To incorporate the EU Network Code Requirement for Generators (RfG) with existing GB documentation a number of new Engineering Recommendations are being drafted.

G98-1 covers the connection procedure and technical requirements for Type Tested Generating Units up to 16 A per phase which are referred to as Micro-generators. (G83/2)

G98-2 covers the connection procedure and technical requirements for multiple Type Tested Micro-generating Plants in a Close Geographic Region and Type Tested Generating Units above 16 A per phase but with a maximum capacity less than 50 kW. (G83/2 and G59/3).

G99 covers the connection procedure and technical requirements for all non-Type Tested Generating Units that G59/3 covers at present.

This draft references EN 50438 which is the EU equivalent of G83/2. This is to demonstrate GB coming more into line with the EU.

It is intended to have text in the Distribution Code similar to the existing DPC7.1.3 which sends the appropriate reader to G98-2 and removes any further Distribution Code obligations in respect of generation to which this document is applicable.

This EREC G98-2 draft uses text from a number of sources and is therefore colour coded to demonstrate where the words have come from as follows.

G98-2 Connection procedure and technical requirements for multiple Type Tested Micro-generating Plants in a Close Geographic Region and Type Tested Generating Units above 16 A per phase but with a maximum capacity less than 50 kW.

Blue text = from G83 (and G59 where equivalent)

Purple text = from G59 definitions

Orange text = from RfG (including those suggested by ENTSO-E after the 15/01/21 version)

Green text = from other EU documents referenced by RfG

Black text = Changes/ additional words

Red text = Words that may/ will need changing

NEW doc.	G83	G59	RfG June 2015	Suggested text	EN 50438	Notes
Publishin						

g and copyright						
Contents						
1				**Foreword**		
1.1	1			This Engineering Recommendation (EREC) G98-2 is published by the Energy Networks Association (ENA) and comes into effect on x/x/xx for: (1) multiple **Micro-generating Plants** in a **Close Geographic Region** and (2) **Type Tested Generating Unit**s greater than 16 A per phase with an aggregate rated capacity of less than 17 kW per phase or 50 kW three phase; per customer installation, **,** first installed on or after that date.		DNO/DSO discussion ongoing DNO used at present Refer to both Micro-generator and Generating Unit as Generating Unit
1.2				It has been prepared and approved under the authority of the **Great Britain Distribution Code Review Panel.** This EREC G98-2 replaces EREC G83 and G59, to take account of the EU Network Code on Requirements for Grid Connection of Generators DATE		Note – need to update if we include any other EU Codes
1.3				**Generating Units** covered by this document are (1) one or more Type Tested **Micro-generators** in multiple **Micro-generating Plants** in a **Close Geographic Region** and (2) Type Tested **Generating Units** that are greater than 16A per phase but where the aggregate rated capacity is less than or equal to 50kW 3 phase (or 17 kW 1 phase). **Generating Units** that meet all of the requirements set out in this document can be considered to be **Type Tested**; those that do not are considered non-**Type Tested** and are covered by EREC G99		
1.4				In order to comply with this EREC G98-2 connections shall comply with the requirements of EN 50438 and the additional requirements set out in this document. The purpose of this EREC G98-2 is to explain the additional technical requirements for connection of **Generating Units** for operation in		This approach of requiring compliance with EN 50438 means there are some new

				parallel with a public low-voltage **Distribution Network**, by addressing all technical aspects of the connection process from standards of functionality to site commissioning. For one or more **Type Tested Micro-generators** forming a **Micro-generating Plant** in single premises, refer to EREC G98-1. For non-**Type Tested Generating Units** refer to EREC G99. Note: **Generating Units** larger than 50 kW 3 phase cannot be deemed to be **Type Tested**.		requirements (Such as under frequency) which neither G83 nor RfG specify
1.5				The procedures described are designed to facilitate the connection of **Generating Units** whilst maintain the integrity of the **GB** public low-voltage **Distribution Network**, both in terms of safety and supply quality.		Distribution System definition in UK codes excludes the DNO's distribution system therefore "public low-voltage Network" is used. RfG refers to system generally and does not define it. GB added to clarify applicability of this document
1.6				This EREC G98-2 provides sufficient information to allow: a) **Manufacturers** of **Generating Units** to design and market a product for connection to design and market a product that is suitable for connection to the **GB** public low-voltage **Distribution Network**; b) **Users**, **Manufacturers** and Installers of **Generating Units** to be aware of the requirements that will be made by the **Distribution Network Operator (DNO)** before the **Generating Unit** installation will be accepted for connection to the **DNO's Distribution Network**.		
2				**Legal aspects**		

2.1	1		A3 (1) A40 (1) covered	**Generating Units** which do not meet the requirements set out in EREC G98-1 and EREC G98-2 are considered non-**Type Tested** and must connect under the procedure set out in EREC G99.		ESQCR text not required for multiple SSEG / <50kW, as an application is required prior to installation.
2.2				In addition to the requirements specified in this document which allows connection to the **GB** public low-voltage **Distribution Network**, the **Generating Unit** and all of its components shall comply with all relevant legal requirements including European Directives and CE marking.		
3				Confidentiality obligations		TITLE ONLY
3.1			A12 (1)	Any confidential information received, exchanged or transmitted pursuant to this EREC G98-2 shall be subject to the conditions of professional secrecy laid down in paragraphs 1.3.2, 1.3.3 and 1.3.4.		This was identified during the mapping as probably being covered by the existing licences and an action was taken to review this by DECC
3.2			A12 (2)	The obligation of professional secrecy shall apply to any person subject to the provisions of this EREC G98-2.		These clauses cover both parties
3.3			A12 (3)	Confidential information received by the persons referred to in paragraph 1.3.2 in the course of their duties may not be divulged to any other person or authority, without prejudice to cases covered by national law, the other provisions of this EREC G98-2 or other relevant Union law.		
3.4			A12 (4)	Without prejudice to cases covered by national or Union law, regulatory authorities, bodies or persons who receive confidential information pursuant to this EREC G98-2 may use it only for the purpose of carrying out their duties under this EREC G98-2.		
4	2	2.1 6.1	A6 (5)	**Scope**		
4.1				This EREC G98-2 provides guidance on the **GB** technical requirements for the connection of **Type Tested Generating Units** in parallel with public low-voltage **Distribution Networks**. The requirements set out in this	EN 50438 also considers:	Note Additional EN 50438 requirements. For

				EREC G98-2 are in addition to those of European standard EN 50438 which should be complied with.	Controllable reactive power, connection and starting to generate electrical power, voltage control by active power, synchronisation, single fault tolerance of interface protection system	discussion
4.2				**Generating Units** covered in this EREC G98-2 are: (1) multiple **Micro-generating Plants** in a **Close Geographic Region** and (2) **Type Tested Generating Unit**s greater than 16 A per phase with an aggregate rated capacity of less than 17 kW per phase or 50 kW three phase; per customer installation provided that any existing connected **Generating Units** are also **Type Tested**.		
4.3				For the purposes of this EREC G98-2 a **Micro-generator** is a source of electrical energy rated up to and including 16 Ampere per phase, single or multi- phase, 230/400 V **AC**. This corresponds to 3.68 kilowatts (kW) on a single-phase supply and 11.04 kW on a three-phase supply. The kW rating shall be based on the nominal voltage (ie 230 V) as defined in BS EN 50160 and the **Electrical Supply Quality and Continuity Regulations (ESQCR)**.		
4.4				Combined heat and power generating facilities shall be assessed on the basis of their electrical **maximum capacity**.		CHP included to cover off micro CHP.
4.5				Where the **Micro-generator** includes an **Inverter** its rating is deemed to be the **Inverter's** continuous steady state rating.		

4.6				Where a new **Generating Unit** is to be connected to an existing installation then the aggregate capacity of the complete installation must be used to determine which EREC is applicable irrespective of technology. Where this EREC G98-2 is applicable only the new **Generating Unit** will be required to meet the requirements of this EREC G98-2.		
4.7				For the avoidance of doubt where there is a single **Connection Point** and more than one inverter that sums to less than 16 Amperes per phase, single or multi phase, 230/400 V **AC**; they shall be considered as a single **Micro-generator**.		Included this "for the avoidance of doubt" to cover the possibility of numerous small inverters connecting to a single connection point without compliance to RfG in respect of the power park module definition
4.8				The connection of one or more **Type Tested Micro-generators** forming a **Micro-generating Plant** in a single premises is covered by EREC G98-1.		
4.9				This EREC G98-2 only specifies the connection requirements applicable to those **Micro-generator** and **Generating Unit** installations that are designed to normally operate in parallel with a public low-voltage **Distribution Network**. Those installations that are designed to operate in parallel with the **DNO's Distribution Network** for short periods (ie less than 5 minutes) or as an islanded installation or section of network are considered to be out of scope, on the basis that it is not possible to devise generic rules that will ensure safe operation under all operating conditions.		
4.10				**Micro-generators** that are not **Type Tested** to conform to the requirements of this document can only be connected via the guidelines laid down in EREC G99.		

