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Ofgem: Consultancy Support for the Evaluation of Engineering Recommendation G83/2

Final Report
7789 – R2

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CONTENTS

1 Introduction

1.1 Background

This report has been prepared by TNEI and PPA Energy in response to a request from Ofgem for assistance with the evaluation of Engineering Recommendation G83/2, "Recommendations for the Connection of Type Tested Small-scale Embedded Generators (Up to 16 A per Phase) in Parallel with Low-Voltage Distribution Systems". This Engineering Recommendation (EREC) has been produced by a Working Group (WG) co-ordinated by the Energy Networks Association (ENA) to supersede EREC G83/1-1.

The report presents the findings of our review of G83/2 and the associated Report to the Authority that was produced by the DNOs to accompany the new EREC. It also incorporates responses received from the G83 Working Group to the recommendations presented in the draft version of this report.

1.2 Structure of this Report

Section 2 of this document comments on:

- the overall suitability of the new G83/2 for the purposes of providing guidance to generators and Distribution Network Operators (DNOs) regarding the connection of Small Scale Embedded Generators (SSEG) to the distribution networks;

- the relationship between G83/2 and the previous document, G83/1-1, noting particular points of difference between the coverage of the new recommendation and the previous EREC; and

- the impact of the revised G83/2 on the Distribution Code.

Section 3 presents a review of the issues raised in the Report to the Authority, including comments submitted by respondents to the consultation process that was undertaken by the WG in the course of producing the new document.

Section 4 summarises the conclusions of our work regarding the key questions of:

1. the suitability of G83/2 for replacing G83/1-1; and

2. whether G83/2 meets objectives defined in the Electricity Act,

and presents the Consultants' recommendations. It also presents the G83 Working Group responses to the recommendations and the Consultants' acceptance.

The appendices to this report are structured as follows:

- Appendix 1 contains details of the mapping of the content of G83/1-1 onto the content of G83/2 and identifies new material in G83/2;

- Appendix 2 summarises those issues relating to G83/2 on which two or more respondents raised queries during the consultation process, or where the Working Group did not accept the comments raised; and

- Appendix 3 lists editorial points noted in the text of G83/2 in the course of the Consultants' review.

2 Review of ER G83/2

2.1 Overall suitability for purpose

The Report to the Authority describes the drivers for change to G83. They include:

- The need to align protection settings between the revised G59/2 and G83; and
- There being no type testing annex for wind generation in G83/1-1.

The Terms of Reference for the Distribution Code Review Panel (DCRP) G83 Working Group (WG) state that the review should consider these items, as well as a number of other areas.

It is clear that most of these items have been addressed. For example, G83/2 has an annex for wind generation, and the protection settings in general align with those in G59/2 (Section 10.5.7.1 of G59/2).

Concerning other areas identified in the Terms of Reference (ToR), there is no confirmation in the Report to the Authority that consideration by the WG has been given to items in the ToR such as alignment with the latest version of EN 50438:2007, Multi-phase devices – testing requirements, and guidance on type testing facilities. Although Health and Safety is discussed in respect of a certificate of exemption there is no clear statement in the Report to the Authority that all new Health and Safety requirements have been considered. There is no mention of the suggestion that guidance be provided on where access to appropriate Type Testing facilities can be found.

As noted in the Report to the Authority, EREC G83 is the main industry document for the connection of SSEG. The connection process for SSEG, compared with that for larger generation, is relatively straightforward; it can be described as "fit and inform". The principle is that if equipment is designed to meet a set of conditions and complies with the relevant Engineering Recommendation and standards ("type tested" equipment), this can be installed and commissioned with minimal input required from the DNO. Where SSEG are being installed in multiple premises, the DNO will consider the impact of this on their network, and may specify conditions for connection, e.g. carrying out facilitating works.

The structure of G83/2, subsequent to introductory sections, is as follows:

- Connection, protection and testing requirements – this is the largest chapter in the main body of the document;
- Operation and Safety; and

- Commissioning / Decommissioning and Acceptance Testing.

This is followed by a series of pro-forma in appendices, and type testing requirements in annexes. This structure aligns well with the connection process, in that the focus of the document is on the type testing requirements, whilst also covering other relevant areas such as safety and commissioning.

The structure of G83/2 is very similar to the document it is replacing, and is considered to be suitable for purpose. The details within key sections of the document have undergone significant revision. These detailed changes have been reviewed, and are discussed in this report.

2.2 Relationship to previous Engineering Recommendations

In general the recommendations within G83/1-1 have been transferred into G83/2, although there have been significant changes to the details of the interface protection and type testing requirements. A detailed mapping analysis on a paragraph basis is given in Appendix 1. The main points are summarised below.

2.2.1 References

There are seven new references to British and European standards in respect of the following topics:

- Voltage characteristics of electricity supplied by public electricity networks
- Connection of micro-generators in parallel with public electricity networks
- Insulation coordination for equipment in low voltage systems
- Low voltage switchgear and control gear
- Functional safety of programmable electronic safety related systems
- Electromechanical relays
- Test procedure of islanding prevention measures for pv inverters

Consolidation is required between the two references to BS EN 61000 standards and also between the two references to BS EN 60255 and IEC 60255. This is noted in the table of editorial comments (Appendix 3).

2.2.2 Reference to ESQCR

The first paragraph of Section 5.1 in G83/1-1 has not been carried forward to G83/2. This paragraph referred the reader to ESQCR, with respect to the

requirement to notify the DNO about SSEG installations, and regarding the DNO accepting SSEG provided that certain clauses of ESQCR are met.

The Consultants' view is that it would be useful for the reader to have a reference to ESQCR; either at the start of Section 5 (from where it has been removed), or in the foreword of G83.

2.2.3 Single Connection vs Single Premises

The "two stage" connection processes in G83/1-1 have been revised to two distinct processes; one for one or more SSEG connections in a single premises; the other for SSEG connections in multiple premises. As per an accepted comment[1], the titles of the flow charts in Appendix 1 have changed from the original G83/2 draft, from "Single Connection Process" to "Connecting SSEG(s) in a single premises", and from "Multiple Connection Process" to "Connecting SSEG(s) in multiple premises". These changes to the process title changes should also be reflected in the headings of Section 5.1.1 and 5.1.2, and in 7.1 paragraph 3. This is noted in the table of editorial comments (Appendix 3).

2.2.4 HSE Certification of Exemption (editorial)

The HSE Certification of Exemption has been reduced from 30 days to 28 days; G83/2 has been updated to reflect this. The wording regarding the notification and information required in the G83/2 draft was "within 28 days". A comment[2] was made that this was ambiguous and should be changed to "no later than 28 days after commissioning". However, the sentence was changed to "no later than 28 days of commissioning" ("of" instead of "after"), which does not read well and should be corrected. Also for consistency this change should be made throughout the document: Section 5.1.2, the flow chart and Appendix 5 of G83/2. This is noted in the table of editorial comments (Appendix 3).

An alternative would be to reject the comment, as "within 28 days" is typical of the language used elsewhere, e.g. ENA website, D Code. Either way the reference to 28 days should be consistent throughout the document.

2.2.5 Protection

The interface protection settings in G83/2 have been altered significantly from G83/1-1 with the introduction of two stage voltage and frequency protection to reduce nuisance tripping. This brings G83/2 in line with the G59/2 protection settings for LV generators. Although a significant change, this has been well communicated to the industry and appears to be widely supported.

There is still an issue in the alignment of the G83/2 and G59/2 under and over voltage settings. The G83/2 settings are defined from a nominal voltage of 230V,

[1] Comment number 182, NPG, Appendix 5 of Report to the Authority
[2] Comment number 238, BSC, Appendix 5 of Report to the Authority

with over-voltage settings of +14% and +19%. The G59/2 settings are based on a user selectable nominal voltage of 230-240V with over-voltage settings of +10% and +15%.

The level of over-voltage permitted has not changed from G83/1-1 and remains at 264V, which is consistent with G59/2, however it is now mandatory for the SSEG to remain continuously connected up to the first over-voltage setting. In addition, the statement that the SSEG should, as a minimum, operate within statutory voltage and frequency limits has been removed from the text.

The consultation responses highlight that these changes have caused some confusion and concern that these voltage excursions are wider than those permitted in the ESQCR. It is noted that the ESQCR defines voltage at the Exit Point, and in the case of SSEGs there can be up to a 5% (BS 7671) voltage drop between the interface protection and the Exit Point. However many SSEGs will be embedded into a domestic network, and these protection settings may result in continuous operation at up to 4% over voltage above statutory limits.

It is suggested that the WG provide a brief explanation of the reasoning behind these voltage settings.

The WG have recommended that the voltage settings in G59/2 be updated to match these settings in G83/2. It is expected that this will clarify the matter significantly.

Reconnection times are considered in section 3.4.2.

2.2.6 Stability

In this revision of G83 much greater emphasis has been placed on the stability of the SSEG within the protection limits, with stability tests added to the protection tests accordingly.

The public consultation raised several requests for clarification as to how the "no trip" tests should be performed. The WG has now included an example in Appendix A and B.

The revised G83/2 includes a note on the expected increase in RoCoF stability requirements proposed in new European network codes. This comment is useful and provides some insight into the need for stability tests.

2.2.7 Power Quality

The basic limits for flicker and harmonics have been mapped from G83/1-1 to G83/2, however the testing process now requires that SSEGs under 2 kW must be tested as a group, with the results then normalised to a rating of 3.68 kW per phase. This change is in response to concern that multiple micro SSEGs are being installed at one site, resulting in harmonics and flicker levels much higher than

prescribed in G83/1-1. However, these pro-rata limits are contrary to the stage 1 procedure of G5/4 which states that "*For a group of non-linear equipment, the aggregate of rated currents must be less than or equal to 16A and each individual piece of equipment must comply with BS EN61000-3-2*". The Consultants are concerned about this conflict with both G5/4 stage one and BS EN 61000-3-2, and suggest that this is resolved prior to G83/2 finalization.

G83/2 now includes a note particular to wind turbines, requiring flicker tests to be conducted across a range of operating wind speeds. It is stated that these flicker tests should be undertaken during the power and performance tests; the latter of which are detailed in IEC 61400-12. This new test procedure is significantly different from a simple running, starting and stopping flicker test described in IEC 61000-3-3. The new method will yield multiple values of P_{st}, and D_{max}, but no guidance is given as to which values should be recorded in the Type Test Report in Appendix 4, and how these values correspond to the limits given in IEC 61000-3-3. It is a concern that this approach moves away from the simplicity of G83/1 and could add confusion. It is suggested that the WG provide a clear explanation as to which values are required from the test, and where these should be recorded.

DC injection, as with flicker and harmonics, now requires SSEGs under 2 kW to be tested as a group if intended to be installed as a group. The DC injection limits have also been revised to 0.25% of the AC current rating per phase. This percentage limit follows the example of the European standards, however European limits at present are between 0.5% and 1%. Multiple comments[3] from the public consultation raised concern that this pro-rata limit would penalise small SSEGs designed to the 20 mA G83/1-1 limit. A 1 kW single phase inverter would now have a DC current limit of 10.9 mA. It is noted in G83/2 that DC injection is an area currently under investigation and the 0.25% limit is imposed until the investigation is concluded.

2.2.8 Short Circuit

The inclusion of a specific short circuit test is useful, though the actual description of the test lacks clarity and it is the recommendation of the Consultants that this section should be reviewed by the WG. For correct operation of the short circuit test, the following modifications are suggested:

- For clarity, IEC symbols should be used, and the switches numbered.
- The inverter should be shown connected to a power supply on the DC side to clearly show the inverter is exporting power to the grid.
- The connection to the mains supply should also be clearly marked.

[3] Comment numbers 94, 98, 111, SMA, Smart Power Solutions, HHC, Ceres Power, Appendix 5 of Report to the Authority.

