Appendix 5

PRODUCED BY THE OPERATIONS DIRECTORATE OF ENERGY NETWORKS ASSOCIATION

Engineering Recommendation G59

Issue 3 Amendment ~~4~~ 5 ~~July 2018~~27 May 2019

RECOMMENDATIONS FOR THE CONNECTION OF GENERATING PLANT TO THE DISTRIBUTION SYSTEMS OF LICENSED DISTRIBUTION NETWORK OPERATORS

PUBLISHING AND COPYRIGHT INFORMATION

© 2015 Energy Networks Association

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of Energy Networks Association. Specific enquiries concerning this document should be addressed to:

Operations Directorate
Energy Networks Association
~~**6th Floor, Dean Bradley House**~~
~~**52 Horseferry Rd**~~
~~**London**~~
~~**SW1P 2AF**~~**4 More London Riverside**
London
SE1 2AU

This document has been prepared for use by members of the Energy Networks Association to take account of the conditions which apply to them. Advice should be taken from an appropriately qualified engineer on the suitability of this document for any other purpose.

First published, June 1985

Amendments since publication

Issue	Date	Amendment
G59/1	1991	Revised incorporating Amendment 1 (1992) and Amendment 2 (1995)
G59/2	Aug 2010	Revised - replaced two previous Engineering Recommendations, ER G59/1 and its associated Engineering Technical Report ETR 113, and ER G75/1.
G59/2-1	March 2011	Revised Amendment 1 – Appendix A13.1 - Change to DC injection current limits
G59/3	Sept 2011	Major revision to the document to align with G83/2 and to cater for type tested equipment upto 50kW. Other areas revised included: • *Connection application and commissioning procedures* • *Connection and Commissioning Procedure for Power Stations above EREC G83/2 limits but less than 50kW or 17kW per phase using Type Tested Generating Units only* • *Connection and Commissioning Procedure for Power Stations above 50kW which use Type Tested Generating Units only* • *Voltage Unbalance* • *Generation capacity for single and split phase supplies* • *Generating Unit performance requirements for Type Tested Units* • *Over and Under Voltage Stability Tests* • *Frequency Drift and Step Change Stability Test.* • *Protection Settings* • *Revised Forms* • *Simplified application form*

G59/3	Nov 2013	Correction of error. The error relates to the British Standard which is to be used to determine the 'flicker' contribution from small wind turbines. References to this standard are found at 9.6.2.1 and 13.8.5.5 of ER G59/3. The standard that should be referred to is BS EN 61400-12. However, the standard that was referred BS EN 61400-21was incorrect. Therefore, to correct this error, the two references (i.e. at 9.6.2.1 and 13.8.5.5) have been changed and the description of the standard corrected at 3.2 (page 9) of ER G59/3. This will now read: ***BS EN 61400-12-1:2006*** *Wind turbines. Power performance measurements of electricity producing wind turbines.*
G59/3-1	Aug 2014	Revised RoCoF settings in Section 10.5.7
G59/3-2	Sept 2015	Revocation of Section 12.4 (f) – It is no longer a requirement to undertake an additional functional check of the LoM protection by removing one phase of the supply to the Generating Unit. Revision to section 12.3.1 (g) to include the provision of two options to carry out a functional test confirming that the Interface Protection has operated. Testing of RoCoF elements in Appendix 13.3. A discrepancy has been corrected between the wording contained in Section 12.4 and the testing requirements contained in Appendix 13.3 on how to undertake the test . Section 13.8.3.2 is repeated on page 130. Change to 13.8.3.3 and revise subsequent numbering.
G59/3-3	Feb 2018	Modifications to prevent the use of vector shift protection on all new installations from 01/02/2018, and setting out the requirements for RoCoF settings, again for installations commissioned on or after 01/02/2018. Consequential changes to the following clauses. Foreword; 2.10; 10.3.12-14; 10.5.1; 10.5.2; 10.5.7; 10.5.8; 12.4.1; 13.1; 13.3; 13.7.1; 13.7.3; 13.11 (13.11 deleted)
G59/3-4	Jul 2018	Modification to disallow the use of VS protection and to provide new RoCoF requirements for type tested generation. Changes to the following clauses: Foreword; 1.1, 2.10, 9.3.7, 10.3.13, 13.1 Protection (b), 13.8.3.6
G59/3-5	27 May 2019	Note added to the foreword and to 2.11 to make it clear that generation connected on or after 27 April 2019 must comply with G99. Modifications to Section 4 to remove unnecessary dated references. Modification to 12.4.1(b)(ii) to harmonize text with requirements of Section 13.3.