4.11				EN 50438 Annex D describes a methodology for testing the particular types of electrical interface between the **Generating Unit** and the public low-voltage **Distribution Network.** The purpose of the **type tests** is to demonstrate compliance with the generic requirements of this EREC G98-2. By satisfying the test conditions in EN 50438 Annex D, supplementary tests in Annex A of this EREC G98-2 and completing the **Type Test** sheets in Appendix 5 of this EREC G98-2 the **Generating Unit** can be considered an approved **Generating Unit** for connection to the **GB** public low-voltage **Distribution Network**.		BSEN 50438 has type testing requirements annex. Some specific requirements from G83 will still be needed e.g. s/c test for inverters The type testing methodology is covered by Annex D in EN 50438. The G83 type test sheets should remain as an appendix of this document. Tests required by RfG e.g. LFSM-O should be included
4.12				In the event that a new **GB** type testing annex is required then this should be formally initiated by the **GB Distribution Code Review Panel (DCRP)**.		Check this still applies re EN50438 type testing annex
4.13				The Appendices contain pro forma that relate to the connection, commissioning, type testing, and decommissioning of **Generating Units**.		
4.14				This document does not remove any statutory rights of an individual or organisation; equally it does not remove any statutory obligation on an individual or organisation.		
4.15				Connection agreements (i.e. the legal documentation supporting the connection of a **Generating Unit**), energy trading and metering are considered to be out of scope. These issues are mentioned in this document only in the context of raising the reader's awareness to the fact that these matters might need to be addressed.		
4.16			A66 (1) covered	For **Generating Units** classified as emerging technology some clauses of this EREC G98-2 shall not apply. Details of emerging technology and their		

				requirements are given in Appendix 1.		
5				**References**		
5.1 to 5.3	3			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. **Standards publications** **BS 7671: 2008 Requirements for Electrical Installations** IEE Wiring Regulations Seventeenth (Amendment 3 2015) Edition. **BS EN 50160: 2010+A1:2015** Voltage characteristics of electricity supplied by public electricity networks. **EN 50438:2013** Requirements for the connection of micro-generators in parallel with public low-voltage distribution networks. **BS EN 60034-4:2008** Rotating electrical machines. Methods for determining synchronous machine quantities from tests. **BS EN 60255 series*** Measuring relays and protection equipment. **BS EN 60664-1: 2007** Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests (IEC 60664-1:2007). **BS EN 60947 series*** Low-voltage switchgear and controlgear. **BS EN 61000-3-2:2006+A2:2009** Limits for harmonic current emissions (equipment input current up to and including 16 A per phase).		As per G83, but including RfG And ref from Art 7 BS EN 60044-1 has been superseded by BS EN 61869-2

				BS EN 61000-3-3:2008 Electromagnetic compatibility (EMC) Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current < 16A per phase and not subject to conditional connection. **BS EN 61000 series*** Electromagnetic Compatibility (EMC). BE 7430:1999 Code of Practice for Earthing BS EN 61896-2 2012 Instrument Transformers Additional requirements for current transformers IEC 60364-7-712:2002 Electrical installations of buildings – special installations or locations – Solar photovoltaic (PV) power supply systems **BS EN 61508 series*** Functional safety of electrical/ electronic/ programmable electronic safety-related systems. **BS EN 61810 series*** Electromechanical Elementary Relays. BS EN 61896-2 2012 Instrument Transformers Additional requirements for current transformers **BS EN 62116** Test procedure of islanding prevention measures for utility-interconnected photovoltaic **Inverters**. **IEC 60255 series*** Measuring relays and protection equipment **IEC 60725**		

				Considerations or reference impedances for use in determining the disturbance characteristics of household appliances and similar electrical equipment. **IEC 60909 series*** Short circuit currents in three-phase AC systems. Calculation of currents **IEC 62282-3-2 ed1.0: 2006** Fuel cell technologies - Part 3-2: Stationary fuel cell power systems - Performance test methods. ***Where standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable.*** **Other publications** **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)** The Electricity Safety, Quality and Continuity Regulations 2002 - 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. **Engineering Recommendation G5/4-1 (2005)** Planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission and distribution networks in the United Kingdom.		

				Engineering Recommendation G99 **Engineering Recommendation P28 (1989)** Planning limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the United Kingdom. **Engineering Recommendation P29 (1990)** Planning limits for voltage unbalance in the UK for 132kV and below. **Engineering Recommendation G74 (1992)** Procedure to meet the requirements of IEC 60909 for the calculation of short-circuit currents in three-phase **AC** power systems. **COMMISSION REGULATION (EU) No …/.. of XXX** Establishing a network code on Requirements for Grid Connection of Generators **Directive 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009** Concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC **Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009** on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003 **Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008** Setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93		

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>4</td><td></td><td></td><td>Terms and definitions
<table>
<tr><td>Active Power</td><td>‘active power’ means the real component of the apparent power at fundamental frequency, expressed in watts or multiples thereof such as kilowatts ('kW') or megawatts ('MW');</td></tr>
<tr><td>Active power frequency response</td><td>‘active power frequency response’ means an automatic response of active power output, from a Micro-generator, to a change in system frequency from the nominal system frequency;</td></tr>
<tr><td>Close Geographic Region</td><td>A close geographic region is defined as the area typically served by a single low voltage feeder circuit fed from a single distribution transformer. In a situation where this definition cannot be reliably applied by an Installer, the Installer can either confirm with the DNO whether a proposed Micro-generator is in a Close Geographic Region or ensure that at least one of the following criteria is met:
1) The postcodes of any of the premises where a Micro-generator installation is planned by the same organisation are the same when the last two letters are ignored…i.e. AB1 2xx, where xx could be any pair of letters or where x could be any letter.
2) The premises where a Micro-generator installation is planned by the same organisation are within 500m of each other.</td></tr>
<tr><td>Connection Agreement</td><td>‘connection agreement’ means a contract between the Distribution Network Operator and the User, which includes the relevant site and specific technical requirements for the Micro-generating Plant or Generating Plant;</td></tr>
<tr><td>Connection Point</td><td>‘connection point’ means the interface at which the Generating Unit or demand facility is connected to a Distribution Network, as</td></tr>
</table></td><td></td><td>Use of Connection points vs point of supply to be reviewed</td></tr>
</table>

					identified in the connection agreement.			
				Customer	**'customer'** means a wholesale or final **customer** of electricity			
				Customer's Installation	The electrical installation on the **Customer**'s side of the supply terminals together with any equipment permanently connected or intended to be permanently connected thereto.			
				Direct Current or DC	The movement of electrical current flows in one constant direction, as opposed to Alternating Current or AC, in which the current constantly reverses direction.			
				Distribution Code Review Panel or Panel	The standing body established under the Distribution Code.			
				Distribution Network	**'distribution network'** means an electrical network, including closed distribution networks, for the distribution of electrical power from and to third party[s] connected to it, a transmission or another **distribution network.**			
				Distribution Network Operator (DNO)	The person or legal entity named in Part 1 of the distribution licence and any permitted legal assigns or successors in title of the named party. A distribution licence is granted under Section 6(1)(c) of the Electricity Act 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004).			
				Droop	'**droop**' means the ratio of the steady-state change of **frequency**, referred to as nominal **frequency**, to the steady-state change in **active power** output, referred to as **maximum capacity**, expressed in percentage terms;			
				DNOs Distribution Network	The system consisting (wholly or mainly) of electric lines owned or operated by the **DNO** and used for the distribution of electricity			
				Electricity Safety, Quality and Continuity	The statutory instrument entitled The **Electricity Safety, Quality and Continuity Regulations** 2002 as amended from time to			

				Regulations (ESQCR)	time and including any further statutory instruments issued under the Electricity Act 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004) in relation to the distribution of electricity.			
				Entry Point	The point at which a User connects to the DNO's Distribution System where power flows into the DNO's Distribution System under normal circumstances.			
				Frequency	'**frequency**' means the electric **frequency** of the system expressed in hertz that can be measured in all parts of the synchronous area under the assumption of a consistent value for the system in the time frame of seconds, with only minor differences between different measurement locations. It's nominal value is 50Hz;			
				Generating Plant	sum of **Generating Unit**s connected at one point of connection, including auxiliaries and all connection equipment.			
				Generating Unit	an indivisible set of installations which can generate electrical energy running independently and which can feed this energy into a **Distribution Network**. This includes **Micro-generators.**			
				Great Britain or GB	The landmass of England & Wales and Scotland, including internal waters.			
				Installation document	'**installation document**' means a simple structured document containing information about a **Micro-generator** and confirming its compliance with the relevant requirements set out in this EREC G98-2.			
				Installer	The person who is responsible for the installation of the **Micro-generator**(s).			
				Interface Protection	The electrical protection required to ensure that any **Micro-generator** is disconnected for any event that could impair the integrity or degrade			