- The switches do not need to be interlocked, but if shown as interlocked switches or a changeover switch, then it must be specified to be a make before break switch to avoid a momentary open-circuit on the inverter.

The phrase "change-over switch" is confusing, and instead, the numbered switch could be referred to. The short circuit test could be described more clearly as a series of steps instead of A1.4.6 para 3&4.

2.2.9 Voltage Unbalance

A section on voltage unbalance has been added to the main body of G83/2. The requirement is clear and concise, that voltage unbalance is only to be considered for multiple installations of SSEGs.

2.2.10 Type Testing

The content of the protection and testing section of G83/2 has been significantly increased with respect to G83/1-1, with the addition of stability requirements, two-stage protection settings, and new test procedures for harmonic, flicker and short circuit current tests. This does increase the complexity of the type test verification form in Appendix 4. However, no general comments on this were made during the consultation period.

Several new standards are referred to in G83/2, in place of full descriptions of test procedures, including:

- BS EN 62116:2011 – Loss of Mains tests, Annex A; and
- BS EN 60034-4:1995 – Short Circuit Current Contribution, Annex B.

It is a potential area of concern that these external standards may cause conflict with G83/2 in parts. One response to the consultation suggested that BS EN 62116 allows a longer disconnection time of 2 seconds. The BS EN 60034-4 standard was not mentioned in the draft copy for public consultation of G83/2.

The content of the five technology specific Annexes from G83/1-1 has now been simplified into two generic Annexes, A and B, for inverter connected SSEGs and directly coupled SSEGs respectively. This change has been welcomed as all technologies are now considered, and the volume of similar material considerably reduced.

2.2.11 Reference to Appendix 1

The reference to Appendix 1 (connection procedure flow chart) has been removed from Section 7.1 (paragraph 1). There are now no references to Appendix 1 in the main text of the document. It is recommended that there should be a reference to this Appendix; this could be achieved by including the sentence from G83/1-1

that has been removed in G83/2 ("Appendix 1 shows flow diagrams that describe the connection and commissioning process").

2.2.12 Format of Pro-Forma Tables in Appendices

There seems to be inconsistency in section headings or titles in the pro-forma tables contained in the appendices of G83/2. For example, Appendix 1 contains clear section headings, whereas Appendix 3 could benefit from a heading for "SSEG details" and Appendix 5 could benefit from a heading for "SSEG address details". It is suggested that the section headings in the pro-forma tables are reviewed.

2.3 Interface with Distribution Code provisions

The Distribution License conditions require the Distribution Code to satisfy various requirements in respect of connected generation:

License condition requirements	**Discussion in respect of SSEG**
The Code must cover all material technical aspects relating to connections to and the operation and use of the licensee's Distributions System or (so far as is relevant to such operation and use) the operation of electric lines and electrical plant connected to that system;	G83/2 is referenced by The Distribution Planning and Connection Code DPC 7 for SSEG. As per the license requirement G83/2 covers the requirements for connection and operation of SSEG.
The Code must include a Distribution Planning and Connection Code that must contain: • Planning conditions that specify the technical and design criteria and procedures that are to be applied by the licensee in the planning and development of its distribution system and taken into account by persons having a connection or seeking a connection to that system in the planning and development of their own plant and systems; • Connection conditions that specify the technical, design and operational criteria to be complied with by any person having a connection or	G83/2 covers the connection of SSEG and the use of type tested plant. As discussed in Section 2.2.5 the SSEG has to operate in the voltage range defined by the G83/2 protection requirements. This provides a provision to keep SSEG operational during voltage transients. However DPC 4.2.2.1 states: • The DNO's Distribution System and any User connections to that System shall be designed to enable the Normal Operating Frequency and voltages

seeking a connection to the licensee's distribution system. The Code must include a Distribution Operating code that must specify the conditions under which the licensee must operate its distribution system and under which persons must operate their own plant and systems in relation to that system, so far as it is necessary to protect the security, quality of supply, and safe operation of the licensee's distribution system under both normal and abnormal operating conditions.	supplied to Customers to comply with the ESQCR. This puts the requirement to ensure that the normal operational voltage of the distribution system is within the permitted ESQCR variations (230 V +10%, -6%) with the design of both the DNO system and the User connection. There is a conflict here in terms of the Users system design between the SSEG interface protection settings and ensuring compliance with ESQCR which should be raised with the WG. It should be noted that this conflict existed in respect of G83/1-1.
The Code must be designed (so far as is consistent with the first two requirements) to: • Permit the development, maintenance and operation of an efficient, co-ordinated and economical system, for the distribution of electricity; and • Facilitate competition in the generation and supply of electricity	G83/2 provides guidance to generators and Distribution Network Operators (DNOs) regarding the connection of Small Scale Embedded Generators (SSEG) to the distribution networks to enable this license requirement to be met. The use of type testing equipment enables SSEG to be installed and commissioned with minimal input required from the DNO which is in line with this License requirement.

In the process of revising G83/1-1, small changes have been made to the Distribution Code. The proposed Distribution Code, including these changes, has been presented in the Report to the Authority (Appendix 4). The issue summary at the end of the Distribution Code summarises the revisions between versions. The changes required for the proposed G83/2 are cited as being:

Replace G83/1-1 with G83/2 and update Guidance Note 2

As noted in the Report to the Authority (section 5.2), the changes replacing the references to G83/1-1 are editorial, and do not have a significant impact.

The updated Guidance Note is discussed in Section 3.5.1 of this report, in respect of the implementation period.

2.4 Errors in diagrams and typographical mistakes

A number of editorial errors and typographical mistakes have been identified in G83/2 during the course of this review. These are detailed in Appendix 3.

3 Review of the Report to the Authority

3.1 Introduction

A report, titled "Generator Connexion Requirements – a review of Engineering Recommendations G83/1-1 (2008)", has been submitted to Ofgem by the DNOs in relation to the proposed changes to the D Code and G83/1-1. The report contains a summary of the proposed amendments, with significant supporting background information in the appendices, including:

- A proposal paper to the DCRP for the review of G83/1-1 (DCRP paper 3 March 2011 – DCRP_11_01_02);
- The G83/1-1 Consultation paper ("DCRP 11_05_05") with three annexes:
    - The Terms of Reference for the DCRP Working Group (WG).
    - A list of the DCRP Working Group members.
    - The G83 revision timetable.
- The final draft of G83/2 and proposed changes to the D Code;
- Detailed comments arising from the consultation and the WGs' responses; and
- Consultation responses, in the format of the pro-forma table suggested in the consultation document.

This section presents the Consultants' review of this report.

3.2 Appropriateness of the Process

In their report to the Authority, DNO's outline the measures taken to make sure that this consultation process has had representation from a wide and suitable range of stakeholders, including:

- Setting up a Working Group to undertake the review (comprising all DNOs, an IDNO representative and direct representation from the Renewable Energy Industry);
- Publicising updates from the revision process at conferences and events, and posting the WG meeting minutes and actions on the DCRP website;
- Consulting widely with stakeholders and bringing proposals to a wide audience; and

- Having a period of public consultation.

Responses to the public consultation were received from DNOs, NGET, generators, manufacturers and installers associations, and regulators, showing good engagement from industry. It is noted that the DCRP unanimously supported the proposals put forward in the Report to the Authority.

It is the Consultants' view that a good balance of comments was submitted. Responses to the public consultation were received from:

- Seven DNOs / TSOs;
- Five installers (one installer's comments were received after the comment deadline);
- Five manufacturers;
- Seven "Other"; Renewable UK, Electricity Safety Council, Association of Meter Operators, the Heating and Hotwater Industry Council, EA Technology Ltd, Strathclyde University and the Health and Safety Executive; and
- One individual.

It should be noted that some respondents made no comments. This includes two large DNOs, who were however sitting members on the G83 WG, and Renewable UK and the Health and Safety Executive who were corresponding members of the G83 Working Group.

The majority of the comments have been accepted by the Working Group. Those that were not accepted are discussed in Section 3.4.

The Consultants would like to strongly recommend that it would be useful for future reviews if the WG could give an explanation for rejecting comments, rather than simply stating that they have been rejected.

It is noted that there have been significant changes to the consultation draft in the final draft submitted in the Report to the Authority. The majority of these revisions are in direct response to comments received during the consultation period. Several changes that were not related to comments are highlighted at the end of section 3.3.10. At present the review process does not allow stakeholders to view and comment on these changes.

3.3 Issues

A number of issues have been identified in the DNO's report, which have arisen during the course of drafting G83/2. The response to the most significant of these

issues and the way they have been handled has been reviewed and is discussed in this section.

3.3.1 Protection Requirements

The interface protection settings in G83/2 have been altered significantly from G83/1-1 to bring them in line with the G59/2 protection settings. This is discussed in Section 2.2.5.

3.3.2 Clarification of 16A per phase threshold

G83/2 details both the current rating and corresponding power rating for both single phase and three phase SSEG connections. This should clarify the confusion which arose following the issue of G59/2 about what 16A per phase referred to.

3.3.3 HSE Certification of Exemption

Regulation 22 (2) (d) of ESQCR requests that installers of SSEG notify the DNO about their installation at or before the commissioning of the plant. The Health and Safety Executive issued a Certification of Exemption, which originally relaxed this requirement to notifying the DNO within 30 days of commissioning. This relaxation period has since been reduced to 28 days. In practice this is beneficial as the notification timescale has been aligned with the timescale for submitting commissioning confirmation to the DNO.

G83/2 has been updated to reflect this change in the notification period.

3.3.4 Connection Procedure

As discussed in Section 2.2.3, G83/1-1 described two stages of connection, stage 1 and stage 2, relating to connection processes for installing one SSEG unit and multiple SSEG units respectively. As noted in the Report to the Authority, this terminology has been the cause of confusion. The stage 1 process was also limited to a single SSEG unit; if a household wanted to install multiple units, even if the aggregate capacity was less than 16 A per phase, they had to follow the stage 2 connection process.

This has now been revised, and in the Consultants' view improved, to two distinct connection processes, for installations in single or multiple premises. The single premises connection allows for multiple units, provided that the aggregate capacity is less than 16 A per phase. Apart from the comments noted in Section 2.2.3 the text and flow charts in G83/2 reflect this revision.

3.3.5 Frequency Drift and Step Change Stability Test

Refer to Section 2.2.6.

3.3.6 Testing for Harmonics, Flicker and DC Injection

Not withstanding the comments already made in Section 2.2.7 of this report, the WG is requested to review 5.4.1 and 5.4.2 of the proposed G83/2 to ensure that the text is sufficiently clear and that there are no ambiguities. In particular, the consistency of the text and clarity of the equations could be improved.

Section 5.5 of the proposed G83/2 needs to be reviewed by the WG after consideration of the comments made in Section 2.2.7 of this report.

3.3.7 Short Circuit Current Contribution

Refer to Section 2.2.8.

3.3.8 Voltage Unbalance

Refer to Section 2.2.9.

3.3.9 Revised Forms

It has been noted in the mapping exercise that some of the pro-forma tables in the Appendices are much simpler, with fewer requirements on applicants, than the equivalent forms in G83/1-1. This particularly applies to the application for connection (Appendix 2) and the commissioning confirmation (Appendix 3). The de-commissioning confirmation (Appendix 5) is largely unchanged. This concurs with the comments made in the Report to the Authority that, following complaints that the forms in G83/1-1 were difficult to complete, the Working Group has revised the forms.

The revision of the Type Test Verification Report (Appendix 4) is largely functional, to accommodate the results of the new tests and procedures specified in Section 5 and Annex A and B. The responses to these changes were largely typographical. The Type Test Report submitted as part of the Report to the Authority contains a revised Loss of Mains results table, including the disconnection time of the SSEG when any single phase is removed. This was not present in the draft for public consultation, and is not the result of comments submitted to the WG, however this change is not regarded as contentious by the Consultants.

