issue to a new user, to ensure consistency.*

xii. *Requirement for the compliance report has been included in Issue 5 to ensure consistency.*

xiii. *G5 Issue 4 did not provide any guidance on the concurrent connections, when two or more new users apply to connect to the network in the vicinity of each other in a short time window. G5 Issue 5 sets the connection process for such cases*

Why

The changes are required to align the Grid Code and the Distribution Code with the new requirements of EREC G5/5. In addition, it is recommended that text and diagrams in EREC G5/5 should not be duplicated in the Grid Code and that the Grid Code should only signpost the reader to EREC G5/5.

How

The current baseline of the Grid Code has been reviewed for references to EREC G5/4 and Electromagnetic Compatibility Leve. Changes are being proposed based on this; please see Section 9 for more detail.

Governance

Justification for Normal Governance Procedures

Though it could be argued that the Grid Code changes could meet the criteria for Fast-Track Self-Governance, it is proposed that this modification is made under normal governance arrangements.

The update to EREC G5 is subject to approval by the Authority (Ofgem) before publication. Choosing the Normal Governance route will allow the Authority to consider the changes to the Grid Code along with EREC G5.

Requested Next Steps

This modification should:

- Follow the normal governance route and proceed to Code Administrator Consultation

The material effects of this change come from the update to EREC G5, which has been subject to both a working group and public consultation.

Why Change?

The Distribution Code Review Panel (DCRP) has recently held a consultation to update Engineering Recommendation (EREC) G5 to issue 5 (G5/5). EREC G5 defines planning levels and compatibility levels for the assessment of voltage distortion from Network User's equipment and installations with harmonic emission to be connected to transmission systems and distribution networks in the United Kingdom.

This modification is required to align the Grid Code and the Distribution Code with the new requirements of EREC G5/5. In addition, it is recommended that text and diagrams in EREC G5/5 should not be duplicated in the Grid Code and that the Grid Code should only signpost the reader to EREC G5/5.

Code Specific Matters

Technical Skillsets

It is not proposed that a Workgroup is required for this modification. If a Workgroup is formed that the skill set required is likely to be:

- Grid Code Governance Procedures; and
- Harmonics caused by the connection of resonant plant and equipment.

Reference Documents

The Consultation on updating EREC G5 can be found here:

http://dcode.org.uk/assets/files/DCode-Consultations/2019/DCRP_19_03_PC_Consultation_Pack.zip

3 Proposers Solution

Section 2 (Original Proposal) and **Section 3 (Proposer's solution**) are sourced directly from the Proposer and any statements or assertions have not been altered or substantiated/supported or refuted by the Workgroup.

It is proposed to update the references within the Grid Code to refer to EREC G5/5. Please see Section 11 for the proposed changes to the text of the Grid Code.

4 Impacts & Other Considerations

This modification is being proposed alongside the update to G5 and the change to the Distribution Code. It is proposed that these will be presented to Ofgem as a package so the changes can be considered alongside each other.

Does this modification impact a Significant Code Review (SCR) or other significant industry change projects, if so, how?

This modification is not expected to impact any SCR's or other significant industry change projects or other Consumers directly.

Consumer Impacts

This modification is not expected to impact Consumers directly.

5 Relevant Objectives

Impact of the modification on the Applicable 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
(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 which neither prevent nor restrict competition in the supply or generation of electricity);	None
(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
(d) To efficiently discharge the obligations imposed upon the licensee by this license and to comply with the Electricity	None

Regulation and any relevant legally binding decisions of the European Commission and/or the Agency; and	
(e) To promote efficiency in the implementation and administration of the Grid Code arrangements	None

Updating the Grid Code concurrently with the EREC G5 and the Distribution Code changes will align the GB framework. This should lead to an efficient, coordinated solution.

6 Implementation

It is proposed that this modification should be implemented concurrently with the changes to EREC G5 and the Distribution Code.

The proposed modification would be implemented 6 months from the time of Approval by the Authority or 1 March 2020 whichever is the later.

This will come into effect for connection offers issued by National Grid ESO to their customers from 1 March 2020 or earlier if mutually agreed by both parties.

No costs are foreseen in relation to the implementation of this Grid Code Modification.

7 Code Administrator Consultation: Responses

The Code Administrator Consultation was issued on 20 September 2019 for 15 Working Days and close on 11 October 2019.