					the safety of the **Distribution Network.** The interface protection is typically not all installed at the interface between the **DNO** and **Customer's** network.			
				Inverter	A device for conversion from **Direct Current** to nominal frequency Alternating Current.			
				Limited Frequency Sensitive Mode - overfrequency (LFSM-O)	'**limited frequency sensitive mode – overfrequency**' or '**LFSM-O**' means a **Micro-generator** operating mode which will result in **active power** output reduction in response to a change in system **frequency** above a certain value. In GB this value is 50.4Hz.			
				Low Voltage or LV	A voltage normally exceeding extra-low voltage (50V) but not exceeding 1000V AC or 1500V DC between conductors or 600V AC or 900V DC between conductors and earth.			
				Manufacturer	A person or organisation that manufactures **Micro-generators** and also 'packages' components manufactured by others to make **Micro-generators** which can be **Type Tested** to meet the requirements of this EREC G98-2.			
				Maximum capacity	'**maximum capacity**' or '**Pmax**' means the maximum continuous **active power** which a **Micro-generator** can feed into the **network** as defined in the connection agreement or as agreed between the **DNO** and the **User**;			
				Meter Operator	A person, registered with the registration authority, appointed by either a **Supplier** or **Customer** to provide electricity meter operation services.			
				Micro-generating Plant	**micro-generating plant** electrical installation with one or more micro-generators with nominal currents in sum not exceeding 16 A per phase.			
				Micro-generator	**micro-generator** source of electrical energy and all associated interface equipment able to be connected to a			

					regular electric circuit in a low voltage electrical installation and designed to operate in parallel with a public low voltage distribution network with nominal currents up to and including 16 A per phase			
				Network	'**network**' means a plant and apparatus connected together in order to transmit or distribute electricity;			
				Network Operator	**network operator**' means the natural or legal person that operates a **network** and can be either a transmission system operator or a **Distribution Network Operator.**			
				Point of Supply	The point of electrical connection between the apparatus owned by the DNO and the User.			
				Supplier	(a) A person supplying electricity under an Electricity Supply Licence; or (b) A person supplying electricity under exemption under the Electricity Act 1989 (as amended by the Utilities Act 2000 and the Energy Act 2004); in each case acting in its capacity as a **Supplier** of electricity to **Customers.**			
				System	An electrical network running at various voltages.			
				Type Tested	A **Micro-generator or Generating Unit** design which has been tested by an organization accredited in accordance with EC Regulation No 765/2008 to ensure that the design meets the requirements of this EREC G98-2, and for which the **Manufacturer** has declared that all products supplied will be constructed to the same standards, and with the same protection settings as the tested product.			
				User	person with responsibility for the premises in which the **Micro-generator** or **Generating Unit** is installed, normally referred to in other documentation as the customer / consumer / network user.			

7	5			**Connection, Protection & Testing Requirements**		Title only
7.1	5.1.2	6.1.4 12.3.2 6.2.4		This document is aimed at two scenarios of generation: • One or more **Type Tested Micro-generators** in multiple **Micro-generating Plants** in a **Close Geographic Region** • **Type Tested Generating Unit**s (>16 A per phase but ≤ 50 kW 3 phase (or 17 kW 1 phase)).		Multiple Premises and G59 type tested Connection Procedure
7.2				The use of **Type Tested** equipment simplifies the connection process, the protection arrangements and reduces the commissioning test requirements. The process is described in this document.		
				The **Installer** shall discuss the installation project with the local **DNO** at the earliest opportunity. The initial connection application will need to be in a format similar to that shown in Appendix 3. The application should include the **Type Tested** Reference Number. Where a reference number is not available the **User** or **Installer** shall provide the **DNO** with a **Type Test** report as per Appendix 5 confirming that the **Generating Unit** has been **Type Tested** to satisfy the requirements of this EREC G98-2. On receipt of the application, the **DNO** will assess whether any **Distribution Network** studies are required and whether there is a requirement to witness the commissioning tests. Connection of the **Generating Unit** is only allowed after the application for connection has been approved by the **DNO** and any **DNO** works facilitating the connection have been completed.		
7.3				Guidance to **Manufacturers** on type testing is included in Annexes A-C of this document.		Annexes to be reviewed
7.4				Where commissioning tests are not witnessed, confirmation of the commissioning of each **Generating Unit** will need to be made no later than 28 days after commissioning; the format and content shall be as shown in Appendix 4. Where tests are witnessed, the **Installer** or **User**, as appropriate, shall complete the declaration at the bottom of the form, sign and date it and provide a copy to the **DNO** at the time of commissioning.		

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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td><td>Frequency withstand</td><td></td><td></td></tr>
<tr><td>8.1 to 8.3</td><td></td><td></td><td>A13
(1a)</td><td>The Generating Unit shall comply with the frequency withstand requirements as follows:

The Generating Unit shall be capable of remaining connected to the Distribution Network and operate within the frequency ranges and time periods specified in Table 1 unless disconnection was triggered by rate-of-change-of-frequency-type loss of mains protection.

Table 1: Minimum time periods for which a Generating Unit has to be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network.
<table><tr><td>47.0 Hz – 47.5 Hz</td><td>20 seconds</td></tr><tr><td>47.5 Hz – 48.5 Hz</td><td>90 minutes</td></tr><tr><td>48.5 Hz -49.0 Hz</td><td>90 minutes</td></tr><tr><td>49.0 Hz – 51.0 Hz</td><td>Unlimited</td></tr><tr><td>51.0 Hz – 51.5 Hz</td><td>90 minutes</td></tr><tr><td>51.5 Hz – 52.0 Hz</td><td>15 minutes</td></tr></table></td><td>4.2.3 Continuous frequency operation range

The generating plant shall be capable to operate continuously when the frequency at the point of connection stays within the range of 49 Hz to 51 Hz.

Linear generators, coupled directly and synchronously to the grid, and powered by free piston stirling engines are permitted to disconnect below 49,5 Hz and above 50,5 Hz.
NOTE The exception for linear generators is under discussion in the framework of the development of European network codes and may be removed by the next revision of this standard.

4.2.4 Response to Under frequencies

A generating plant shall be resilient to reductions of</td><td>EN 50438 has different requirements for under and over frequency times which is covered in the note, but mean that specific GB thresholds should be stated</td></tr>
</table>

					frequency at the point of connection while reducing the maximum power as little as possible. **Table 1** **Minimum time periods for operation in under-frequency situation** **Frequency range** / **Time period for operation** 47,5 Hz – 49 Hz / 30 min Table 1 shows the minimum time periods a generating plant has to be able to operate without disconnecting from the network NOTE Respecting the legal framework, it is possible that a more stringent requirement regarding minimum time periods for operation in under-frequency situation are required by the DSO in coordination with the TSO. …..active power reductions…. **4.2.5 Power response to over-frequency** A generating plant shall be resilient to	

					over- frequency at the point of connection **Table 2 Minimum time periods for operation in over-frequency situation** **Frequency range** | **Time period for operation** 51 Hz – 51.5 Hz | 30 min Table 2 shows the minimum time periods a generating plant has to be able to operate without disconnecting from the network NOTE 1 Respecting the legal framework, it is possible that a more stringent requirement regarding minimum time periods for operation in over frequency situation are required by the DSO in coordination with the TSO.	
9				**Interface Protection and Control**		
9.1.1 to 9.1.2	5.3			The **Micro-generator** shall comply with the **GB** specific interface protection settings set out in EN 50438 however means shall be provided to protect the settings from unpermitted interference (eg password or seal).	**4.6 Interface protection** **4.6.1 General** **4.6.1.1 Introduction** The purpose of the	

				The **DNO** is responsible under the **Distribution Code** for ensuring, by design that the **voltage** and **frequency** at the **Connection Point** remains within statutory limits. The **Interface Protection** settings have been chosen to allow for voltage rise or drop within the **Customer's Installation** and to allow the **Generating Unit** to continue to operate outside of the statutory frequency range as required by the *EU Network Code on Requirements for Grid Connection of Generators*.	interface protection is to ensure that the connection of a micro-generator will not impair the integrity or degrade the safety of the distribution network. The interface protection shall be insensitive to voltage and frequency variations in the distribution network within the voltage and frequency settings. The interface protection, monitoring and control functions may be incorporated into the micro-generator control system, or may be fitted as discrete separate mounted devices. The interface protection settings shall be field adjustable. For field adjustable settings means shall be provided to protect the settings from unpermitted interference (e.g.	

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<td>password or seal) if required by the DSO.</td>
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<td>9.1.3 to 9.1.4</td>
<td>5.3.1</td>
<td>10.5.7.1</td>
<td>A13 1(a)</td>
<td>
Interface Protection shall be installed which disconnects the Generating Unit from the DNO's Distribution Network when any parameter is outside of the settings shown in Table 2.

Table 2 Protection Settings
<table>
<tr><th>Protection Function</th><th>Trip Setting</th><th>Trip Setting (Time)</th></tr>
<tr><td>U/V stage 1</td><td>Vφ-n† -13% = 200.1V</td><td>2.5s</td></tr>
<tr><td>U/V stage 2</td><td>Vφ-n† - 20% = 184V</td><td>0.5s</td></tr>
<tr><td>O/V stage 1</td><td>Vφ-n† +14% = 262.2V</td><td>1.0s</td></tr>
<tr><td>O/V stage 2</td><td>Vφ-n†+ 19% = 273.7V1</td><td>0.5s</td></tr>
<tr><td>U/F stage 1</td><td>47.5Hz</td><td>20s</td></tr>
<tr><td>U/F stage 2</td><td>[47Hz]</td><td>[0.5s]</td></tr>
<tr><td>O/F stage 1</td><td>[52Hz]</td><td>[0.5s]</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Loss of Mains*
(Vector Shift)</td><td>12 degrees</td><td>0.0s</td></tr>
<tr><td>Loss of Mains*
(RoCoF)</td><td>[1 Hz per second]</td><td>0.0s</td></tr>
</table>
† A value of 230V phase to neutral

* Other forms of Loss of Mains techniques may be utilised but the aggregate of the protection operating time, disconnection device operating time and trip delay setting shall not exceed 1.0 second.