3.3.10 Type Testing Annexes

Refer to Section 2.2.10 for a discussion on the Type Testing Report (Appendix 4) and type testing annexes.

It was observed by the Consultants that, as with Appendix 4, Annex B was modified further after the publication of the draft for public consultation, not in direct response to comments. The short circuit test procedure outlined in both Annexes A and B has now been replaced in Annex B by a reference to BS EN

60034-4 (Methods for determining synchronous machine quantities from tests). The Consultants are unsure as to whether this standard is in common usage amongst SSEG manufacturers and would suggest that the WG review this with the appropriate stakeholders.

3.4 Response to Detailed Comments - Technical

Technical comments with input from more than one respondent on the same issue, or that have not been accepted by the WG, are detailed in Appendix 2 for completeness. The most significant comments raised that have not already been discussed are summarised below, with reference to the specific clauses of G83/2 to which they apply.

3.4.1 Voltage at exit point

Several comments were received[4] concerning the voltage at the exit point to the DNO's network.

"In all installations a variable voltage drop exists between the SSEG terminals and the Supply Terminals. Hence there is 'voltage lifting' proportional to the exported power."[5]

As discussed in Section 2.2.1 it is suggested that the WG provide a brief explanation of the reasoning behind these voltage settings, a clear demonstration that there are no significant safety risks and an explanation as to how this sits against the ESQCR defined operating region.

3.4.2 Clarity on total disconnection time

It was commented that there is a slight difference in the terminology used in G59/2 and G83/2 to describe trip delay settings.

"Table 1 refers to Trip Delay Settings, the implication being that there is a timing device which needs to be set, whilst the note refers to total disconnection time."[6]

It is the opinion of the Consultants that the "trip delay settings" wording used in G83/2 is clear and it is recommended that any future revision of G59/2 improves the wording there to ensure that the terms used for this are consistent.

The Consultants do suggest, however, that a clear description of protection operation time is needed to clearly discriminate between voltage and frequency protection and Loss of Mains protection. The revision process of G83/2 had identified that the LoM operating time is significantly longer as identified by the Note in Appendix 4:

[4] Comment numbers 20, 29, 51, 112, Appendix 5 of Report to the Authority
[5] Comment number 112, Ceres Power, Appendix 5 of Report to the Authority.
[6] Comment number 53, NPG, Appendix 5 of Report to the Authority

"Note for technologies which have a substantial shut down time this can be added to the 0.5 seconds in establishing that the trip occurred in less than 0.5s. Maximum shut down time could therefore be up to 1.0 seconds for these technologies."

For directly coupled generators with a separate protection relay and a contactor it is reasonable to expect 100 ms operation time to be achievable. The Consultants suggest that the tolerance in section 5.3.1 is changed to -0s + 0.1s, which is in line with G59/2, but that the LoM disconnection requirement would stay at 1 second for maximum shut down time.

3.4.3 Required accuracy of interface protection

There is a typographical error which appears to have caused some confusion amongst the responses to Section 5.3.1 in the consultation.

*"The **Manufacturer** must ensure that the **Interface Protection** is capable of measuring frequency to ± 0.2% of the nominal value (± 0.2Hz)"*

Can the WG confirm the intended capability is ± 0.2% (± 0.1Hz). If this is the case the stability tests and no-trip tests are consistent with this setting.

3.4.4 Reference to IEC 60255-5 Standard

One comment suggests that the reference to IEC 60255-5 in section 5.3.1 is inappropriate[7]. It is suggested by the Consultants that this is a typographical error, and the reference should be to IEC 60255; the series of standards for Measuring Relays and Protection Equipment. This requires confirmation with the WG.

3.4.5 LoM detection

Other techniques of LoM detection are referred to in G83/2, and one comment was seeking clarity on this[8]. The allowance for other techniques is appropriate so as not to exclude technologies using methods other than RoCoF and vector shift. The test procedure described is applicable to any LoM protection.

3.4.6 Automatic reconnection

It has been noticed that responses #74 & 76 have been observed as accepted in the G83 Report to the Authority. These responses call for the minimum automatic reconnection time, originally expressed as a range of 20 – 60 seconds, to be increased to 60 seconds. Several other comments expressed concern over the ambiguity of presenting a range, and as a result the value was set at 20 seconds.

[7] Comment number 62, Smart Power Solutions, HHIC, Ceres Power, Appendix 5 of Report to the Authority
[8] Comment number 65, BSC, Appendix 5 of the Report to the Authority

Comment # 74 claims this value will not prevent a SSEG being damaged, which is a serious implication.

It is noted by the Consultants that the value of 20 seconds is inconsistent with the setting in G59/2. It is requested by the Consultants that the WG consider increasing this value to 60 seconds to align with the G59/2 setting, or justify the difference between the two recommendations.

3.4.7 Clarity on group testing

Refer to Section 2.2.7.

3.4.8 Ramp rates

As an alternative to flicker testing, it is permitted to use an inverter with the ramp rate limits set such to avoid excessive flicker. One comment from a manufacturer expresses concern about such a method:

"Introducing ramp rate control at extremely low values suggested will increase rotor speed, noise, wear, and reduce output."[9]

The risk of reduced output is clearly explained in section 5.4.2, and we are satisfied that this is presented as a manufacturer choice, applicable or desirable only for a minority of wind turbines in practise. This option is an important alternative for small wind turbines with low inertia, to full flicker testing during certification.

3.4.9 DC Injection

Two comments highlight the design implications of the proposed 0.25% DC injection limits:

"*The new pro rata limit which is intended to protect against multiple microinverters unfairly penalises single SSEGs in the sub 2 kW range that were designed to be compliant to the 20 mA limit of G83/1-1*."[10]

These concerns relate specifically to <2 kW units, where the new limits are more arduous than G83/1-1 and G59/2 and the cost of an isolation transformer would be significant. G83/2 does not appear to make provision for small units designed to be installed in groups as part of a single installation. The Consultants suggest that this issue is discussed once more between the WG and small SSEG manufacturers to ensure a barrier to connection is not created.

[9] Comment number 85, Eagle Power, Appendix 5 of Report to the Authority.
[10] Comment numbers 98 and 111, Smart Power Sols, Ceres Power, Appendix 5 of Report to the Authority

3.4.10 Use of Interface Protection with configurable settings

No protection relay test bodies responded to the consultation, however one DNO commented on the need to *"indicate if devices with installer / user configurable settings are acceptable or if only devices with fixed manufacturer settings are deemed approved."*[11]

Devices with installer or user configurable settings such as dials for voltage and frequency settings cannot be type tested, as each unit requires testing once the dials have been set. The recommendation of the Consultants is that a statement is included to clarify that devices with a factory programmed settings can be type tested, but devices relying on site configurable settings must be have these settings tested during commissioning.

As a general point, the question of the reliability of type tests and the repeatability of results is not dealt with in G83/2, but the type test verification form now includes a statement by the manufacturer or supplier that all products with the same SSEG type reference number will perform as stated in the type test report.

3.5 Response to Detailed Comments – Non-technical

As well as technical comments, there were also sections of general and editorial comments. Some of these comments, while not included in the table in Appendix 2, are discussed below.

3.5.1 Implementation Period

In the general comments, a number of respondents noted the significant impact of the changes proposed, and called for a transitional or implementation period:

"*The document introduces a number of substantial changes that alter the protection and type test requirements for SSEGs. Given this, it is essential that installers / manufacturers are given sufficient time to develop and test new equipment before the requirements of this document become mandatory."*[12]

The Consultants noted from the mapping exercise that the type tests have become more involved with additional references to external standards.

The Report to Authority (section 5.2.2) states:

"The DCRP has agreed to a 15 month implementation period to allow stakeholders, but specifically manufacturers of SSEG equipment, to change production processes from G83/1-1 to G83/2"

[11] Comment number 129, SP, Appendix 5 of Report to the Authority
[12] Comment number 160, WPD, Appendix 5 of Report to the Authority

An implementation period or transitional period is not discussed in G83/2. However, in the proposed Distribution Code, Guidance Note 2 has been updated, permitting connection under G83/1-1 until 1st September 2013. This is a 15 month period from 1st June 2012.

The implementation date in the foreword of G83/2 should be adjusted from April 2012 to June 2012. This point has been included in the table of editorial comments.

3.5.2 Installer checklist

A comment by Northern Power Grid requested that a check list for installers, which was present in the original G83, be re-considered for inclusion in G83/2[13]. The Working Group (WG) response to this comment was that the comment had been noted and the WG would decide. The WG should be asked to provide an update on the status of this.

3.5.3 Meter Operator definition

One respondent queried the Meter Operator definition, regarding the licensing of Meter Operators[14]. The Working Group response was recorded as "noted". The Distribution Code defines Meter Operator, describing them as being "registered with the Registration Authority", rather than licensed. We have also observed in an Ofgem Guidance document[15] that Meter Operator is not a licence type. Licensed activities are generation, transmission, interconnector, distribution and supply.

The Association of Meter Operators are recorded as not having any comments on G83/2. However, given the difference terms used between the G83/2 and the Distribution Code definition, clarity is requested on this point.

[13] Comment number 309, NPG, Appendix 5 of Report to the Authority
[14] Comment number 172, ENW, Appendix 5 of Report to the Authority
[15] Ofgem; Guidance for gas and electricity license applications; 6th September 2010

4 Conclusions

4.1 Suitability of ER G83/2 for replacing G83/1-1 under the Distribution Code

It is the Consultants' view that a good balance of comments was submitted, the majority of which have been accepted by the Working Group. There have been significant changes to the consultation draft in the final draft submitted in the Report to the Authority. The majority of these revisions are in direct response to comments received during the consultation period; however several changes that were not related to comments were made to Appendix 4 and Annex B. At present the review process does not allow stakeholders to view and comment on these changes.

Following the WG consideration of and response to the recommendations in Section 4.4 below, G83/2 removes a number of inconsistencies and shortfalls which were present in G83/1 and generally provides a simpler, more standardised approach to the connection of SSEG.

Any issues that are considered by the Consultants to be critical to the compliance of G83/2 with the objectives set out in the Terms of Reference are summarised in Section 4.3. Section 4.4 contains additional suggestions for areas of improvement, but these points are not critical to the suitability of ER G83/2 for replacing G83/1-1. These recommendations have been reviewed by the Working Group, whose responses are summarised in this chapter.

The Consultants therefore consider that G83/2 better meets the requirements of the Distribution Code, as set out in Standard Licence Condition 21 of the Electricity Distribution Licence.

4.2 Compliance of ER G83/2 with Electricity Act objectives

A key requirement of ER G83/2 is that it supports Ofgem in meeting its obligations under the Electricity Act; any conflicts between the recommendations of ER G83/2 and Ofgem's obligations are therefore to be avoided.

The most relevant of Ofgem's duties to the areas of activity covered by G83/2 are:

- to promote competition in the generation and supply of electricity – Section 3A(1) of the Act; and

- to protect the public from dangers arising from the generation, transmission or supply of electricity – Section 3(5)(b).

Note that the Electricity Act, when originally enacted, contained a duty on the Authority to protect the interest of consumers in respect of quality of supply (Section 3(3)(a)(iii)). This clause is not in the revised Section 3A of the Electricity Act; the revisions to the duties of the Authority were set out in the

Utilities Act 2000. The quality of supply is covered by the license obligations of the DNOs.

ER G83/2 has an important role to play in these areas, for a number of reasons:

- transparency in the planning and design of the distribution network to accommodate increased amounts of DG is important in encouraging DG developers to come forward, and thus to contribute to increased competition in generation;

- the application of adequate technical standards to minimise the risks to the integrity of the distribution network is crucial if supply quality is not to be compromised with increasing DG penetration; and

- provisions for the protection and earthing of generator plants are crucial to maintain the safe operation of the distribution networks and thus to protect the public adequately.