1 response was received (from the Proposer) to the Code Administrator Consultation and is detailed in the table below:

Respondent	Do you believe that GC0129 better facilitates the Grid Code objectives?	Do you support the proposed implementation approach?	Do you have any other comments?
National Grid ESO	Yes. GC0129 updates the Grid Code to reference the correct version of the Engineering Recommendation (EREC) G5. This better facilitates Objectives (a) and (c)	Yes. This was agreed via the Distribution Code Review Panel (DCRP) consultation and has been discussed at the Grid Code Panel.	The DCRP held a consultation to update EREC G5 to issue 5 (G5/5). The G5 Working Group provided industry with the opportunity to feed into the review of the G5 standard, including the conditions and timeline for implementation. This has now been completed and the specifications for G5/5 have been agreed. The intention is now for GC0129 to be submitted to the Authority simultaneously with the Distribution Code modification (DCRP/MP/19/03), both of which update references in the codes to the latest version

			of G5, in order that both can be reviewed at the same time.

8 Grid Code Review Panel Views

At the Grid Code Review Panel meeting on 29 October 2019, Panel voted on GC0129 against the Applicable Grid Code Objectives. The Panel members unanimously agreed that the Original was better than the baseline and recommended that it should be implemented.

For reference the Applicable Grid Code Objectives are:

(a) To permit the development, maintenance and operation of an efficient, coordinated and economical system for the transmission of electricity

(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 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;

(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

(e) To promote efficiency in the implementation and administration of the Grid Code arrangements

Vote 1: ***Does the Original facilitate the objectives better than the Baseline?***

Panel Member: Alastair Frew

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Neutral	Neutral	Neutral	Neutral	Yes
	Voting Statement					
This modification introduces the new standard approach to dealing with harmonic content.						

Panel Member: Christopher Smith

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Yes	Yes	Yes	Yes	Yes
	Voting Statement					
This is a welcome Grid Code modification.						

Panel Member: Damian Jackman

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Neutral	Yes	Neutral	Neutral	Yes
	Voting Statement					
The G5/5 standard provides alignment between the distribution and transmission codes which will be welcome to developers as it avoids different standards for different voltages and a level playing field for connection costs across the GB system.						

Panel Member: Joe Underwood

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Neutral	Yes	Neutral	Neutral	Yes
	Voting Statement					
The modification updates the EREC in the Grid Code.						

Panel Member: Robert Longden

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Neutral	Neutral	Neutral	Neutral	Yes
	Voting Statement					
GC0129 updates the Grid Code to reference the correct version of engineering Recommendation G5. As such it better facilitates Applicable Objective (i)						

Panel Member: Rob Wilson

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Yes	Yes	Yes	Neutral	Yes
	Voting Statement					
GC0129 updates references in the Grid Code to the latest version of the standard dealing with harmonics, EREC G5, to amend this from G5/4 to G5/5. Comments were not invited during the development of GC0129 on the content of the updated G5 standard for which separate consultations were carried out, administered by the Electricity Networks Association (ENA). The updated references to the Grid Code in GC0129 are being provided to Ofgem at the same time as their approval is sought by the ENA to the update of the standard hence allowing a single decision to be made.						

Panel Member: Richard Woodward (Alternate to Ross McGhin)

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Neutral	Yes	Neutral	Yes	Yes
	Voting Statement					
Aligns Grid Code with D-Code modifications to update the Engineering Standards. In respect of the D-Code mod, we believe the updated Engineering Recommendation would serve the industry better by providing clear guidelines for connection process, allocation of harmonic headroom and compliance process considering fast changing power system and emerging technologies.						

Panel Member: Graeme Vincent (Alternate to Steve Cox)

	Better facilitates ACO (a)	Better facilitates ACO (b)?	Better facilitates ACO (c)?	Better facilitates ACO (d)?	Better facilitates ACO (e)?	Overall (Y/N)
Original	Yes	Neutral	Yes	Neutral	Neutral	Yes
	Voting Statement					
Aligns Grid Code with the Distribution Code and makes reference to the latest version of Engineering Recommendation G5. This will ensure that consistent arrangements apply at both Distribution and Transmission levels.						