The trip delay setting should be applied as the TIME DELAY SETTING in
</td>
<td>G83/2 protection settings are Given in A12 G</td>
<td>
G83 U/F stage 1 was 47.5 Hz for 20s and U/F stage 2 was 47 Hz for 0.5s. RfG requires operation at ≥47.0Hz for 20s – so no change necessary.

G83 O/F stage 1 was 51.5 Hz for 90s and stage 2 was 52 Hz for 0.5s. G83 out of alignment with G Code. G Code and RfG have the same requirement – ie 15 mins operation at ≥ 51.5Hz. To retain 0.5s trip at 52Hz there is no room left for a two stage trip, so need a single O/F trip at 52.0Hz

RoCoF settings need update from working group.

Propose to change our Trip delay setting to Time delay setting to tie up with EN 50438 in both this and G98-1

LoM note to be reviewed
</td>
</tr>
</table>

				EN 50438, Section 3, Figure 1- Main times defining the interface protection performance.		with RoCoF WG
9.1.5	5.3.1			The total disconnection time for voltage and frequency protection including the operating time of the disconnection device shall be the trip delay setting with a tolerance of, -0 s + 0.5s.	Section 4.6.1.1 The minimum required accuracy is: • for frequency measurement ± 0,05 Hz; • for voltage measurement ± 1 % of Un.	Note G59 tolerance is +100ms
9.1.6				For the avoidance of doubt voltage and frequency excursions lasting less than the trip delay setting shall not result in disconnection.		
9.1.7				Only devices that have protection settings set and locked during manufacture can be considered as **Type Tested.**	**6. Commissioning** This European Standard applies to type-tested micro-generators. • access to the interface protection settings shall be tamper-proof;	For discussion – MK comment – is this necessary?
9.1.8				The **Manufacturer** needs to establish a secure way of displaying the settings in one of the following ways. a) A display on a screen which can be read; b) A display on a PC which can communicate with the device and		

				confirm that it is the correct device by means of a serial number permanently fixed to the device and visible on the PC screen at the same time as the settings; c) Display of all settings including nominal voltage and current outputs, alongside the serial number of the device, permanently fixed to the device.		
9.1.9				The provision of loose documents, documents attached by cable ties etc, a statement that the device conforms to a standard, or provision of data on adhesive paper based products which are not likely to survive due to fading, or failure of the adhesive, for at least 20 years is not acceptable.		
9.1.10		9.4.9		In response to a protection operation the **Generating Unit** shall be automatically disconnected from the **DNO's Distribution Network**, this disconnection must be achieved preferably by the separation of mechanical contacts or alternatively by the operation of a suitably rated solid state switching device. Where a solid state switching device is used to afford disconnection of the **Generating Unit**, the switching device shall incorporate fail safe monitoring to check the voltage level at its output stage. In the event that the solid state switching device fails to disconnect the **Generating Unit**, the voltage on the output side of the switching device shall be reduced to a value below 50 volts within 0.5 seconds of the protection and trip delay timer operation. For the avoidance of doubt this disconnection is a means of providing Loss of Mains disconnection and not as a point of isolation to provide a safe system of work.	**4.6.1.2 Response to protection operation** The micro-generator shall disconnect from the network in response to an interface protection operation.	
9.1.11 9.1.12				Where a common protection system is used to provide the protection function for multiple **Generating Units** the complete installation cannot be considered to comprise **Type Tested Generating Units** as the protection and connections are made up on site and so cannot be factory tested or **Type Tested**. Once the **Generating Unit** has been installed and commissioned the protection settings shall only be altered following written agreement	**4.6.1.3 Place of the interface protection** The interface protection can either be incorporated within the micro-generator or implemented by separate devices. In either case, the	

				between the **DNO** and the **User** or his agent.	interface protection shall meet the relevant requirements of IEC 60255-127 and the manufacturer of the micro-generator shall declare that the combined devices fulfil these requirements. Annex D.2.2: The manufacturer shall declare the ambient operating temperature range of the micro-generator and verify where appropriate that the interface protection control system operates satisfactory throughout this temperature range.	
9.2				**Loss of Mains Protection**		
9.2.1	5.3.2			Loss of mains protection shall be incorporated and tested as defined in the compliance type testing annex of EN 50438. Active methods which use impedance measuring techniques by drawing current pulses from or injecting **AC** currents into the **DNO's** system are not considered to be suitable. For **Generating Unit**s which generate on more than one phase, the loss of mains protection should be able to detect the loss of a single phase of the supply network. This should be tested during type testing and recorded in Appendix 5.		
9.3				**Frequency Drift and Step Change Stability Test**		
9.3.1 to	5.3.3			Under normal operation of the network the frequency changes over time due to continuous unbalance of load and generation or can see a step		

9.3.5				change due to the loss of a network component which does not cause a loss of supply.		
9.3.2				In order to ensure that the phenomena do not cause un-necessary tripping of **Generating Unit**, stability Type Tests shall be carried out.		
9.3.3				The Rate of Change of Frequency (RoCoF) and Vector Shift values required for this test are marginally less than the corresponding protection settings for RoCoF protection and Vector shift protection in Table 1. These are two common methods used to detect loss of mains in **Generating Unit**s though other techniques are also acceptable. Both stability tests shall be carried out irrespective of the methods used to detect loss of mains.		
9.3.4				National Grid has advised that these test values are acceptable in the short term but that in future it is likely that larger rates of change of frequency might need to be withstood without tripping, as system inertia decreases at times when a high proportion of the load is being met by generation without inertia.		
9.3.5				The stability tests are to be carried out as per the table in Appendix 4 of this document and the generator should remain connected during each and every test. • RoCoF –[0.99]Hz per second from 49.5Hz to 51.5Hz and from 50.5Hz to 47.5Hz • Vector shift – 9 degrees plus from 49.5Hz and 9 degrees minus from 50.5Hz		This is not included in BSEN 50438 and so is left in this document RoCoF stability tests 0.99 Hz used to reflect the 1 Hz requirement This to be reviewed once the new RoCoF withstand

						is established by the RoCoF WG
9.4 and 9.4.1			A13 1(b)	**Rate of Change of Frequency** With regard to the rate of change of frequency withstand capability, a **Generating Unit** shall be capable of staying connected to the **network** and operate at rates of change of frequency up to [1 Hz/s]		Updated text with initial view on parameters from NG National Parameter Selection document. Input required from NGT / **DNO**s / Ofgem.
9.5 and 9.5.1			A13 (2)	**Limited Frequency Sensitive Mode - Overfrequency** With regard to the **limited frequency sensitive mode — overfrequency (LFSM-O)**, the **Generating Unit** shall be capable of activating the provision of **active power frequency response** according to EN 50438. The **GB** specific standard **frequency** threshold shall be [50.4 Hz]; the **droop** setting shall be [10 %]. No intentional delay should be programmed to ensure that the initial delay is as short as possible with a maximum of 2s.	The generator shall be capable of activating active power frequency response as fast as technically feasible with an initial delay that shall be as short as possible with a maximum of 2 s. If the initial delay is below 2 s an intentional delay shall be programmable to adjust the total response time to a value between the initial response time and 2 s. A 12 GB Power reduction at over-frequency – GB does not implement power reduction at	There are some small conflicts between A 12 (GB specific requirements) in EN 50438 and RfG. Do we know if there are plans for BSEN 50438 to be updated to take account of RfG? New clause in RfG: instead of the capability referred to in paragraph (a), the relevant TSO may choose to allow within its control area automatic disconnection and reconnection of power generating modules of Type A at randomised frequencies, ideally uniformly distributed, above a frequency threshold, as determined by the relevant TSO where it is able to demonstrate to the relevant regulatory authority,

					over-frequency and is therefore excluded from this requirement	and with the cooperation of power generating module owners, that this has a limited cross-border impact and maintains the same level of operational security in all system states; Need decision within WG0048 if this approach is being adopted
9.6			A6 (4)	**Active Power Output**		TITLE ONLY
9.6.1			A13 (3)	The **Generating Unit** shall be capable of maintaining constant output at its target **active power** value regardless of changes in **frequency**, except where output follows the changes defined in the context of paragraphs 5.3.4 and 5.3.5.2 as applicable.		Could improve the way this para refers to the above and below paras
9.6.2			A13 (4)	The **Generating Unit** shall be capable of maintaining constant output at its target **active power** value regardless of changes in **frequency** in the range [49.5 – 50.4 Hz]. Power Output should not drop by more than prorata with frequency, i.e. maximum permitted requirement is 100% power at 49.5 Hz falling linearly to 95 % at 47.0 Hz.	A12 GB GB Frequency Range - 47,0 Hz – 52,0 Hz - The Frequency of the GB DNO's Distribution System shall be nominally 50 Hz and shall normally be controlled within the limits of 49,5 Hz - 50,5 Hz in accordance with principles outlined in the Electricity Safety, Quality and Continuity Regulations.	NGET (national parameters doc) has suggested 49.5 – 50.4 Hz, which it states is consistent with CC.6.3.3. As already noted there are some small conflicts between A 12 (GB specific requirements) in EN 50438 and RfG. BSEN 50438 to be updated to take account of RfG