In many areas the new Engineering Recommendation G83/2 is considered to deliver all of the above requirements. Where there were concerns in specific areas, these have been highlighted in this report and are summarised in Section 4.4 below. As satisfactory responses from the Working Group have been received, the Consultants now consider that the revised G83/2 is consistent with the Authority's principal objectives under The Electricity Act.

4.3 Critical Recommendations

These issues are considered by the Consultants to be critical to the compliance of G83/2 with the objectives set out in the Terms of Reference and should be addressed prior to the finalisation of G83/2. These issues have been reviewed by the G83 Working Group, whose responses are shown in italics under each point.

4.3.1 Accuracy of interface protection

The WG should be asked to confirm that the intended capability of the frequency measurements detailed in Section 5.3.1 is ± 0.2% (± 0.1Hz). The existing draft states ± 0.2Hz, which conflicts with the requirements of the stability tests.

The WG response is that the reference to 0.2Hz is an error and will be corrected to± 0.2% (± 0.1Hz). This is accepted by the Consultants.

4.3.2 Type testing interface protection

Devices with installer or user configurable settings such as dials for voltage and frequency settings cannot be type tested, as each unit requires testing once the

dials have been set. The recommendation of the Consultants is that a statement is included to clarify that devices with factory programmed settings can be type tested, but devices relying on site configurable settings must be have these settings tested during commissioning.

The WG response is that a statement that "only devices that have protection settings set and locked during manufacture can be considered as type tested" will be included. This is accepted by the Consultants.

4.3.3 Automatic reconnection

The original draft had a minimum automatic reconnection time, expressed as a range of 20 – 60 seconds. This was changed to 20 seconds despite comments in favour of the use of 60 seconds to prevent damage to SSEGs and the fact this would align G83/2 with G59/2.

It is recommended by the Consultants that the WG consider increasing this value to 60 seconds to align with the G59/2 setting.

The WG response explains that the 20 second reconnection time is taken from BS EN 50438 and a reference to this standard will be included. Manufacturers of inverter connected equipment have confirmed that no damage will occur to such equipment with a 20 second reconnection time. This is accepted by the Consultants.

4.3.4 Power Quality limits

Harmonics: The new pro rata harmonics limit, which is intended to protect against multiple microinverters, is in conflict with (and more arduous than) G5/4 stage 1 which refers directly to BS EN 61000-3-2. The Consultants recommend that the WG be asked to address this conflict and potential ambiguity between G5/4 and G83/2 prior to the finalization of G83/2.

Flicker: The new pro rata approach to the flicker limits is in conflict with ER P28 Stage 1, which refers directly to BS EN 61000-3-3. The Consultants recommend that the WG be asked to address this conflict and potential ambiguity between P28 and G83/2 prior to the finalization of G83/2.

The WG response is that it is expected that both G5/4 and P28 will be updated to provide proportional standards for all connected devices. A cover note will be included in the publication communication alerting stakeholders to the follow up work required on ER G5/4, P28 and G59/2(Annex 1). This is accepted by the Consultants.

DC Injection: The DC injection limit of 0.25% of the AC current rating per phase could penalise small SSEGs designed to the 20 mA G83/1-1 limit. A 1 kW single phase inverter would now have a DC current limit of 10.9 mA. The Consultants are also concerned about the implications of choosing a lower limit than much of

Europe, where 0.5% to 1% limits are common. It is the recommendation of the Consultants that the WG consider an impact assessment on the < 2kW SSEG industry to find out how many manufacturers would be adversely affected by these limits and the technical viability of meeting this limit.

The WG response states that there is no evidence that further relaxing DC injection limits would be safe in terms of potential damage to buried utility plant. A review of international limits was conducted by a recent DCRP working group declared that the basis for the various limits was unclear. In relation to the < 2kW SSEG, text will be added to include a reference to 20mA for single installations. This is accepted by the Consultants.

4.3.5 Flicker testing for wind turbines

The new test method proposed in G83/2 will yield multiple results for Pst. However no guidance is given as to which results should be recorded in the Type Test Report in Appendix 4. It is suggested that the WG insert a clear explanation as to which values are required from the test, and where these should be recorded.

The WG response is that text shall be included in section 5.4.2 to state the highest parameter measured across the entire range of tests shall be recorded. This is accepted by the Consultants.

4.3.6 Short Circuit test

The description of the short circuit test is at points confusing and conflicts with the diagram. To ensure correct interpretation of the short circuit test, it is recommended by the Consultants that the circuit diagram is modified as follows:

- For clarity, IEC symbols should be used, and the switches numbered.
- The inverter should be shown connected to a power supply on the DC side.
- The connection to the mains supply should also be clearly marked.
- The switches do not need to be interlocked, but if shown as interlocked switches or a changeover switch, then it must be specified to be a make before break switch to avoid a momentary open-circuit on the inverter.

The switch connecting the inverter to the reduced voltage point does not switch out the load as currently drawn. This text should be changed to reflect the revised diagram.

The WG response is that the diagram shall be re-drawn to include an IEC symbol for the make before break switch and the text updated accordingly. The DC power supply and Mains supply will also be marked on. This is accepted by the Consultants.

4.4 Additional Recommendations

These recommendations are not critical to the suitability of ER G83/2 for replacing G83/1-1, however the Consultants suggest that they are considered by the WG.

As a general note, it would be useful for future reviews if the WG could give an explanation for rejecting comments, rather than simply stating that they have been rejected.

4.4.1 Reference to ESQCR

The Consultants' view is that it would be useful for the reader to have a reference to ESQCR; either at the start of Section 5 (from where it has been removed), or in the foreword of G83.

The WG response is that a reference to ESQCR, and in particular part 22 (2), will be included in the foreword of G83/2 and appendices. This is accepted by the Consultants.

4.4.2 Distribution License Conditions

G83/2 complies with the License conditions in respect of the Distribution Code with the exception of the conflict between DPC 4.2.2.1 and Section 5.3 of G83/2 which should be raised with the WG. It should be noted that this conflict existed in respect of G83/1-1.

The WG response is that an additional paragraph shall be included in section 5.3, stating that the DNO is responsible for ensuring, by design, that the voltage and frequency at the connection point remains within statutory limits. This is accepted by the Consultants.

4.4.3 Interface Protection Settings

The WG have recommended that the voltage settings in G59 be updated to match these settings in G83/2 and is expected that this will clarify the G83/2 voltage protection settings. However as the voltage protection settings are outside the statutory voltage limits there is a possibility of continuous operation at up to 4% over voltage above limits. It is suggested that the WG be asked to provide a brief explanation of the reasoning behind the voltage settings in G83/2, and a clear demonstration that there are no significant safety risks.

The WG response clarifies that the G83/2 Interface Protection settings have been chosen to allow for voltage rise or drop within the customer's installation and this explanation shall be included in Section 5.3. This is accepted by the Consultants.

The tolerance on the total disconnection time for voltage and frequency protection is -0s + 0.5s which is of the same order of magnitude of the Trip Delay Setting itself. The Consultants suggest that for harmony with G59/2, this tolerance is reduced from -0s + 0.5s to -0s + 0.1s. A brief review of products currently on the market suggests most manufacturers achieve this already.

The WG response explains that the value of 0.5s was requested by a directly coupled SSEG manufacturer due to the inability to disconnect electrically before mechanical braking has been applied.

*This reason is **not** accepted by the Consultants. The interface protection is not intended to provide protection for the SSEG itself – mechanical SSEG protection should be fail safe, and no SSEG should be dependent on the continuity of supply in order to safely disconnect. The resolution of this issue is not critical to the publication G83/2, however it is likely to be raised again if G59/2 is considered for review.*

4.4.4 Type Test Verification Report

As discussed in Section 4.1 several changes have been made between the draft circulated for comment and the revised document that were not related to the comments received. The changes to Appendix 4, Type Test Verification Report, accommodate the results of the new tests and procedures specified in Section 5 and are not regarded as contentious.

The WG response is that these changes were made following a comment by a DNO about the general layout of the document. This is accepted by the Consultants.

4.4.5 Short Circuit Test

The short circuit test procedure outlined in Annexe B has been replaced by a reference to BS EN 60034-4 (Methods for determining synchronous machine quantities from tests). The Consultants are unsure as to whether this standard is in common usage amongst SSEG manufacturers and would suggest that the WG review this with the appropriate stakeholders prior to G83/2 finalisation

The WG response states that BS EN 60034-4 is referenced in G59/2 for synchronous machines, and was therefore appropriate to include in G83 for any conventional generating units. This is accepted by the Consultants.

4.4.6 Check list for installers

The WG should be asked to provide an update on the status of the inclusion of a check list for installers, which was present in the original G83.

The WG response is that the Microgeneration Certification Scheme adequately ensures that generation is commissioned satisfactorily; installers on the WG agreed with this. This is accepted by the Consultants.

4.4.7 Meter Operator definition

The Meter Operator definition refers to the "licensing" of Meter Operators. The Distribution Code defines Meter Operator as being "registered with the Registration Authority", rather than licensed. We have also observed in an Ofgem Guidance document that Meter Operator is not a licence type. Clarity is requested on this point.

The WG response is that the definition will be aligned with the D-Code. This is accepted by the Consultants.

4.4.8 Reference to Standard

Confirmation should be sought from the WG in respect of the reference to IEC 60255-5 in section 5.3.1. This is carried over from G83/1-1, but it is suggested by the Consultants that the reference should be to all sections of IEC 60255; the series of standards for Measuring Relays and Protection Equipment, as is the case in G59/2.

The WG response is that reference will now be made to all sections of the BS EN 60255 series, with additional text to clarify that where standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable. This is accepted by the Consultants.

4.4.9 General typographical comments

A table of drafting typographical comments is given in Appendix 3 which should be addressed prior to finalisation of G83/2.

The WG response is that all typographical comments will be accepted. This is accepted by the Consultants.