Foreword

This Engineering Recommendation (EREC) is published by the Energy Networks Association (ENA) and comes into effect from 01 July 2018. It has been prepared and approved for publication under the authority of the Great Britain Distribution Code Review Panel.The approved abbreviated title of this engineering document is “EREC G59”, which replaces the previously used abbreviation “ER G59”.

Generation commissioned on after 27 April 2019 must comply with EREC G99. EREC G59 is not applicable to generation commissioned on or after that date.

1 Purpose

1.1 The purpose of this Engineering Recommendation (EREC) is to provide guidance on the connection of **Generating Plant** to the **Distribution Systems** of licensed **Distribution Network Operators (DNOs)**. It is intended to address all aspects of the connection process from standards of functionality to site commissioning, such that **Customers, Manufacturers** and **Generators** are aware of the requirements that will be made by the local **DNO** before the **Generating Plant** will be accepted for connection to the **Distribution System**. This Engineering Recommendation replaces Engineering Recommendations G59/3, G59/3-1, G59/3-2 and G59/3-3.

1.2 The guidance given is designed to facilitate the connection of **Generating Plant** whilst maintaining the integrity of the **Distribution System**, both in terms of safety and supply quality. It applies to all **Generating Plant** within the scope of Section 2, irrespective of the type of electrical machine and equipment used to convert any primary energy source into electrical energy.

1.3 This EREC is intended to provide guidance to **Generator**s and **DNO**s. The mandatory requirements governing the connection of Distributed **Generating Plant** are generally set out in the Distribution Planning and Connection Code 7 (DPC7) of the **Distribution Code** and in the Connection Conditions (CC) of the **Grid Code**. In the event of any conflict with this EREC, the provisions of the **Distribution Code** and **Grid Code** will prevail.

2 Scope

2.1 This EREC provides guidance on the technical requirements for the connection of **Generating Plant** to the **Distribution System**s of licensed **DNO**s. For the purposes of this EREC, a **Generating Plant** is any source of electrical energy, irrespective of the prime mover and **Generating Unit** type. This EREC applies to all **Generating Plant** which is not in the scope of EREC G83 or is not compliant with EREC G83 requirements.[1] EREC G59 describes a simplified connection procedure for connection of a **Type Tested single Generating Unit** of less than 17kW per phase or 50kW three phase, or the connection of multiple **Type Tested Generating Units** with a maximum aggregate capacity of less than 17kW per phase or 50kW three phase, per **Customer** installation, provided that any existing connected **Generating Units** are also **Type Tested.** It is effective from 1 July 2018.

2.2 This EREC does not provide advice for the design, specification, protection or operation of **Generating Plant** itself. These matters are for the owners of plant to determine.

---

1 Engineering Recommendation EREC G83 – Recommendations for the connection of small-scale embedded generators (up to and including 16 A per phase) in parallel with public low-voltage distribution networks. This Engineering Recommendation provides guidance on the technical requirements for the connection of **Generating Units** rated up to and including 16 A per phase, single or multi-phase, 230/400 Volts AC. The recommendations cover the connection of **Generating Units**, either single or multi-phase within a single Customer's installation up to the limit of 16A per phase, and multiple **Generating Unit**s in a close geographic region with a limit of 16A per phase in each customer installation, under a planned programme of work.

2.3 Specific separate requirements apply to **Generating Plant** comprising **Generating Unit**s less than or equal to 16A per phase and these are covered in EREC G83. However, **Generating Unit**s ≤16A per phase that have not been **Type Tested** in accordance with EREC G83 or whose technology type is not covered by one of the EREC G83 annexes should comply with the requirements set in this document. Section 6 of this document provides more guidance on how to apply this document to **Generating Unit**s that are below the 16A threshold but do not meet the requirements of EREC G83.

2.4 The connection of mobile generation owned by the **DNO**, EREC G83 compliant **Generating Unit**s or offshore **Transmission System**s containing generation are outside the scope of this Engineering Recommendation.

2.5 This document applies to systems where the **Generating Plant** can be paralleled with a **Distribution System** or where either the **Generating Plant** or a **Distribution System** with **Generating Plant** connected can be used as an alternative source of energy to supply the same electrical load.