9.6.3			A13 (6)	The **Generating Unit** shall be equipped with a logic interface (input port) in order to cease active power output within five seconds following an instruction being received from the **Network Operator** at the input port. The **DNO** shall have the right to define requirements for equipment to make this facility operable remotely.		
9.6.4				Other than under sections 9.6.1 and 9.6.2 of this EREC G98-2, requirements relating to the capability to maintain constant active power output or to modulate active power output shall not apply to **Generating Units** of facilities for combined heat and power production embedded in the networks of industrial sites, where all of the following criteria are met: (a) the primary purpose of those facilities is to produce heat for production processes of the industrial site concerned; and (b) heat and power generation is inextricably interlinked, that is to say any change of heat generation results inadvertently in a change of active power generation and vice versa.		
9.7				Automatic Connection		
9.7.1.to 9.7.3	5.3.4	13.8.3.5	A13 (7)	[Settings for connection are: • Frequency range: 47.5 Hz ≤ f ≤ 50.05 Hz; • Voltage range: 0.85 U_n ≤ U ≤ 1.10 U_n; • Minimum observation time: 60 s. After reconnection the active power generated by the **Generating Unit** shall not exceed a specified gradient expressed as a percentage of the active nominal power of the unit per minute. If no gradient is specified by the **DNO**, the default setting is 10 % P_n/min. Non-adjustable or partly adjustable **Generating Units** may connect after 1 min to 10 min (randomised value) or later.] **Generating Units** should comply with the **GB** automatic reconnection in EN 50438 ie the protection system shall ensure that the **Generating Unit**	**4.7.2 Automatic reconnection after tripping** If no settings are specified by the DSO, the default settings for the reconnection after tripping of the interface protection are: • Frequency range: 47,5 Hz ≤ f ≤ 50,05 Hz; • Voltage range: 0,85 U_n ≤ U ≤ 1,10 U_n; • Minimum	The maximum admissible gradient of increase in active power output to be determined by NGET/ GC0048. We have used EN 50438 standard in [] for now Non-adjustable generating units are those that can only output a single power level. This is inferred from ENTSO-E Load frequency

				remains disconnected from the **DNO's Distribution Network** until the **voltage** and **frequency** on the **DNO's Distribution Network** have remained within the **GB** interface protection limits for a minimum of 20 seconds.	observation time: 60 s. After reconnection the active power generated by the generating plant shall not exceed a specified gradient expressed as a percentage of the active nominal power of the unit per minute. If no gradient is specified by the DSO, the default setting is 10 % P_n/min. Non-adjustable or partly adjustable generating units may connect after 1 min to 10 min (randomised value) or later. A12 GB **Automatic reconnection** - With reference to 4.7.2, the interface protection shall ensure that feeding power to the distribution network will only commence, after the voltage and frequency on the distribution network have been within the limits of the interface protection settings for a minimum of 20 s for any generation system.	control policy. 20 s vs 60 s for consideration

10				**Quality of Supply**		
10.1.1 to 10.1.2	5.4			The power quality requirements set out in EN 50438 should be met along with the procedures described in this section of EREC G98-2. **Generating Units** are likely to be installed in large numbers on **LV** networks and they are likely to operate for long periods with no diversity between them, and adjacent **Generating Units** are likely to be of the same technology. Therefore in order to accommodate a high number of **Generating Units** on a network the following procedures need to be applied when testing for harmonic current emissions and flicker. The procedure for **Micro-generators** is in paragraphs 10.2 and 10.3. The procedure for other **Generating Units**, to which this EREC G98-2 is applicable, is in paragraphs 10.4 and 10.5.	**4.8 Power quality** **4.8.1 General** As any other apparatus or fixed installation, micro-generators have to comply with the requirements on electromagnetic compatibility established in Directive 2004/108/EC. **Table 5 · Harmonics and flicker emission standards** Harmonics ≤ 16 A EN 61000-3-2 Voltage fluctuations and Flicker ≤ 16 A EN 61000-3-3 In addition, the application of the requirements and tests described in IEC/TR 61000-3-15 is recommended, with the exception of those aspects already regulated by specific national rules. Generating plants can	EN 50438 requires the same standards to be met but doesn't take into account the fact that there may be many micro-generators all close together. Therefore need to keep the procedures described in G83.

					also disturb mains signaling (ripple control or power line carrier systems). EMC requirements on inter-harmonics and on conducted disturbances in frequency range between 2 kHz and 150 kHz are under development. In countries where such communication systems are used, national requirement may apply.	
10.2				**Testing for Harmonic emissions for Micro-generators**		
10.2.1 to 10.2.3	5.4.1			The test must be carried out with a minimum of 2kW of rated **Micro-generators**. Where an individual **Micro-generator** is smaller than 2kW it should be tested as a group. However where a **Micro-generator** is designed to be installed singly in an installation then this can be tested alone, for example a domestic CHP unit. The maximum group size for the test is 3.68kW. The results for all **Inverters** should be normalised to a rating of 3.68kW. The **Micro-generator** or group shall meet the harmonic emissions of table 1 in BS EN 61000-3-2 with a scaling factor applied as follows for each harmonic current; Table 1 current limit × rating of **Micro-generator** being tested (kW) per phase / 3.68		
10.3				**5.4.2 Testing for flicker of Micro-generators**		

10.3.1 to 10.3.15	5.4.2			The test must be carried out with a minimum of 2kW of rated **Micro-generators**. Where an individual **Micro-generator** is smaller than 2kW it should be tested as a group. However where a **Micro-generator** is designed to be installed singly in an installation then this can be tested alone, for example a domestic CHP unit. The maximum group size for the test is 3.68kW. The **Micro-generator** or group shall meet the required d_{max}, d_c, $d_{(t)}$, P_{st}, P_{lt} requirements of BS EN 61000-3-3 with a scaling factor applied as follows for each voltage change component. d_{max}, d_c, $d_{(t)}$, P_{st}, P_{lt} **×** rating of **SSEG** being tested (kW) per phase / 3.68 The results for groups of **Inverters** should be normalised to a rating of 3.68kW and to the standard source impedance. Single **Inverters** need to be normalised to the standard source impedance, these normalised results need to comply with the limits set out in Appendix 5. For voltage change and flicker measurements the following simplified formula is to be used to convert the measured values to the normalised values where the power factor of the generation output is 0.98 or above. Where it is less than 0.98 then compliance with the full requirements of BS EN 61000-3-3 is required. Normalised value = Measured value × reference source resistance/measured source resistance at test point. And for units which are tested as a group. Normalised value = Measured value × reference source resistance/measured source resistance at test point × 3.68/rating per phase. Reference source resistances to be used • Single phase units reference source resistance is 0.4 ohms		

				• Two phase units in a three phase system reference source resistance is 0.4 ohms • Two phase units in a split phase system reference source resistance is 0.24 ohms • Three phase units reference source resistance is 0.24 ohms. The stopping test should be a trip from full load generation. The duration of these tests need to comply with the particular requirements set out in the testing notes for the technology under test and can be found in Annex C. The dates and location of the tests need to be noted in Appendix 5 *Note*: For wind turbines, flicker testing should be carried out during the performance tests specified in IEC 61400-12-1. Flicker data should be recorded from wind speeds of 1m/s below cut-in to 1.5 times 85% of the rated power. The wind speed range should be divided into contiguous bins of 1m/s centred on multiples of 1m/s. The dataset shall be considered complete when each bin includes a minimum of 10 minutes of sampled data. The highest value of each parameter measured across the entire range of tests shall be recorded. Note that as an alternative to **Type Testing** the supplier of a **Micro-generator** incorporating an **Inverter** may give a guarantee that rates of change of output do not exceed the following ramp rate limits. Output needs to ramp up at a constant rate. This exception to site testing does not apply to devices where the output changes in steps of over 30ms rather than as a ramp function, a site test is required for these units. • Single phase units and two phase units in a three phase system, maximum ramp up rate 333 watts per second;		