Appendices

Appendix 1 – Mapping of G83/1-1 to G83/2

Existing document (G83/1-1)	G83/2 applicable paragraphs	Comments
1 Foreword		
	General	Has now become Section 1 Foreword, most of this has come across to G83/2, noting the following.
	1 para 1	NEW paragraph in G83/2 (paragraph 1) including effective date, approval authority and approved abbreviated title.
1 para 3	1 para 4	Deleted point (c) in G83/1-1.
2 Scope		
	General	Similar to G83/1-1, but with improved clarity and description of processes.
2 para 1	2 para 1	Added clarity on power rating corresponding to current limit of SSEG.
	2 para 2	NEW clarity on inverter rating.
2 para 2	2 para 3 – 5	Rather than "two stage process", which was considered to be misleading, now describes two separate connection processes. Improvement on G83/1-1.
2 para 3	2 para 6	No change.
2 para 3 Notes 1 and 2	2 para 7, last sentence	Notes removed – this is now covered in a sentence (updated references).
2 para 4	2 para 7	No change (except for sentence noted above)
2 para 5	2 para 8	Updated for correct annex references, and to state that requirement for new annex to be referred to DCRP.
2 para 6	2 para 9	Removed "that have been designed to simplify and standardise type verification".
2 para 7	2 para 10	No change.
2 para 8	2 para 11	No change.
3 References		
	3 para 1	NEW Introductory paragraph.
		Removed the following references: IEC 60364-7-712 Electrical installations of buildings – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems. ETR 113 (no longer in use) Updated for correct BS number: BS EN 61034-4: 1995 Methods for determining synchronous machine quantities from tests. Note version referenced is 1995, there is a 2008 version available – however not says for dated references only edition cited applies – therefore presume this is deliberately given as 1995

		Added nine new references to British and European standards.
4 Definitions		
		Added significant number of defined terms. Comments on individual terms have been captured in the Review of the Report to the Authority (WG comments) and editorial comments.
5. Requirements		
5.1 para 1		Removed – no longer a 2 stage procedure.
5.1 para 2		Removed. This paragraph referred the reader to ESQCR wrt need to advise DNO about SSEG and for DNO to accept if Reg 22 (parallel operation) and 26 (danger or interference) complied with. D Code fits in here legally with Ofgem legal req: "The DNO and potential and existing generators, suppliers and customers connected to (or seeking connection to) the DNO's distribution system must comply with the Distribution Code." D Code DPC 7 has compliance with G83 or with sections of DPC 7 and G59. Would be useful for reader to have reference to ESQCR either at start of this section, or in foreword.
5.1.1 para 1	5.1.1 para 1	Now allows for multiple generating units to connect, provided that the aggregate is no greater than 16 A per phase. Updated 30 day notification to 28 days. As per accepted comment #182 the titles in Appendix 1 Connection Procedure Flow Chart have changed from the original draft of 'Single Connection Process' to 'Connecting SSEG(s) in a single premises' and 'Multiple Connection Process' to 'Connecting SSEG(s) in multiple premises. These process title changes should be reflected in the headings of 5.1.1 and 5.1.2.
	5.1.1 para 2	NEW Clarifies where the multiple connection process should apply.
5.1.2 para 1	5.1.2 para 1	Specifies that this is across two or more premises. Updated 30 day notification to 28 days. As per note above 5.1.1 para 1 As per accepted comment #238 the last sentence should read "no later than 28 days after commissioning"
5.2 para 1	5.2	Change of terminology: Supply Terminals to Exit Point.
5.3 para 1	5.3 Para 1 & 5.3.3	Design of SSEG to operate within statutory limits has been removed Physical location of interface protection clarified.
5.3.1 para 1	5.3.1 para 7 & 5.3.3	General statement on withstand of voltage + freq variation changed to include need for **full stability test requirement**
5.3.1 para 2	5.3.1 para 8	No Change
5.3.1 para 3	5.3 para 1 & 5.3.1 para 8	No Change
5.3.1 para 4	5.3.1 para 9	No Change

5.3.1 para 5	5.3.1 para 10	No Change
Table 1 and Notes	Table 1 and Notes	Protection settings changed to bring in 2-stage protection for voltage and freq. Actual Volts settings aligned with G59/2 but nominal voltage still 230V for G83 and 240 for G59 so % settings adjusted accordingly. Extended relay operation times for inverter connected SSEG units removed. To align with G59/2.
New	5.3.1 para 2	Addition of trip delay settings tolerance (including operation time)
New	5.3.1 para 3	Clarification of Trip Delay
New	5.3.1 para 4 & 5	NEW requirement to display protection settings on a screen or permanent attachment to the device.
New	5.3.1 para 6	NEW requirement for measuring accuracy of interface protection.
5.3.2	5.2.3 & Table 1	Detection of loss of a single phase now required for 3 phase machines. Part of type test.
New	5.3.3	Freq Drift and Step Change Stability Test: Stability type tests - RoCoF and Vector Shift stability tests to be carried out as part of type test. Note included to warn of increase in RoCoF stability requirement with new European network codes (2014/2015).
5.3.3	5.3.4	Minimum re-connection time decreased from 3 mins to 20 seconds. There was discussion in comments re range given in draft 20 – 60 s. Both 20 and 60 s were accepted (Comments 73 – 76) and 20 s is in revised document.
5.4 para 1	5.4 para 1	No Change.
Table 2 & Notes	Table 2 and 5.4 para 2-3	No change to basic emission standards requirements. Emphasis on impact of large volumes of SSEGs on LV network. NEW procedure for harmonic and flicker tests.
New	5.4.1	Testing for harmonic emissions: Grouped testing for SSEGs<2kW. All results normalised to 3.68kW per phase.
New	5.4.2	Testing for Flicker: Grouped testing for SSEGs<2kW. All results normalised to 3.68kW per phase AND standard source impedance. Simplified source impedance conversion method provided for the case PF >0.98 For Wind Turbines flicker test to be carried out during IEC 61400-12 performance testing OR inverter ramp-rate limits to be set.
5.5	5.5	DC Injection – NEW proportional limit of 0.25% of AC current per phase replaces 20mA limit.
5.6	5.6	No change
5.7 para 1	5.7.1 para 1 & 5.7.2 para	Responsibility change from installer to manufacturer to declare maximum short circuit current contribution from SSEG.
5.7 para 2	5.7.1 para 2	No Change
5.7 para 3	5.7.1 para 3&4	No Change
Table 3	Table 3	No Change

New	5.7.2	Inverter Connected Generation: NEW test for inverter system fault levels detailed in Annex 4.6
5.8	DELETED	Technologies not referenced in the Annexes – DELETED This is covered in Section 2 Scope – requirement for new type testing annex
New	5.8	Voltage Unbalance: To be considered for multiple installations of SSEGs.
5.9.1	5.9.1	Reference to test house type testing removed.
5.9.2	5.9.2	No Change
5.9.3	5.9.3	No Change
6 Operation and Safety		
	General	Changes mainly relate to updates to reflect revised defined terms. New reference to standard (BS EN 60664-1). More detailed example circuit diagram.
6.1 para 1	6.1 para 1	No change.
6.2 para1	6.2 para 1	No significant change, updated to reflect revised defined terms.
Figure 1	Figure 1	Additional warning on label – as in original text
6.2 para 1 note	6.2 para 1 note	No change.
6.2 para 2	6.2 para 2	No significant change, updated to reflect revised defined terms.
6.2 para 3	6.2 para 3	Introduction to circuit diagram – deleted sentences to reflect changes to diagram.
6.2 para 4	6.2 para 4	No change.
6.3 para 1	6.3 para 1	No change.
6.4 para 1	6.4 para 1	Included text on "following exception" (editorial).
6.4 para 2	6.4 para 2	NEW reference to requirements in 5.3.3 of BS EN 60664-1 for basic insulation ("Insulation coordination for equipment within low-voltage systems. Principles, requirements and tests").
6.4 para 3	6.4 para 3	No change.
Figure 2	Figure 2	Example circuit diagram is more detailed, containing more parts of the SSEG.
7 Commissioning / Decommissioning and Acceptance Testing		
7.1 para 1	7.1 para 1	Removed reference to Appendix 1 (Connection Procedure Flow Chart). There is now no reference to Appendix 1 in the main text of the document. There should be a reference to this Appendix – suggest including the sentence that has been removed.
7.1 para 2	7.1 para 2	No change.
7.1 para 3	7.1 para 3	Removed reference to "stage 2 process". As per comment #182 should this reference Multiple Premises Connection application rather than multiple connection application
7.2 para 1	7.2 para 1	More detailed/complete description of installers.
7.2 para 2	7.2 para 2	No change.
7.2 para 3	7.2 para 3	No change.
7.2 note	7.2 para 4	Expanded in respect of description of LoM test.
7.3 para 1	7.3 para 1	Updated to reflect HSE notification timescale reduced

		from 30 days to 28 days
7.3 para 2	7.4 para 1	No change (moved to own section, 7.4, in G83/2).
7.4 para 1	7.5 para 1	No change.

Appendices - mapping

Existing document (G83/1-1)	G83/2 applicable paragraphs	Comments
Appendix 1 Connection Procedure Flow Chart		
	General	Updated to reflect revised processes.
	Description of Appendix	NEW description of Appendix, redirects reader to G59 where appropriate.
Note	Note	No change.
Flow charts	Flow charts	Updated to reflect improved definition of single and multiple premises connections, and HSE notification timescale reduced from 30 days to 28 days.
Appendix 2 Application for Connection		
	General	Simpler form, fewer requirements on applicant.
Project details	Installer details / Proposed SSEG details	Some of these fields have been removed; some are contained in other sections of the form.
Installer details	Installer details	Not requesting fax number.
SSEG details	Proposed SSEG details	Not requesting SSEG owner and SSEG location. Now requesting Type Testing reference number.
Other information to be enclosed		Not requesting type verification test certificate, copy of system circuit diagram, earthing arrangements, site layout plans.
Declaration		No declaration section.
DNO comments		No pro-forma for DNO response to application.
Appendix 3 SSEG Installation Commissioning Confirmation		
	General	Simpler form, fewer requirements on applicant.
Site details	SSEG Installation details	
Contact details	SSEG owner if different from above	
SSEG details	No section heading Appendix 4	Include section heading, e.g. SSEG details. Not requesting manufacturer and model type, serial number of SSEG, serial number / versions of software, SSEG rating (A) and power factor, maximum peak short circuit current, location of SSEG and isolator. Some of these are captured in Appendix 4. Now requesting capacities (kW) and type test reference number.
Installer details	Below declaration	Not requesting fax number.
Information to be enclosed	Part of declaration	Not requesting SSEG test report (Appendix 4), schedule of protection settings, electricity meter(s) make and model.
Declaration	Declaration	Not requesting declaration of LoM test, protection

		settings compliance, protection settings protection, safety labels, compliance with BS767 and installation test certificate. Some of these are captured in Appendix 4.
Appendix 4 Type Verification Test Report		
SSEG Details	Appendix 4	Inclusion of a SSEG Type Reference Number. *To be assigned by manufacturers?*
Test House Details		REMOVED
Test Details	Power Quality. Voltage fluctuations and Flicker.	Location and test date now required only for Voltage Flicker test – due to onsite testing requirement.
New	SSEG Manufacturer declaration	NEW statement of self certification by manufacturer or supplier that all products with a specific type reference number will be manufactured and tested to ensure they perform as stated in this test report.
Power Quality	Harmonics Voltage fluctuations and Flicker DC Injection Power Factor	Normalised values required + measurements at 45-55% of rated output as well as full load. Greater emphasis on recording all measured data prior to normalization. D_c and $D_{(t)}$ values also required. *No additional space to include results from Wind Turbine flicker tests at different wind speeds.* No change No change
U/O Freq Tests	Protection. Frequency tests	Inclusion of 'no trip tests' for stability.
U/O Voltage Tests	Protection. Voltage tests	Inclusion of 'no trip tests' for stability.
LoM Test	Protection. Loss of Mains tests	Much stronger emphasis on LoM testing. All LoM tests to be performed with a load on the islanded network of 95% of SSEG output and 105% SSEG output. Loss of phase to be tested for each phase. Acknowledgement of inverter type testing to BS EN 62116 as alternative route.
New	Protection. Frequency change, Stability test	NEW section to accompany stability requirement from section 5.3.3
Reconnection Times	Protection. Re-connection timer	Potential for Individual time delay settings for U/OV U/OF and LoM removed. One time delay setting. Minimum 20sec. NEW test to confirm no reconnection when voltage or freq just outside limits.
Fault Level Contribution	Fault Level Contribution	NEW section of results table for Inverter connected SSEGs. REMOVED * note to say I''_k and i_{DC} and $^X/_R$ should only be provided where the SC duration is sufficiently long to enable interpolation o the plot.
Self Monitoring – Solid State	Self Monitoring – Solid State Switching	No change

Switching		
Appendix 5 SSEG Decommissioning Confirmation		
	General	Data requests different, but no significant changes.
Site details	Top section of Appendix (no section heading)	Include SSEG address details section heading Not requesting DNO. Now requesting electricity customer at site.
SSEG details	Details of installation	Not requesting manufacturer and model type, serial number of SSEG, SSEG rating (A). Now requesting capacity (kW).
Decommissioning agent details	Below declaration	Not requesting fax number.
	Declaration	NEW declaration that SSEG has been modified or decommissioned. Now requested to provide a copy of the system schematic.