2.6 The generic requirements for all types of **Generating Plant** within the scope of this document relate to the connection design requirements, connection application and notification process including confirmation of commissioning. The document does not attempt to describe in detail the overall process of connection from application, through agreement, construction and commissioning. It is recommended that the ENA publications entitled – "*Distributed Generation Connection Guides*" are consulted for more general guidance.

2.7 **Medium and Large Power Station**s are, in addition to the general requirements of this EREC, bound by the requirements of the **Grid Code**. In the case of **Large Power Station**s, the **Grid Code** will generally apply in full. For **Medium Power Station**s, only a subset of the **Grid Code** applies directly, and the relevant clauses are listed in DPC7 of the **Distribution Code**.

2.8 This EREC is written principally from the point of view of the requirements in Great Britain. There are some differences in the requirements in Great Britain and Northern Ireland, which are reflected in the separate Grid Codes for Great Britain and Northern Ireland, and the separate Distribution Code for Northern Ireland. These documents should be consulted where necessary, noting that the numbering of sections within these documents is not necessarily the same as in the **Distribution Code** for Great Britain and the **Grid Code** for Great Britain.

2.9 The separate synchronous network operating in the Shetland Isles has specific technical challenges which are different to those of the Great Britain synchronous network. This EREC is not in itself sufficient to deal with these issues

2.10 EREC G59/3-4 (ie this version of G59) has been updated to remove vector shift as an allowed loss of mains (LoM) technique for type-tested generation. This follows changes to non-type-tested generation which were made with effect from February 2018.

2.11 Generation commissioned on after 27 April 2019 must comply with EREC G99. EREC G59 is not applicable to generation commissioned on or after that date.

3 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

3.1 Statutory Requirements

Health and Safety at Work etc Act (HASWA): 1974

The Health and Safety at Work etc Act 1974 also referred to as HASAW or HSW, is the primary piece of legislation covering occupational health and safety in the United Kingdom. The Health and Safety Executive is responsible for enforcing the Act and a number of other Acts and Statutory Instruments relevant to the working environment.

Electricity Safety, Quality and Continuity Regulations (ESQCR): 2002

The Electricity Safety, Quality and Continuity Regulations 2002 (Amended 2006) - Statutory Instrument Number 2665 -HMSO ISBN 0-11-042920-6 abbreviated to ESQCR in this document.

Electricity at Work Regulations (EaWR): 1989

The Electricity at Work regulations 1989 abbreviated to EaWR in this document.

3.2 Standards publications

BS 7671: ~~2008~~ Requirements for Electrical Installations

IEE Wiring Regulations: Seventeenth Edition.

BS 7430: ~~1999~~

Code of Practice for Earthing.

BS 7354

Code of Practice for Design of Open Terminal Stations.

BS EN 61000 series*

Electromagnetic Compatibility (EMC).

BS EN 61508 series*

Functional safety of electrical/ electronic/ programmable electronic safety-related systems.

BS EN 60255 series*

Measuring relays and protection equipment.

BS EN 61810 series*

Electromechanical Elementary Relays.

BS EN 60947 series*

Low Voltage Switchgear and Controlgear.

BS EN 61869-2:~~BS EN 60044-1: 1999~~

Instrument Transformers. Current Transformers.

BS EN 60034-4:~~2008~~

Methods for determining synchronous machine quantities from tests.

BS EN 61400-12-1:~~2006~~

Wind turbines. Power performance measurements of electricity producing wind turbines.

IEC 60909 series*

Short-circuit currents in three-phase a.c. systems. Calculation of currents.

IEC TS 61000-6-5: ~~2001~~

Electromagnetic Immunity Part 6.5 Generic Standards. Immunity for Power Station and Substation Environments.

IEC 60364-7-712: ~~2002~~

Electrical installations of buildings – Special installations or locations – Solar photovoltaic (PV) power supply systems.

ENA Engineering Recommendation G5

Planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission and distribution networks in the United Kingdom.

ENA Engineering Recommendation G74

Procedure to meet the requirements of IEC 909 for the calculation of short-circuit currents in three-phase AC power systems.

ENA Engineering Recommendation G83

Recommendations for connection of small-scale embedded Generators (up to 16 A per phase) in parallel with public low voltage distribution networks.

ENA Engineering Recommendation P2

Security of Supply.

ENA Engineering Recommendation P18

Complexity of 132kV circuits.

DNO at the time of commissioning (where tests are witnessed) or within 28 days of the commissioning date (where the tests are not witnessed).