				• Two phase units in a split phase system and three phase units, maximum ramp up rate 860 watts per second. It should be noted that units complying with this declaration are likely to be less efficient at capturing energy during times when the energy source is changing. For technologies other than wind turbines, testing should ensure that the controls or automatic programs used produce the most unfavourable sequence of voltage changes.		
10.4				**Power Quality for Generating Units >16 A per phase and <50 kW**		
10.4.1				**Harmonic Emissions** for **Generating Units** >16 A per phase and <50 kW		
10.4.1.1 to 10.4.1.4		9.6.3		Harmonic voltages and currents produced within the **User**'s system may cause excessive harmonic voltage distortion in the **Distribution Network**. The **User**'s installation must be designed and operated to comply with the planning criteria for harmonic voltage distortion as specified in EREC G5. EREC G5, like all planning standards referenced in this recommendation, is applicable at the time of connection of additional equipment to a **Customer**'s **Installation**. For **Generating Unit**s of up to 17kW per phase or 50kW three phase harmonic measurements as required by BS EN 61000-3-12 shall be made and recorded in the type test declaration for the **Generating Unit**. The **DNO** will use these declared figures to calculate the required maximum supply impedance required for the connection to comply with BS EN 61000-3-12 and will use this data in their design of the connection for the **Generating Unit**. This standard requires a minimum ratio between source fault level and the size of the **Generating Unit**, and connections in some cases may require the installation of a transformer between 2 and 4 times the rating of the **Generating Unit** in order to accept the connection to a **DNO's Distribution Network.** Alternatively, if the harmonic emissions are low and they are shown to meet		

				the requirements of BS EN 61000-3-2 then there will be no need to carry out the fault level to **Generating Unit** size ratio check. **Generating Unit**s meeting the requirements of BS EN 61000-3-2 will need no further assessment with regards to harmonics.		
10.4.2				**Flicker for Generating Units >16 A per phase and <50 kW**		
10.4.2.1 to 10.4.2.3		9.6.2		Where the input motive power of the **Generating Unit** may vary rapidly, causing corresponding changes in the output power, flicker may result. The operation of **Generating Unit** including synchronisation, run-up and desynchronisation shall not result in flicker that breaches the limits for flicker in EREC P28. The fault level of the **Distribution Network** needs to be considered to ensure that the emissions produced by the **Generating Plant** do not cause a problem on the **Distribution Network**. For Three phase voltage step change and flicker measurements as required by BS EN 61000-3-11 shall be made and recorded in the type test declaration for the **Generating Unit**. The **DNO** will use these declared figures to calculate the required maximum supply impedance required for the connection to comply with EREC P28. This calculation may show that the voltage fluctuations will be greater than those permitted and hence reinforcement of the **Distribution Network** may be required before the **Generating Plant** can be connected.		
10.4.2.4		9.6.2.1		For wind turbines, flicker testing should be carried out during the performance tests specified in IEC 61400-12. Flicker data should be recorded from wind speeds of $1ms^{-1}$ below cut-in to 1.5 times 85% of the rated power. The wind speed range should be divided into contiguous bins of $1ms^{-1}$ centred on multiples of $1ms^{-1}$. The dataset shall be considered complete when each bin includes a minimum of 10 minutes of sampled data.		
10.4.2.5				The highest recorded values across the whole range of measurements should be used as inputs to the calculations described in BS EN 61000-3-11 to remove background flicker values. Then the required maximum supply impedance values can be calculated as described in Appendix 5.		

				Note that occasional very high values may be due to faults on the associated HV network and may be discounted, though care should be taken to avoid discounting values which appear regularly.		
10.4.2.6		9.6.2.2		For technologies other than wind, the controls or automatic programs used shall produce the most unfavourable sequence of voltage changes for the purposes of the test.		
10.5		7.5		**Balance of Generating Unit output at LV**		
10.5.1		7.5.1		Connection of multiple **Micro-generating Plants** in **a Close Geographic Region** and single phase **Generating Unit**s up to 17kW under this EREC G98-2 is allowable, but this requires application to the **DNO** and may not be possible in many cases for technical reasons (such as causing voltage issues and unacceptable phase imbalance) depending on point of connection and network design.		
10.5.2		7.5.2		A solution to these voltage issues and phase imbalance issues may be to utilise 3-phase **Generating Unit**s (the same export power will result in lower voltage rises due to decreased line currents and a 3 phase connection will result in voltage rises of a sixth of those created by a single phase connection), or to use multiple single phase **Generating Unit**s connected across three phases. If these individual **Generating Units** are of differing ratings, current and voltage imbalance may occur. To maintain current and voltage imbalance within limits the Installer shall consider the phase that each **Generating Unit** is connected to in an installation. In addition the **DNO** may define to an **Installer** the phases to which the **Generating Units** in any given installation should be connected.		
10.5.3		7.5.3		An **Installer** should design an installation on a maximum imbalance in output of 16A between the highest and lowest phase. Where there are a mixture of different technologies, or technologies which may be operational at different times (eg. wind and solar) **Generating Unit**s shall be connected to give a total imbalance of less than 16A based on assumed worst case conditions, those being: a. One **Generating Unit** at maximum output with the other(s) at zero		

				output –all combinations to be considered. b. Both / all **Generating Units** being at maximum output A **Generating Unit** technology which operates at different times due to location eg east and west facing roofs for PV, must allow for the PV on one roof to be at full output and the PV on the other roof to be at zero output.		
10.5.4		7.5.4		In order to illustrate this requirement examples of acceptable and unacceptable connections have been given in Appendix 8.		
10.6		7.6		**Generation Unit capacity for single and split LV phase supplies**		
10.6.1		7.6.1		The maximum aggregate capacity of **Generating Units** that can be connected to a single phase supply is 17kW. The maximum aggregate capacity of **Generating Units** that can be connected to a split single phase supply is 34kW.		
10.6.2		7.6.2		There is no requirement to provide intertripping between single phase inverters where these are installed on multi-phase supplies up to a limit of 17kW per phase (subject to balance of site output as per section 10.5). A single phase 17kW connection may result in an imbalance of up to 17kW following a **Distribution Network** or **Generating Unit** outage. However the connection design should result in imbalance under normal operation of below 16A between phases as noted above.		
10.6.3		7.6.3		The requirement to disconnect all phases following a fault in the **Customers Installation** or a **Distribution Network** outage applies to three phase inverters only and will be tested as part of the type testing of the **Generating Unit**.		
10.7		7.7		**Voltage Management Units in Customer's premises**		
10.7.1		7.7.1		Voltage Management Units are becoming more popular and use various methods, in most cases to reduce the voltage supplied from the **DNO's System** before it is used by the **Customer**. In some cases where the **DNO's System** voltage is low they may increase the voltage supplied to		

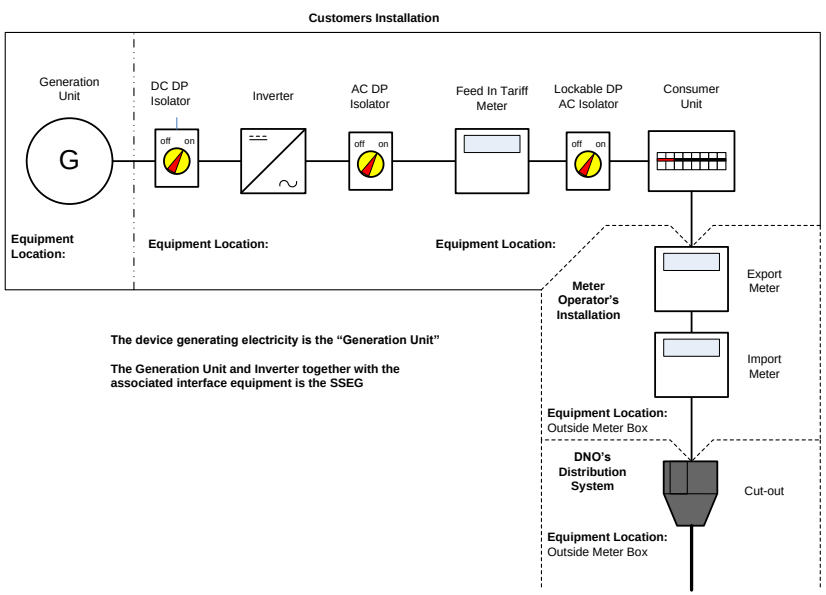
				the **Customer**. Some technologies are only designed to reduce voltage and cannot increase the voltage.		
10.7.2		7.7.2		The use of such equipment has the advantage to the **Customer** of running appliances at a lower voltage and in some cases this can reduce the energy consumption of the appliance. A higher current consumption will result for some appliances when running at a lower voltage as the device needs to take the same amount of energy from the **System** to carry out its task.		
10.7.3		7.7.3		If a Voltage Management Unit is installed between the **Entry Point** and the **Generating Unit** in a **Customer's Installation**, it may result in the voltage at the Customer side of the Voltage Management Unit remaining within the limits of the protection settings defined in section 9.1.3, while the voltage at the **Entry Point** side of the unit might be outside the limits of the protection settings. This would negate the effect of the protection settings. Therefore this connection arrangement is not acceptable and all **Generating Units** connected to **a LV Distribution Network** under this EREC G98-2 must be made on the **Entry Point** side of any Voltage Management Unit installed in a **Customers Installation.**		
10.7.4		7.7.4		**Users** should note that the overvoltage setting defined in section 9.1.3 is 4% above the maximum voltage allowed for the voltage from the **DNO System** under the ESQCR and that provided their **Installer** has designed their installation correctly there should be very little nuisance tripping of the **Generating Unit**. Frequent nuisance tripping of a **Generating Unit** may be due to a fault in the **Customers Installation** or the operation of the **DNO's Distribution System** at too high a voltage. **Users** should satisfy themselves that their installation has been designed correctly and all **Generating Units** are operating correctly before contacting the DNO if nuisance tripping continues. Under no circumstances should they resort to the use of Voltage Management Units installed between the **Entry Point** and the **Generating Unit**.		
10.8 and 10.8.1	5.5	9.6.8		**DC Injection**	**4.8.2 DC injection** The generating unit shall not inject a direct current.	E-mails 24/7/15 and 28/7/15 in respect of