Annexes - mapping

Existing document	**G83/2 applicable paragraphs**	**Comments**
G83/1-1 Annex A	REMOVED	Network Design Considerations not included in G83/2.
NEW	G83/2 Annex A-C Guidance on Type Testing Requirements	Explains use of NEW separate Annexes for Inverter connected OR directly coupled SSEGs. Specific Technology requirements to be applied in addition to most appropriate Annex A or B.
G83/1-1 Annex B Domestic CHP	REMOVED	
B.1	C1.1 & A1.1 or C1.1 & B1.1	Type testing method now split for Inverter connected and directly coupled CHP.
B.2	A1.2 or B1.2	Removal of the explicit reference to EMC and LV Directives.
B.3	A1.3 or B1.3	Additional statement that type testing will verify the SSEG remaining connected to the DNO's network when the network conditions are within the protection settings.
B3.1	A1.3.2 & Fig A2 or B1.3.2 & Fig B2	Change in test voltage steps – decrease to +/- 0.5%. Inclusion of "no trip" tests. Example included to clarify test procedure. Figure to show test Set Up
B3.2	A1.3.3 & Fig A3 or B1.3.3 & Fig B3	Test frequency should preferably be applied as ramp. Disabling LoM protection is now allowed to test O/UF operation. Inclusion of ride-through operation tests.
B3.3	A1.3.4 Or B1.3.4	LoM tests to be carried out in accordance with BS EN 62116 for inverter connected SSEGs. For directly coupled SSEGs test simplified to single SSEG connected to the network

		with a resonant circuit to model interaction with other SSEGs. Load levels specified as 10%, 55% and 100%
B3.4	A1.3.5 or B1.3.5	No significant change
New	A1.3.6 or B1.3.6	
B4.1	A1.4.1 or B1.4.1	Harmonics – measurements to be undertaken at two power levels.
B4.2	A1.4.2 or B1.4.2	Power Factor – No change
B4.3	A1.4.3 or B1.4.3 and C1.1	No change
B4.4	A1.4.4 or B1.4.4	DC injection to be measured at three power levels for inverter connected. 0% load is acceptable measuring point for directly coupled. Isolation transformer accepted in lieu of meeting the test requirements.
B4.5	A1.4.5 or B1.4.5	Removal of blanket requirement for over current protection. Where appropriate shall comply with BS7671.
B4.6	A1.4.6 Or B1.4.6	Reference to BS EN 61034-4 removed. NEW test circuit and test method for inverter connected SSEGs. For directly coupled SSEGs test procedure is now referred to BS EN 60034-4.
New	A1.4.7	
New	A1.4.8 & B1.4.7	Compliance with generic EMC standards moved to here.
G83/1-1 Annex C Photo-Voltaic (PV)	REMOVED	
C1	C1.2 & A1.1	Consideration of G77/1 certified inverters removed. Reference to inverters > 16A removed.
C2	A1.2	Removal of the explicit reference to EMC and LV Directives.
C3	A1.3	Additional statement that type testing will verify the SSEG remaining connected to the DNO's network when the network conditions are within the protection settings.
C3.1	A1.3.1	Removal of provision for inverters able to withstand a 180deg out of synch re-connection.
C3.2	A1.3.2 & Fig A2	Inclusion of "no trip" tests. Example included to clarify test procedure. Figure to show SSEG O/UV Test Set Up
C3.3	A1.3.3 & Fig A3	Test frequency should preferably be applied as ramp. Disabling LoM protection is now allowed to test O/UF operation. Inclusion of ride-through operation tests.
C3.4	A1.3.4	LoM tests to be carried out in accordance with BS EN 62116 for inverter connected SSEGs. Load levels specified as 10%, 55% and

		100%
C3.5	A1.3.5	Minimum re-connection time of 3 minutes removed.
C4.1	A1.4.1	Harmonics – measurements to be undertaken at two power levels.
C4.2	A1.4.2	Power Factor – No change
C4.3	A1.4.3	No change
C4.4	A1.4.4	DC injection to be measured at three power levels for inverter connected. 0% load is acceptable measuring point for directly coupled. Isolation transformer accepted in lieu of meeting the test requirements.
C4.5	A1.4.5	Removal of blanket requirement for over current protection.
C4.6	A1.4.6	Automatic compliance for inverters REMOVED. NEW test circuit and test method for inverter connected SSEGs.
C4.7	A1.4.7	No change
C4.8	A1.4.8	No change
C4.9	REMOVED	Removed reference to installation standards for PV.
G83/1-1 Annex D Fuel Cells	REMOVED	
D1	C1.3 & A1.1	Type testing method now covered by Inverter Connected annex A.
D2		Background to fuel cells removed.
D3	A1.2	Removal of reference to fuel cell standards IEC 62282 or equivalent. Removal of the explicit reference to EMC and LV Directives.
D4	A1.3	Additional statement that type testing will verify the SSEG remaining connected to the DNO's network when the network conditions are within the protection settings.
D4.1	A1.3.1	Removal of provision for inverters able to withstand a 180deg out of synch re-connection.
D4.2	A1.3.2 & Fig A2	Inclusion of "no trip" tests. Example included to clarify test procedure. Figure to show SSEG O/UV Test Set Up
D4.3	A1.3.3 & Fig A3	Test frequency should preferably be applied as ramp. Disabling LoM protection is now allowed to test O/UF operation. Inclusion of ride-through operation tests.
D4.4	A1.3.4	LoM tests to be carried out in accordance with BS EN 62116 for inverter connected SSEGs.
D4.5	A1.3.5	Minimum re-connection time of 3 minutes removed.
D5.1	A1.4.1	Harmonics – measurements to be undertaken at two power levels.
D5.2	A1.4.2	Power Factor – No change

D5.3	A1.4.3	No change
D5.4	A1.4.4	DC injection to be measured at three power levels for inverter connected. Isolation transformer accepted in lieu of meeting the test requirements.
D5.5	A1.4.5	Removal of blanket requirement for over current protection.
D5.6	A1.4.6	Automatic compliance for inverters REMOVED. NEW test circuit and test method for inverter connected SSEGs.
D5.7	A1.4.7	No change
New	A1.4.8	Compliance with generic EMC standards moved to here.
D6		Decommissioning & Fuel Cell Stack replacement REMOVED. Like-for-like replacement of fuel stacks without notification of the DNO no longer allowed.
D7		Earthing arrangements REMOVED.
G83/1-1 Annex E	REMOVED	Micro wind now included in testing annexes.
G83/1-1 Annex F Micro Hydro	REMOVED	
F1	C1.4 & A1.1 or B1.1	Type testing method now covered by Inverter Connected annex A or Directly Coupled Annex B.
F2		Type A system design considerations REMOVED
F3		Type B system design considerations REMOVED
F4	A1.2	
F5.1		Reference to BS 7671 GN7 Ch 18 REMOVED.
F5.2	Annex A	Same principal of Type A and Type B followed.
F6	Annex B	Same principal of Type A and Type B followed.
F6.1		Reference to BS 7671 GN7 Ch 18 REMOVED.
F6.2 – 6.9	B1.3	As Fuel Cells, see above for comments.
F6.10	REMOVED	No site tests required for interface protection.
F7.1	B1.4.1	Harmonics – measurements to be undertaken at two power levels. G5/4 limits no longer apply.
F7.2	B1.4.2	Power Factor – No change
F7.3	B1.4.3	Tests must be to BS EN 61000-3-3. P28 are no longer applied.
F7.4	B1.4.4	DC injection to be measured at 0% power levels to capture contribution from electronics.
F7.5	B1.4.5	Removal of blanket requirement for over current protection.
F7.6	B1.4.6	Test procedure is now referred to BS EN 60034-4.
F7.7	B1.4.7	No change

Appendix 2 – Consultant's Response to Working Group comments

Technical comments with more than one comment on the same issue, or that have not been accepted.

Comment #	Clause / Sub-clause	Comment	WG Response	Consultant's View
17.	4	**SSEG:** The revised definitions refer to 'power requirements' rather than clarifying if these are import or export requirements. Change text to: …, with a power export capability not in excess of 3.68 killowatts (kW) …	Rejected Added .. Where the **SSEG** includes an **Inverter** its rating is deemed to be the **Inverter's** continuous steady state rating.	Definition is clearer in revised document. OK
21.	2, para 1	Should split phase also be mentioned Consider including "7.36kW split phase, ….)	Rejected	Split phase (3 wire), distribution is used on farms, presumably the WG wanted to keep the document straightforward – the text is still applicable to a split phase system. OK
22 – 23.	2, para 1	Reference to nominal voltage: WPD: The line does not explain the relevance of the nominal voltage. Propose: The kW rating shall be based on the nominal voltage (i.e. 230V) as defined in BS EN 50610 and the Electricity Safety Quality and Continuity Regulations (ESQCR). STA: The sentence regarding nominal voltage is confusing and it is not clear why it is here …ie it is not wholly obvious that it is the voltage to be used when calculating the kW figure. Propose: "When calculating power, the nominal voltage of 230/400 shall be used - as stipulated by BS EN 50160 and the 210 Electricity Supply Quality and Continuity Regulations (ESQCR).	Accepted	No comment, it's been accepted
10, 25, 26.	4	Close geographic region (definition) NPG: **Close Geographic Region 2)**. Clarify that it is the distance between the premises where installation is planned. Change text to:2) The premises where a SSEG installation is planned by the same organisation are within 500m of each other.	Accepted	Change of text between drafting to make onus on DNO to establish if other DNOs in vicinity. Comment been accepted OK

		SP: It seems very onerous to expect every PV installer to survey every property within 500m of a planned installation. Adopt wording more closely related to the paragraph starting on line 567 i.e. an installer should follow the multiple connections process if the installer concerned has themselves previously installed PV within 500m. SP: Why should the question relate to **PV** installations within 500m to determine if the multiple connection process is applicable? Ask if the installer has installed any type of SSEG within 500m of the proposed Connection.		
27.	4	Customer (definition) Customer is defined as being connected to the distribution system yet following the definitions through, suggests that a customer is only connected to another authorised distributor (not directly to a DNO distribution system) not sure that this is the correct intention Add "or to a **Distribution Network**"	Rejected Used the definition from the D Code	Although comment marked as rejected the definition has been changed to D Code definition which is sensible / consistent. OK
29 and 111.	4 Definitions (line 480, 486??)	Sensing grid voltage at the DNO connection is impractical. To implement this would require a pair of sensing wires between Supply Terminals and the SSEG. Since no installation provides these sensing wires so all installations de facto reference to the SSEG terminals anyway. This is a practical problem that will reduce the number of SSEGs exporting on high voltage grids. If this is issue is not allowed for then SSEGs will shut down on lower grid volts than intended. In all installations a variable voltage drop exists between the SSEG terminals and the Supply Terminals. Hence there is 'voltage lifting' proportional to the exported power. The length of wire between the SSEG and Supply Terminals is installation dependant. For example a PV inverter in a roof space or a rotating machine wind or water turbine may be remote from the DNO Supply Terminals compared to a CHP installed in a garage.	Rejected	ESQCR defines Voltage 230 / 400 V +10, -6 % - this is at the Exit point. The interface protection will be physically close to the generator / inverter system, (control cable practical limitations), therefore there will be V drop between the interface protection and the Exit Point. No where is the V produced by the generator specified. The DNO is taking the risk wrt to the V drop and the interface protection settings – perhaps why stage 1 O/V is +14%