12.4 Additional Commissioning requirements for Non Type Tested Generating Units

12.4.1 Additional commissioning tests are required for **Generating Units** that have not been **Type Tested** to EREC G59 or EREC G83 or a later version. The following describes how these should be carried out for the standard range of protection required. Where additional protection is fitted then this should also be tested, additional test requirements are to be agreed between the **DNO** and **Generator**.

The results of these tests shall be recorded in the schedule provided in Appendix 13.2 and 13.3 using the relevant sections for **HV** and **LV** protection along with any additional test results required.

a) Calibration and stability tests shall be carried out on the over voltage and under voltage protection for each phase, as described below:

(i) The operating voltage shall be checked by applying nominal voltage to the protection (so that it resets) and then slowly increasing this voltage (for over voltage protection) or reducing it (for under voltage protection) until the protection picks up. The voltage at which the protection picks up shall be recorded. Where the test equipment increases / decreases the voltage in distinct steps, these shall be no greater than 0.5% of the voltage setting. Each pickup value shall be within 1.5% of the required setting value.

(ii) Timing tests shall be carried out by stepping the voltage from the nominal voltage to a value 4V above the setting voltage (for overvoltage protection) and 4V below the setting (for under voltage protection) and recording the operating time of the protection. The operating time of the protection shall be no shorter than the setting and no greater than the setting + 100ms.

(iii) Stability tests (no-trip tests) shall also be carried out at the voltages and for the durations defined in Appendix 13.3. The protection must not trip during these tests.

b) Calibration and stability tests shall be carried out on the over frequency and under frequency protection as described below:

(i) The operating frequency shall be checked by applying nominal frequency to the protection (so that it resets) and then slowly increasing this frequency (for over frequency protection) or reducing it (for under frequency protection) until the protection picks up. The frequency at which the protection picks up shall be recorded. Where the test equipment increases / decreases the frequency in distinct steps, these shall be no greater than 0.1% of the frequency setting. Each pick up value shall be within 0.2% (ie 0.1Hz) of the setting value.

(ii) Timing tests shall be carried out by stepping the frequency from 0.3Hz below the setting frequency ~~50Hz~~ to a value 0.3~~2~~Hz above the setting frequency (for over frequency protection) and 0.3~~2~~Hz

above the setting frequency to 0.3Hz below the setting (for under frequency protection) and recording the operating time of the protection. The operating time of the protection shall be no shorter than the setting and no greater than the setting + 100ms or the setting + 1% of the setting, whichever gives the longer time.

(iii) Stability tests (no-trip tests) shall also be carried out at the frequencies and for the durations defined in the commissioning test record, Appendix 13.3. The protection must not trip during these tests.

c) Calibration tests for rate of change of frequency protection, where used, shall be carried out as follows:

(i) Rate of change of frequency shall be checked by first applying a voltage with a frequency of 51.0Hz to the protection and then ramping this frequency down at 0.1Hzs^{-1} less than the RoCoF protection setting until a frequency reaches 49.0Hz. This test is repeated at increasing values of rate of change of frequency (in increments of 0.025Hzs^{-1} or less) until the protection operates. The test shall be repeated for rising frequency but this time each tests shall be start at 49.0Hz and end at 51.0Hz. The operating values should be within 0.025Hzs^{-1} of the required setting.

(ii) Timing tests shall be carried out by applying a falling and a rising frequency at rate of 0.05Hzs^{-1} above the setting value. The protection operating times shall be no longer than 0.5s (for historic RoCoF with no time delay) or where 0.5s time delay is required, 1.0s.

d) Calibration for vector shift protection, where used, shall be carried out as follows:

(i) The tests shall be carried out at nominal voltage. An instantaneous shift in the voltage vector shall be applied using an appropriate test set. A vector shift below the setting value shall applied initially (eg starting at 4 degrees). The test shall be repeated with increasing vector shift values (in increments of 1 degree or less) until the pickup value is determined. The tests shall be carried out for both leading and lagging shifts in the voltage vector.

(ii) Timing tests shall be carried out by applying a vector shift of 3 degrees above the setting and recording the operating time of the protection. Test shall be carried out for both a leading and a lagging shift in voltage.

Any **Generating Plant** commissioned after 01 Feb 2018 must not employ vector shift relays as a LoM technique. Any **Generating Plant** commissioned before 01 Feb 2018 must not be retrofited with vector shift as a LoM technique.

e) RoCoF and vector shift stability checks shall be performed on all interface protection relays in accordance with Appendix 13.3 irespective of the type of loss of mains protection employed for a particular **Generating Unit** or **Power Station**.