and 10.8.2				The requirements of EN 50438 shall be met for DC injection. Where necessary the **DC** emission requirements can also be satisfied by installing an isolating transformer between the **Inverter** and the connection to the **DNO's Distribution Network**.	NOTE In general this requirement is fulfilled if the DC current during type testing is less than a set value. The compliance testing Annex D 3.10 DC Injection D.3.10.3 Acceptance criteria This test is passed if the DC current In the test above is lower than 0.5% of nominal current of 20 mA whatever the higher value is.	outcome of DC WG, decision taken to use EN 50438
10.9 and 10.9.1	5.6	9.3.7(e)		**Power Factor** The power factor capability of the **Generating Unit** shall comply with EN 50438. When operating at rated power the **Generating Unit** shall operate at a power factor within the range 0.95 lagging to 0.95 leading relative to the voltage waveform unless otherwise agreed with the **DNO** eg for power factor improvement.		
	5.8					Covered by G59 text on unbalance above
11	5.7			**Short Circuit Current Contribution**		TITLE ONLY
11.1				**Directly Coupled Generation**		

11.1.1	5.7.1			The synchronous **Generating Unit** short-circuit parameters shall be determined by means of a short-circuit test in accordance with EN 50438.	**D.3.7 Short-circui** The micro-generator short-circuit parameters shall be determined by means of a short-circuit test carried out in a similar manner to that for larger alternators as described in EN 60034 series. For electronic inverters, manufacturers shall declare the short circuit contribution.	Use EN 50438 for synchronous generation Keep G83 requirements for inverter connection generation
11.2				**Inverter Connected Generation**		
11.2.1 to 11.2.5	5.7.2			In addition to EN 50438 manufacturers of electronic **inverters** shall take account of the following: **Inverter** connected **Generating Unit**s generally have small short circuit fault contributions. However **DNOs** need to understand the contribution that they do make to system fault levels in order to determine that they can continue to safely operate without exceeding design fault levels for switchgear and other circuit components. As the output from an **Inverter** reduces to zero when a short circuit is applied to its terminals, a short circuit test does not represent the worst		

				case scenario; in most cases the voltage will not collapse to zero for a network fault. A test which ensures that at least 10% of nominal voltage remains and which allows the **Generating Unit** to feed into a load with an X to R ratio of 2.5 is specified as details in Annex A.		
12	5.9			**Certification Requirements**		
12.1				**General**		
12.1.1	5.9.1		A41 (3) covered	**Type Tested** certification is the responsibility of the **Generating Unit Manufacturer**. The requirements are detailed in Appendix 5.		
12.2				**Compliance**		
12.2.1	5.9.2			The **Generating Unit** shall comply with all relevant European Directives and should be labelled with a CE marking.		
12.3	5.9.3			**Verification Test Report**		
12.3.1				The **Manufacturer** shall make available upon request a verification test report confirming that the **Generating Unit** has been **Type Tested** to satisfy the requirements of this EREC G98-2. The report shall detail the type and model of **Generating Unit** tested, the test conditions and results recorded. All of these details shall be included on a test sheet. The required test sheet and declaration is shown in Appendix 4.		
13	6			**Operation and Safety**		
13.1 and 13.1.1 to 13.1.2	6.1			Operational Requirements In all cases the User shall ensure that the **Generating Unit** is so installed, designed and operated to maintain at all times, compliance with the requirements of ESQCR 22(1) (a). The **Generating Unit(s)** shall be connected via an accessible isolation switch that is capable of isolating all phases and neutral. The isolation switch shall be capable of being secured in the 'off' (isolated) position.		Moved from Installation and wiring section of G83

13.2	6.2	11.2		**Isolation and Safety Labelling**		
13.2.1		11.2.2		The **Generator User** must grant the **DNO** rights of access to the means of isolation in the event that disconnection becomes necessary for safety reasons and in order to comply with statutory obligations.		
13.3 and 13.3.1 to 13.3.4	6.2	11.2.4 11.3.3		**Labelling** Labelling shall be placed in accordance with EN 50438.It should be noted that the safety sign does not imply a right on the **User, Installer** or maintainer to operate (remove / replace) the **DNO's** cut-out fuse and a note to this effect should be included on the warning notice In addition to the safety labelling, this EREC G98-2 requires the following, up to date, information to be displayed at the point of interconnection with the **DNO's Distribution Network.** a) A circuit diagram relevant to the installation showing the circuit wiring, including all protective devices, between the **Micro-generator** and the **DNOs** fused cut-out. This diagram should also show by whom all apparatus is owned and maintained; b) A summary of the protection settings incorporated within the equipment. Figure 1 shows an outline example of the type of circuit diagram that will need to be displayed. Figure 2 is non-prescriptive and is for illustrative purposes only.	**5.4 Labelling** A warning notice shall be placed in such a position that any person gaining access to live parts will be warned in advance of the need to isolate those live parts from all points of supply. Special attention should be paid that the power supply, measuring circuits (sense lines) and other parts may not be isolated from the network when the switch of the interface protection is open. As a minimum, warning labels shall be placed: • on the switchboard (DSO panel and consumer unit) that has the micro-generator connected to it;	EN 50438 uses the same warning label but doesn't require up to date information to be displayed at the point of interconnection. GB words therefore kept.

				 Figure 1 - Example of the type of circuit diagram The **Installer** shall advise the **User** that it is the **User's** responsibility to ensure that this safety information is kept up to date. The installation operating instructions shall contain the **Manufacturer's** contact details eg name, telephone number and web address.	• on all switchboards in between the consumer unit and the micro-generator itself; • on, or in the micro-generator itself; • at all points of isolation for the micro-generator. All the information shall be given in the language and in accordance with the practice of the country in which the micro-generator is intended to be installed.	
13.4 and 13.4.1	6.3			**Maintenance & Routine Testing** Periodic testing of the **Generating Unit** is recommended at intervals prescribed by the **Manufacturer**. This information shall be included in the installation and **User** Instructions. The method of testing and/or servicing should be included in the servicing instructions.	**5.5 Maintenance and routine testing** The manufacturer shall provide a time frame for maintenance and routine testing. NOTE Periodical routine testing of the interface protection system can be	EN 50438 doesn't cover how this information should be made available. GB words therefore kept.

					waived because of the provisions in 4.6.3. The user is responsible for the proper maintenance and routine testing. Maintenance and routine testing shall be carried out by qualified service technicians. With respect to service technicians, additional national requirements shall be taken into account.	
13.5 and 13.5.1 to 13.5.2	6.4	8.3.1		**Earthing** Earthing shall be undertaken in accordance with BSEN 50438 noting that **LV Distribution Network**s are always solidly earthed, and the majority are multiple earthed. The following diagrams show typical installations. Include Figures 8.8 – 8.9 from G59.	**4.1.3 Earthing** Earthing shall be according to HD 60364-5-551 and the relevant national standards. When a micro-generator is operating in parallel with the distribution network, there shall be no direct connection between the generator winding (or pole of the primary	Review need for G59 figures

					energy source in the case of a DC sourced micro-generator) and the DSO's earth terminal. For installations where the customer provides his own earth terminal, e.g. when connected to a TT system, it is also advisable to avoid connecting the generator winding to this earth terminal. NOTE The reason for this precaution is to avoid damage to the generator during faults on the distribution network and to ensure correct operation of protective devices. For a micro-generator which is designed to operate in parallel with a distribution network but which is connected via an inverter (e.g. a PV array or a stationary fuel cell power system) it is permissible to connect one pole of the DC side of the inverter to the distribution network if there is insulation between the AC and the DC sides	

					of the inverter. In such cases, the installer/manufacturer shall take all reasonable precautions to ensure that the micro-generator will not impair the integrity of the distribution network and will not suffer unacceptable damage for all credible operating conditions, including faults on the distribution network.	
14	7			**Commissioning/Decommissioning and Acceptance Testing**		TITLE ONLY
14.1				**General**		
14.1.1 to 14.1.3	7.1		A29 (1)	The information required by a **DNO** to confirm commissioning is shown in Appendix 3. It is the responsibility of the **Installer*** to ensure that the relevant information is forwarded to the local **DNO** in accordance with the requirements of 5.1. The pro forma in Appendices 2 and 3 are designed to: a) simplify the connection procedure for both **DNO** and **Generating Unit Installer**; b) provide the **DNO** with all the information required to assess the potential impact of the **Generating Unit**		Appendix 3 of G83 will remain as Appendix 3 of this document RfG places an obligation on the Power Generating Facility Owner to inform the DNO although does recognise that third parties may provide this