		A practical solution is to make an allowance for this voltage drop pro-rataed to exported power. Propose: Voltages are referenced to terminals of SSEG and an additional correction is added to allow for the range of voltage drop in installation wiring. Example Setting is 273.7V. Additional allowance for voltage lift is 0V to 3V from 0 Watts exported to rated power. So setting is now 273.7Vat 0W and 276.7V at rated power. Similarly for undervoltage.		
40.	5.2	Directly connect SSEG to an Isolation switch where phase and neutral are isolated etc Micro inverters cannot comply with this requirement as they are close coupled. How is this expected to be dealt with? The semi conductor switching is clearly accepted in rest of document but not in this section. Propose: Use text from BS7671 and also section 5.3.1 line 607allowing use of semi conductor switching to ensure new technologies not penalised by this reqmt	Rejected Line 589 – change to *The SSEG(s) shall be connected via an isolation etc etc*	Rejection supported by BS 7671 - states semiconductor devices shall not be used as isolating devices. OK.
41 and 44.	5.2	"machines" does not seem appropriate, as the microgenerator might not be a machine Change to "microgenerator installations"	Rejected Remove reference to machines delete sentence from "where to machines"	Have removed reference to machines OK
42 and 45.	5.2	"phase" (meaning phase conductor, in this context) is out of date terminology. Should be "line" (meaning line conductor) Change to "line"	Rejected	SSQCR refers to phase conductors on distribution system. IEE wiring regs use line conductor (definition included in 17th edition) inside a consumers premises. Both terms widely used. OK
43.	5.2	Capable of being secure in off position. Why must the isolators be lockable? Switched fused spurs are acceptable for other hard wired appliances. Why is lockable isolator reqd for an inverter which is	Rejected but change to - secured in the off position	Represents a sensible interpretation of the wiring regulations. In majority of cases, isolation device remote from actual SSEG (eg PV or wind turbine) so must be able to

		intrinsically safe device. Remove lines 589 and 590		be secured in the open position. OK.
51.	5.3.1 Table 1	It would probably be helpful to explain the rationale for the difference between the G59/2 O/V settings for LV connections of +10% and +15%. Add text to explain that the voltage excursions are wider than those permitted in the ESQCR to allow for additional voltage rise and drop within a customer's installation.	Rejected	Believe this comment is justified and explanation of the Voltage settings is required.
53.	5.3.1 Table 1	The table note relating to the total disconnection time is confusing and different from the G59/2 approach. Table 1 refers to Trip Delay Settings, the implication being that there is a timing device which needs to be set, whilst the note refers to total disconnection time. There is a need to be clear and ideally consistent with G59/2. Clarify requirement to differentiate between a tangible 'delay setting' that should be applied and the 'total disconnection time' which is the aggregation of the protection operating time, delay time and circuit breaker operating time.	Rejected	In G59/2, the table columns are called "Protection Function", "Setting" and "Time". There is a slight difference between G59/2 and G83/2
56.	5.3.1 penultimat e para.	Clarify that the protection shall be set as Table 1 because that's what's require for the system to work properly, rather than so they can be verified. I'd combine this sentence with the one in 5.3.1 parag 5 relating to the settings remaining unchanged Change text to: Protection settings shall be applied as shown in Table 1. Any variation to these settings during installation or following commissioning shall only be made following written agreement between the **DNO** and the **Customer** or his agent. The DNO reserves the right to verify the protection settings.	Rejected	The settings to be inspected section have been expanded between versions. There was always a need for written agreement – the order of paragraphs has changed. OK
58.	5.3.1 and Annex 4	'St 1' ('Stage 1') and 'St 2'('Stage 2'), have no defining characteristics that give a clear understanding of the rates of change in voltage intended to be used 'Stage 1' appears to relate to a slow rate of change, while 'Stage 2' appears to be related to a faster rate of change. Likewise, the tables in Annex 4	Rejected - these are definite time settings	Rate of voltage change not relevant here OK

		provide no guidance. Include rates of change associated with the voltage trip point stages.		
59 and 60.	5.3.1 and Annex 4	1: The voltage stability ('no trip') requirements, when taken in conjunction with 'Stage 1' and 'Stage 2' trip points often contradict, allowing very narrow windows to operate or tend to preclude compliant operation. 2: The voltage stability ('no trip') requirements, when taken in conjunction with 'Stage 1' and 'Stage 2' trip points often contradict, allowing very narrow windows to operate or tend to preclude compliant operation. Refer to attached spreadsheets for analysis:G83_2_trip_settings.xlsx (multiple tabs with data G83_2_TripPointTable_Conflict.xlsx (multiple tabs with data) Option 1 (preferred): Delete the voltage stability ('no trip') requirements. Option 2: Refer to attached spreadsheet G83_2_TripPointTable_Conflict.xlsx for analysis and proposals. The voltage requirements contain windows where required PV SSEG performance is undefined, largely created by the delay and no trip parameters. Refer to attached spreadsheet G83_2_trip_settings.xlsx for analysis (multiple tabs with data). Propose: As above (options 1 and 2)	Rejected As 58. Enphase	Trip test levels and Stage 1 and Stage 2 trip points do not conflict. OK.
62.	5.3.1	IEC 60255-5 is referred to for the requirements of the Interface Protection. This standard is all about insulation between the coil and contacts of the interface protection disconnect relay. In many situations this standard would appear to be wholly inappropriate as the control of the interface protection is referenced to the mains and thus only function insulation is required. If no relays are used, then it is even less appropriate. A statement to this effect would make sense. IEC 60255-5 focusses on the insulation between the coil and contacts of the interface protection disconnect relay; where the control of the interface protection is referenced to the mains voltage then only functional insulation is required. If no	Rejected	Believe this is a typo. 5.3.1 should refer to IEC 60255-1 or "all parts of IEC 60255 so far as they are applicable" which is the wording in G59/2.

		interface protection relays are used, then IEC 60255-5 does not apply.		
65.	5.3.3 Para 3	The statement that "other techniques are also acceptable" is very open. What (or whose) requirements would such techniques have to meet? Clarify	Rejected	Test procedure described would work for any LoM protection. OK
66.	5.3.3 Para 5	In line 648 the accuracy of the frequency measurement is defined to +/- 0.2 % which means +/- 0.1 Hz. In line 681 the range in which to apply the RoCoF is going until the trip settings (47.5 Hz and 51.5 Hz). It would be better to consider the accuracy of the required frequency measurement. Change to: RoCoF: 0.19 Hz per second from 49.5 Hz to 51.4 Hz and from 50.5 Hz to 47.6 Hz.	Rejected	Suggestion to take account of frequency measurement accuracy in defining frequency limits not logical. OK
67, 73, 74, 75, 76	5.3.4	Solar century: SSEG shall remain disconnected from Network until voltage and freq have remained within limits of Table 1 for between 20 and 60 seconds. How does the SSEG manufacturer choose the value between 20 and 60 seconds? Provide more information and guidance on this so SSEG manufacturer can choose appropriate value. NPG: Clarity - There can only be one minimum setting – unless it varies by DNO (in which case the setting would need to be managed) - 20sec or 60 sec. Confirm the minimum setting required eg change text to: …for a minimum of 20 seconds. EATL: Some DNOs employ dead times in excess of 20 seconds therefore this delay will not "prevent a SSEG being damaged" as stated in this clause. Increase time delay to 60 seconds minimum Ted Marynicz: Why is this a range and not a specific number? Does it mean "at least 20 seconds"? Can it be more than 60 seconds? Needs to be clearer. Propose: a minimum of 20 seconds. WPD: Is the minimum delay 20s or 60s? I would prefer this to be replaced with 60s (to eliminate confusion)	Accepted Value set at 20 seconds	What about DNOs with dead times in excess of 20 sec? Safety implications G59/2 states 60 seconds as a minimum. Query why 20 sec has been chosen instead of 60 sec

77.	5.4	There needs to be clarity as to whether the harmonic and voltage fluctuations emissions are SSEG unit, per SSEG system or per Customers Installation. In G83/1 the expectation was that there would only be one SSEG per Customers Installation so the issue didn't arise. The logical extension to this principle is that the emissions per Customers Installation shouldn't exceed the limits in EN61000 series of standards – however this principle potentially conflicts with the concept of each SSEG needing to comply with a product quality standard (ie where a a 200W invertor could have the same harmonic / voltage fluctuation emissions as a 3.6kW unit and 18 x such 200W inverters could have material emissions) Consider; Clarifying that the emission levels are per Customers Installation rather than per SSEG or Review the network implications if multiple SSEG just have to comply with the product standard.	Rejected	Comment is a valid point – not sure why it's been rejected. It covered in 5.4.1 and 5.4.2, where they talk about "testing in groups"? See also comment #80 Covered anyway so OK
83.	5.4.2	Need clear description of what is meant by 'flicker' precisely. It appears to be Wind specific – need to either make that clear in first line Revise first paragraph with clear description of flicker, how it it affects different technologies and how it is tested for.	Rejected	It is not written as being a wind specific issue. Table 2 headings have changed to "Voltage fluctuation and flicker" which makes flicker clearer. OK
85.	5.4.2	Ramp rates in, for instance, SMA WB series inverters are fully adjustable, but **may** only operate on start-up, not when running. ..... Have installed 100s of these at 2000 watts/sec. without any complaint of flicker from anyone. Problem, if it really exists, is more likely inverter instability due to Installer failing to set correct Manufacturer's program data, or very low inertia turbine rotors typical of "roof-top" machines Proposed change: Please check with SMA and other Manufacturers ..... Please clarify if this is a practical or a paper problem, and type of turbines implicated. Introducing ramp rate control at extremely low values suggested will increase rotor speed, noise, wear, and reduce output.	Rejected	Comment partially supported. Different (and significantly more arduous) test method for wind turbines currently has no mention in the report to the Authority. Would be useful to see justification.

94 and 95.	5.5 Para 1	SMA: The requirement of a maximum DC component of 0.5% or 1% of the nominal current has been successfully applied for many years in many countries. Please see attachment for further information. Change to 0.5% National Grid: An upper DC injected limit of 0.25% of total rated output AC current of SSEG 'system' is recommended in the document and I would be interest to better understand how this has been derived. For a 16 A unit installation, this corresponds to 40mA which is much higher than the 5mA previously adopted in G77/1 (superseded by G83/1). However, this corresponds to ½ of the limit (ie 0.5%) adopted n the IEEE1547.	Rejected Noted	G83/2 states "The effects of, and therefore limits for, DC currents injected in the DNO's Distribution System is an area under current investigation by DNOs. Until these investigations are concluded the upper limit for DC injection is 0.25% of AC current rating per phase."
97.	6.1	Add BS7671 to this section on installation reqmt for safety. Add reference to BS7671.	Rejected	This is covered by para 21 of ESQCR BS7671 is in the list of references (section 3) OK
98 and 111.	5.5	The requirement for pro rata limits of 0.25% of rated power for DC injection is inconsistent with G59/1 which allows for " … the limit for DC injection is no more than 20mA per Generating Unit of less than or equal to 2kW rating, and less than 0.25% of the AC rating per Generating Unit greater than 2kW rating." The new pro rata limit which is intended to protect against multiple microinverters unfairly penalises single SSEGs in the sub 2kW range that were designed to be compliant to the 20mA limit of G83/1-1. This will involve significant redesign costs. In addition measuring the very low currents involved will require complex & expensive measuring equipment and is excessively time consuming. Propose: Replace existing text with:- Note - The effects of, and therefore limits for, DC currents injected into the DNO's Distribution System is an area currently under investigation (March 2011) by DNOs. Until these investigations are concluded the limit for DC injection is no more than 20mA per Generating Unit of less than or equal to 2kW rating, and less than 0.25% of the AC rating per Generating Unit greater than 2kW rating. Where multiple similar generating units may reasonably be expected to operate together in a single installation then the ratings above	Rejected	It seems like parts of this have been addressed – e.g. 5.5 para 3 has the note about isolating transformers. And the section does discuss group testing. Meeting <20mA DC injection requirements is challenging, and isolation transformers or filters costly. (could add another 20% on to small inverters) Under these conditions a 1kW CHP plant would face more favourable connection criteria under G59/2.