<u>Vote 2</u> – *Which option is the best?*

Panel Member	BEST Option?
Alastair Frew	Original
Christopher Smith	Original
Damian Jackman	Original
Joe Underwood	Original
Robert Longden	Original
Rob Wilson	Original
Richard Woodward (Alternate to Ross McGhin)	Original
Graeme Vincent (Alternate to Alan Creighton)	Original

The Grid Code Review Panel therefore recommended unanimously agreed that the Original could be implemented.

Note that 1 Panel Member (Guy Nicholson) abstained from voting.

9 Legal Text

This modification will update the Grid Code with the changes as set out in Annex 1.

10 Cost Impacts

Industry costs (Standard CMP)	
Resource costs	£908.00 Consultation • 1.5 man days effort per consultation response • 1 consultation respondent
Total Industry Costs	**£908.00**

11 Annex 1 – Legal Text

Section	Defect
Glossary and Definitions	
Electromagnetic Compatibility Level	Has the meaning set out in **Engineering Recommendation G5**~~Engineering Recommendation G5/4.~~
Engineering Recommendation G5	Means Engineering Recommendation G5/5.
Planning Code	
APPENDIX C - TECHNICAL AND DESIGN CRITERIA PART 1 – SHETL's TECHNICAL AND DESIGN CRITERIA Item 6	ER G5~~/4~~ (Supported by ACE Report No.73)
APPENDIX C - TECHNICAL AND DESIGN CRITERIA PART 2 – SPT's TECHNICAL AND DESIGN CRITERIA Item 6	ER G5~~/4~~ (Supported by ACE Report No.73)
APPENDIX E - OFFSHORE TRANSMISSION SYSTEM AND OTSDUW PLANT AND APPARATUS TECHNICAL AND DESIGN CRITERIA Item 3	ER G5~~/4~~
Connection Conditions	
CC.6.1.5	The **Electromagnetic Compatibility Levels** for harmonic distortion on the **Onshore Transmission System** from all sources under both **Planned Outage** and fault outage conditions, (unless abnormal conditions prevail) shall comply with ~~the levels shown in the tables of Appendix A of~~ **Engineering Recommendation G5**~~/4~~. **Engineering Recommendation G5**~~/4~~ contains planning criteria which **The Company** will apply to the connection of non-linear **Load** to the **National Electricity Transmission System**, which may result in harmonic emission limits being specified for these **Loads** in the relevant **Bilateral Agreement**. The application of the planning criteria will take into account the position of **GB Code** and **EU Code Users' Plant** and **Apparatus** (and **OTSDUW Plant and Apparatus**) in relation to

	harmonic emissions. **GB Code Users** must ensure that connection of distorting loads to their **User Systems** do not cause any harmonic emission limits specified in the **Bilateral Agreement**, or where no such limits are specified, the relevant planning levels specified in **Engineering Recommendation G5**~~/4~~ to be exceeded.
European Connection Conditions	
ECC.6.1.5	The **Electromagnetic Compatibility Levels** for harmonic distortion on the **Onshore Transmission System** from all sources under both **Planned Outage** and fault outage conditions, (unless abnormal conditions prevail) shall comply with ~~the levels shown in the tables of Appendix A of~~ **Engineering Recommendation G5**~~/4~~. **Engineering Recommendation G5**~~/4~~ contains planning criteria which **The Company** will apply to the connection of non-linear **Load** to the **National Electricity Transmission System**, which may result in harmonic emission limits being specified for these **Loads** in the relevant **Bilateral Agreement**. The application of the planning criteria will take into account the position of **GB Code** and **EU Code Users' Plant** and **Apparatus** (and **OTSDUW Plant and Apparatus**) in relation to harmonic emissions. **GB Code Users** must ensure that connection of distorting loads to their **User Systems** do not cause any harmonic emission limits specified in the **Bilateral Agreement**, or where no such limits are specified, the relevant planning levels specified in **Engineering Recommendation G5**~~/4~~ to be exceeded.
Operating Code No. 5	
OC5.5.4 Harmonic Content	CC.6.1.5(a) or ECC.6.1.5(a) Measured harmonic emissions do not exceed the limits specified in the **Bilateral Agreement** or where no such limits are specified, the relevant planning level specified in

	Engineering Recommendation G5~~G5/4~~.

12 Annex 2 – Code Administrator Consultation Responses

This sets out the Code Administrator Consultation Responses received as part of the Code Administrator Consultation which ran from 20 September 2019 to 5pm on 11 October 2019.