				connection on the operation of the network; c) inform the **DNO** that the **Generating Unit** installation complies with the requirements of this EREC G98-2; d) allow the **DNO** to accurately record the location of all **Generating Units** connected to the network. Compliance with the requirements detailed in this EREC G98-2 will ensure that the **Generating Unit** is considered to be approved for connection to the **DNO's Distribution Network**. It is intended that the **Manufacturers** of **Generating Units** will use the requirements of this EREC G98-2 to develop type verification certification for each of their **Generating Unit** models. * Note The legal onus is on the User		information
14.2				**Installation**		
14.2.1 to 14.2.2	7.2		A40 (2)	No parameter relating to the electrical connection and subject to type verification certification will be modified unless previously agreed in writing between the **DNO** and the **User** or his agent. **User** access to such parameters shall be prevented. As part of the on-site commissioning tests the **Installer** shall carry out a functional check of the loss of mains protection, for example by removing the supply to the **Micro-generator** during operation and checking that the **Interface Protection** operates to disconnect the **Micro-generator** from the **DNO's Distribution Network**. For three phase installations this test can be achieved by opening a three phase Circuit Breaker or isolator and confirming that the **Micro-generator** has shut down. Testing for the loss of a single phase is covered in the type testing of Inverters see section 9.1.5.	**6 Commissioning** This European Standard applies to type-tested micro-generators NOTE An example of a test result sheet is given in Annex E. The following conditions shall be met for the installation: • the micro-generator (including the interface protection) shall fulfil the requirements of	

					this standard and the other applicable standards; • the manufacturer shall provide an installation instruction in accordance with this standard and national or regional requirements; • access to the interface protection settings shall be tamper-proof; • in the absence of product standards the micro-generator shall be type tested against the interface requirements of this standard; • the installation shall be carried out by installers with recognised and approved qualification related to the fuels used, general electrical installations and a particular qualification relating to installation of micro-generators; • the installer shall provide a single line diagram of the electricity generating	

					facility. The single line diagram shall show the circuit breaker, the protections, the inverter, etc. The user respective the installer should be aware that in addition to the DSO the energy supplier and/or the metering authority will need to be informed for contractual reasons. Unless otherwise stated by national legislation or regulation, prior consent of the DSO is necessary. **Annex F Commissioning** The micro-generator shall be installed in accordance with all of the following requirements: this standard; HD 60356 series; (*IET WR)* National regulations;	

					The manufacturer's installation instructions; Technical requirements of the DSO (e.g. grid codes).	
14.3				**Commissioning Tests**		
14.3.1		12.2.1		The **DNO** may decide to witness the **Generating Unit** commissioning tests and checks for which the **DNO** shall charge the **User** for attendance of staff at its own commercial rates.		
14.3.2		12.2.2		The **DNO** will not normally witness the commissioning checks and tests for Type Tested **Generating Units** <50kW 3 phase (17kW 1 phase). In such cases, where the **DNO** does decide to witness they will advise this as part of the connection offer. Reasons for witnessing such installations may include: a. A new **Installer** with no track record in the **DNO** area. b. A check on the quality of an installation either on a random basis or as a result of problems that have come to light at previous installations.		Comment from MK Is this still needed for type tested units?
14.3.3		12.2.4		Where commissioning tests and checks are to be witnessed the **Installer** shall discuss and agree the scope of these tests with the **DNO** at an early stage of the project. The **Installer** shall submit the scope, date and time of the commissioning tests at least 15 days before the proposed commissioning date.		
14.4		12.3		**Generating Unit Commissioning Tests**		
14.4.1				The following tests and checks shall be carried out by the **Installer** on all **Generating Unit**s		

				a. Inspect the **Generating Unit** to check compliance with BS7671. Checks should consider: (i) Protection (ii) Earthing and bonding (iii) Selection and installation of equipment b. Check that suitable lockable points of isolation have been provided between the **Generating Unit**s and the rest of the installation. c. Check that safety labels have been installed in accordance with section 13.2 of EREC G98-2; d. Check interlocking operates as required. Interlocking should prevent **Generating Unit**s being connected to the **DNO** system without being synchronised; e. Check that the correct protection settings have been applied (in accordance with section 9.1.3); f. Complete functional tests to ensure each **Generating Unit** synchronises with, and disconnects from, the **DNO**s **Distribution Network** successfully and that it operates without tripping under normal conditions; g. After all other tests have been completed successfully (including where required additional tests for non type tested equipment) carry out a functional test to confirm that the **Interface Protection** operates and trips each **Generating Unit** when supplies are disconnected between the **Generating Unit** and the **DNOs Distribution Network**. 1. This test may be carried out by opening a suitably rated switch (not the one expected to open for a protection operation) between the **Generating Unit** and the **DNOs Point of Supply** and checking that the **Generating Unit** disconnects quickly (eg within 1s); 2. Alternatively, the test may be carried out by removing one or all of the voltage sensing supplies to the protection relay and checking that the		

				Generating Unit disconnects quickly (eg within 1s); h. Check that once the phases are restored following the functional test described in (g) at least 20s elapses before the **Generating Unit** re-connects.		
14.5				**Notification of Commissioning**		
14.5.1 to 14.5.2	7.3	12.3.2	A30 (1) (3) covered	Notification that the **Generating Unit** has been connected / commissioned is achieved by completing an **Installation document** as per Appendix 4, which also includes the relevant details on the **Generating Unit** installation required by the **DNO**. The **Installer,** or an agent acting on behalf of the **Installer,** shall supply separate **Installation documents** for each **Generating Unit** within the **Customer's Installation** to the **DNO.** Documentation shall be supplied either at the time of commissioning (where tests are witnessed) or within 28 days of the commissioning date (where the tests are not witnessed) and may be submitted electronically.		See comments on obligations re Installer vs User in section 7.1.
14.6				**Notification of Changes**		
14.6.1 to 14.6.5	7.4	12.6.1 12.6.3 12.6.4	A40 (2) (3) (4) (5) A41 (2)	If during the lifetime of the **Generating Unit** it is necessary to replace a major component of the **Generating Unit**, it is only necessary to notify the **DNO** if the operating characteristics of the **Generating Unit** or the **Interface Protection** will be altered when compared against the unit that was originally commissioned. The **DNO** must be notified before the modification is initiated. The **DNO** shall be notified of any operational incidents or failures of **Generating Units** that affect its compliance with this EREC G98-2, without undue delay, after the occurrence of those incidents. The **DNO** shall have the right to request that the **User** arrange to have		Consideration of just referencing equipment certificates here.

				compliance tests undertaken after any failure, modification or replacement of any equipment that may have an impact on the **Generating Unit's** compliance with this EREC G98-2. Where one or more **Generating Unit**s are to be added or replaced at an existing **Customer's Installation** installed under a version of EREC G59 or EREC G83, it is not necessary to modify the other existing **Generating Units** to comply with the latest versions of this suite of documents unless these documents explicitly include retrospective changes. For the avoidance of doubt, this also applies where the changes increase the capacity of the **Customer's Installation** above the 16A per phase threshold. For example, if a new 3kW one phase **Generating Unit** is added to an existing **Customer's Installation** comprising an existing 3kW single phase **Generating Unit** complying with EREC G83, this increases the capacity of the **Customer's Installation** from 3kW (13.04A per phase) to 6kW (26.08A per phase). In this case the new **Generating Unit** will have to comply with EREC G98 (as amended) but the existing **Generating Unit** will not need to be modified. If a **Generating Unit** is changed at a **Customer's Installation** the replacement must comply with the current version of EREC G98.		For discussion: Do we need this note about additional generating units? How can we improve the drafting?
14.7				**Notification of Decommissioning**		
14.7.1 to 14.7.2	7.5	12.6.2	A30 (3)	The **User** shall notify the **DNO** about the permanent decommissioning of a **Micro-generator** by providing the information as detailed under Appendix 6. Documentation may be submitted by an agent acting on behalf of the **User** and may be submitted electronically. Where the presence of **Generating Plant** is indicated in a bespoke **Connection Agreement**, it will be necessary to amend the **Connection Agreement** appropriately.		

Ap 1				**Appendix 1 Emerging Technologies Exceptions**		Refer to separate Appendices document
Ap 2	Ap 1			**Appendix 2 Connection Procedure Flow Chart**		
Ap 3	Ap 2	13.5		**Appendix 3a Application for Connection of multiple Micro-generating unit installations** **Appendix 3b. Application for connection of Type Tested Generating Units with total aggregate Power Station capacity <50kW 3 phase or 17kW single phase**		
Ap 4	Ap 3	13.2		**Appendix 4a Installation Document** **Appendix 4b Installation Cover**		
Ap 5	Ap 4	13.3		**Appendix 5 Type Test Sheet / verification report**		
Ap 6	Ap 5	13.4		**Appendix 6 Micro-generator and Generating Unit <50 kW 3 phase Decommissioning Confirmation**		
Ap 7	Ap 6			**Appendix 7 Not used**		
Ap 8		13.10		**Appendix 8 Example calculations to determine if unequal generation across different phases is acceptable or not.**		