		apply to the total rated power of the multiple generators. E.g. 10 * 200W generators equates to 2kW rating & so should meet 20mA rating. Where applicable the DC emission requirements can be waived where an isolating transformer is installed between the Inverter and the connection to the DNO's Distribution System.		
99.	Appendix 1 Connection procedure flow chart	Diagram / text should show the G59 route for equipment which is not type-tested.	Rejected as it's in the Scope	Agree with WG that this is clear in the scope OK
109 and 110.	5.4 and 5.4.1 Harmonics 5.4.2 Flicker	NB the note that many SSEGs will exist (para 5.;4.) was also know by the original G83 committee and so applying this factoring retrospectively is unreasonable Tests to BS EN 61000-3-2 are for equipment up to 16A per phase. There is no pro rata limit for power. All equipment tested to Table 1(Class A) as called up by G83 is not pro-rata factored in BS EN 61000-3-2. Adding pro-rata factoring excessively penalises equipment which was designed to meet G83/1-1 since in many cases this will involve costly redesign and so So 3 objections- 1. Technically inconsistent. 2. Unreasonable/retrospective 3. Financially burdensome on manufacturers who designed to meet G83/1-1. **Replace** The test must be carried out with a minimum of 2kW of rated SSEGs. Where an individual SSEG is smaller than 2kW it should be tested as a group. However where a SSEG 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 SSEG 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 SSEG per phase (kW) / 3.68 (kW) **With** The test must be carried out with a minimum of 2kW of rated SSEGs. Where an individual SSEG is smaller than 2kW it should be	Rejected	Not retrospective OK

		tested as a group. However where a SSEG 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.		
113.	5.3.1	**Justification** There are legitimate grid operating conditions (surges and spikes) which cause the grid voltage to rise above the 230V +19% level (e.g. BS EN 61000-4-5:2006) Some outer limits for ride-through capability are needed. It is impractical to expect that "the unit must deliver full power for 0.5s at ANY voltage > 230V +19%". There should be a voltage at which the SSEG can legitimately disconnect/stop generating/to self protect. **NB To be inserted in section 5.3.1 of G83/2 and to be noted in Table 1. Overvoltage Protection- Ridethrough** For grid surge voltages greater than 230V +19% which are present for periods of <0.5s the SSEG is permitted to reduce/cease exporting and to commence exporting at rated power once the grid voltage falls below 230V +19%.	Rejected	This was partially accepted in the same comment #61. Think this has been reasonably addressed by the WG with footnote 2. OK
117.	Appendix 4 (text now in 5.5 para 2)	Confusion arises in final sentence of table header: " a 10kW three phase inverter has a current output of 43.5A at 230V so dc limit is 108.75mA" Propose: " a 10kW three phase inverter has a current output of 14.4A per phase at 230V so dc limit is 36mA per phase"	Rejected	They want single phase specified rather than three phase Limit is given per phase so this suggestion makes sense.
119.	Appendix 4	Voltage fluctuations -should impedance values be used (as defined in BSEN61000-3-11) Propose: Reference impedance = 0.25 + j0.25Ω (single phase) and for multi-phase installations = 0.15 = j 0.15Ω for each line and 0.1 + j0.1Ω for the neutral.	Rejected	OK – Resistances are referenced from 61000-3-3.
126.	Appendix 4 LoM test	Max disconnection time for LoM test is only 1 second. Change max disconnection time to 2 seconds (harmonization with IEC 62116).	Rejected Re-closure of 1s on DNO networks	OK. Safety concern significant if Re-closure of network breakers occurs before disconnection of SSEGs.
127.	Appendix 4 Frequency stability tests	Positive vector shift: for how long is it required to stay at + 9 degrees and -9 degrees? Positive frequency drift: See comment for line 678. And for long is it required to stay at start and end frequency? To be clarified	Rejected	OK. Comment not technically coherent.

128.	Appendix 4 Protection reconnecti on timer	Frequency test values are only 0.1Hz outside the trip setting. This is 0.2% of the nominal frequency and hence (just) within the permitted operating accuracy of the frequency relays, which may therefore operate. Change values to 47.3Hz and 51.7Hz	Rejected	End freq values are as per trip settings stage 1 OK
129.	Annex A and B	Given the requirement for all interface protection to meet the specifications in Table 1 page 13, it would be appropriate for Annex A and B to indicate if devices with installer / user configurable settings are acceptable or if only devices with fixed manufacturer settings are deemed approved. Insert a requirement for 'approved interface protection to incorporate manufacturer configurable settings	Rejected	Highlights critical issue in the "repeatability" of type tested results. Issue not dealt with in proposed standard.
138,139, 141, 142, 153	Annex A A3.2	EATL: 5 tests are required, but only one to be recorded, which one of the 5? Specify highest/lowest voltage as appropriate to be recorded SP: If 5 tests are to be carried out how do we know which result to record ? Suggest we record the minimum value (OV) and maximum (UV) – find more suitable wording – record value with greatest % error ?	Accepted Revised A3.2	No comment – comments accepted.
100, 149, 150, 158	Annex A1 Test circuit (diagram)	Component D is connected by only one wire, which seems incorrect	Accepted Test circuit diagram amended accordingly	No comment – comments accepted.
20.	2 Scope	3.68 Kw only valid if mean grid volts 230. Almost invariably it is just below the legal limit. Accept that the grid has become a two way system & start reducing the voltage to facilitate two way use. Some, not all, DNOs seem to justify maintaining excessive voltage as a policy matter rather than a temporary necessity in certain cases.	Noted	Risk to DNO of SSEG operating outside system voltage limits.
36.	5.1.1 and 5.1.2	This states that the DNO should be advised if there is another installation either planned or installed. This means an installation may not be considered a single installation if there are other installations in the vicinity by other installers or other technologies. How would you find out about a nearby CHP installation? This would be problematic in urban centres, meaning any installation may need to be considered as a multiple connection. Also, if the correct procedure is not followed, the system may	Noted	This has been addressed in 5.1.1 para 2 – stating that the single premises connection will not apply where the installer plans or has already installed other SSEGs in a close geographic region. (i.e. not expected to know about other installations). OK

		need to be disconnected and a second application made.		
37.	5.1.2	‘‘In the case of a planned installation project where the proposal is to install multiple SSEG systems in a Close Geographic Region the Installer shall discuss the installation project with the local DNO at the earliest opportunity. The DNO will need to assess the impact that these connections may have on the Network and specify conditions for connection. The initial application will need to be in a format similar to that shown in Appendix 2.’’ This does pass control to the DNOs but it’s difficult to see how this can be avoided given their responsibilities. Perhaps the onus needs to be on the DNO to establish that proposed connections of multiple SSEG poses real operational or safety issues, rather than the installer having to prove the proposal is safe.	Noted	The situation is as described in the comment. OK
68.	5.3.3	‘Note: Manufacturers considering new designs should allow for the Rate of Change of Frequency where … no longer be allowed under future revisions of this document.’ The above note is helpful. In addition to the above, I believe members of the G83 WG is aware that the largest contingency generation loss will be increased from 1320 MW to 1800 MW in 2014. This increase could cause higher rate of change of frequency than previously experienced and hence the possible unwanted operation of the LoM protection when the system remains intact. A transitional plan to manage this change is required by the Industry and will be led by DCRP/GCRP. Appropriate wordings should be included to capture the background stated in the ‘comment’ column [above]. This should be addressed to a wider audience than the manufacturer.	Noted	Maybe the impact of the largest generation loss is not known enough yet to mention in G83/2. OK
80.	5.4.1	For multiple connections of SSEG, is it proposed to aggregate harmonic current contribution from all units, and if so how are currents to be aggregated – linear addition or with an exponent factor. What limits will be applied? IEC 61000-3-2 Table 1 only applies to loads <16A/ph.	Noted Addressed via group testing Multiple customers not referenced for this document – see G5/4	OK
136.	Annexes A and B	I Believe annexes A and B are so similar that there could be a single annex which has different clauses for the different technologies. This would show common	Noted	OK

		tests easier (no separate clauses), and also highlight which areas require separate tests depending on technologies used.		

Appendix 3 – Typographical Points

Section	Comment
1 Foreword	b) **Users** (embolden the 's')
1 Foreword Para 1	Update the effective date from April 2012 to June 2012; this is consistent with the implementation period set out in Guidance Note 2 in the Distribution Code (15 month period to September 2013).
2 Scope	Footnote 1: "…SSEG by applying software settings…" (include 's')
3 Normative references	BS EN 60034-4: 1995 – can the WG confirm whether they have deliberately chosen to reference the 1995 version, when there is a 2008 version available. The reference to BS EN 60255 is missing the E The following references should be consolidated: • BS EN 61000-3-2 and BS EN 61000 series • BS EN 60255 series and IEC 60255-5
4 Terms and Definitions	**AC** – include a full stop at the end of the definition.
4 Terms and Definitions	**Close geographic region** – delete full stop at the end of 1) (there are two full stops).
4 Terms and Definitions	Carriage return between **Other Authorised Distributor** and **Quality Factor**.
4 Terms and Definitions	**Quality Factor** – replace full stop with colon at the end of NOTE (before equation) and use colon before second Qf equation.
4 Terms and Definitions	**Customer with Own Generation** contains the emboldened term **Generating Sets**, which is not defined in G83/2. Suggest the following definitions from the Distribution Code are included in the G83/2 terms and definitions: • Generating Set • Apparatus (used in above definition) • Equipment (used in above definition) • Plant (used in above definition)
5.1.1	Change heading to "Single Premises Connection Procedure" (as per comment #182).
5.1.1 para 1 last sentence	Change "no later than 28 days of the SSEG(s) being commissioned" to "no later than 28 days after the SSEG(s) have been commissioned".
5.1.2	Change heading to "Multiple Premises Connection Procedure" (as per comment #182).
5.1.2 last sentence	Change to "Confirmation of the commissioning of each SSEG system will need to be made no later than 28 days after commissioning" (as per comment #238)

5.3.1 Para 8	IEC 60255-5 Can the WG confirm if this reference should read IEC 60255.
5.4.2 Para 2 on page 18	Change "Note that as an alternative to site testing…" to "Note that as an alternative to type testing…" as per comment #90.
Appendix 4, Voltage Tests	Footnote: Insert full stop after "is the setting ±3.45V". "The time delay…" should be a new sentence.
5.3.3	"National Grid has advised that…" (replace have with has)
5.4.2 Para 2 on page 18	Fragment of sentence "Output needs to ramp up at a constant rate"? Do the bullet points need to be moved?
6.2	Include "Figure 1. Warning Label" underneath the sign (figure currently has no caption).
6.3	"This information shall be included in the installation and **User** instructions." Embolden the defined term 'User'.
7.1 Para 3	Change to "Upon receipt of a multiple premises connection application" (as per comment #182).
Appendix 1, flow chart titles	Connecting SSEG(s) in a single premises – include the 's'.
Appendix 1, flow charts	Text boxes at the bottom of the page cut off the text – can these be expanded? On right hand bottom text box, the frame of the box disappears on the right hand side.
Appendix 1, flow charts	Bottom boxes: Change "within 28 days of commissioning" to "no later than 28 days after commissioning" (as per comment #238).
Appendix 5 Title box	Change "within 28 days of de-commissioning" to "no later than 28 days after de-commissioning" (as per comment #238).
Appendices	Review of section headings in the pro-forma tables (see Section 2.2.12 of this report)
Annex A1.4.6 Test circuit	Diagram should use IEC symbols. Indicate change over switch position at beginning of test.
Annex A1.4.6 Para 2	Change "rated output of the **Inverter**, component a…" to rated output of the **Inverter**. Component a…"
Appendix 1	Include a reference to Appendix 1 in the main document (see Section 2.2.11 of this report