WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

STANDARD TECHNIQUE: SD1E/2

Technical Requirements for Customer Export Limiting Schemes

Policy Summary

This Standard Technique specifies the requirements for customer owned **Export Limitation Schemes**

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Implementation Date	**October 2017**
Approved by	
	Policy Manager
Date	11 October 2017

IMPLEMENTATION PLAN

Introduction

This document specifies the requirements for customer export limiting schemes. The document, which is based on ENA Engineering Recommendation (ENA EREC) G100, allows customers to install parallel generation with an Installed Generation Capacity above the **Agreed Export Capacity** of the site.

Main Changes

The following changes have been made to the document:

- The protection assessment described in 4.3.2.1 has been amended
- Requirements for communication links between separate items of ELS equipment, defined in 4.1.5, have been amended.

Both these changes have been made to align the document with ENA EREC G100.

Impact of Changes

The protection assessment (which is part of the assessment to determine the maximum installed generation capacity) now allows actual protection settings / fuse ratings and the installation's minimum demand to be taken into consideration.

Implementation Actions

This Standard Technique is relevant to planning staff involved in connection of customer owned generators and all staff involved in witnessing generator commissioning tests. Managers shall ensure that appropriate staff are made aware of, and follow, the requirements of this document.

Implementation Timetable

This Standard Technique shall be implemented on issue for new or modified generator connections that include **Export Limitation Schemes**.

Document Revision & Review Table		
Date	**Comments**	**Author**
October 2017	• Clause 4.1.5 and clause 4.3.2.1 have been amended to align with ENA EREC G100	Andy Hood
November 2016	• 2nd paragraph of 4.3.2.2 has been clarified • The flow diagram in Appendix C has been corrected	Andy Hood
November 2016	• References to ENA EREC G100 added throughout the document • Link to G59 updated (clause 1.4) • Requirement to consider battery storage as both demand and generation has been added (clause 1.5) • Definitions of **Active Power**, **Agreed Export Capacity**, **Agreed Import Capacity**, **Connection Point**, **Power Factor** and Reactive Power have been added • Requirements for the maximum installed generation capacity and maximum installed demand have been modified in line with ENA EREC G100 (section 4.3 and 4.4) • Requirements for accuracy, thresholds and response rates have been modified in line with G100 (section 4.6) • Application and acceptance requirements have been modified in line with ENA EREC G100 (section 5.0) • Commissioning testing and witnessing requirements have been modified	Ben Godfrey / Andy Hood
June 2015	• New Standard Technique created	Ben Godfrey

1.0 INTRODUCTION

1.1 This document specifies the requirements for customer owned **Export Limiting Schemes** (**ELSs**) that are designed to restrict the export at an installation in order to satisfy the **Agreed Export Capacity** by either controlling the output from the customer's parallel generation or by temporarily increasing the amount of demand at the site.

1.2 This standard technique is based on ENA EREC G100, which shall be read in conjunction with this document.

1.3 The requirements for WPD owned Generator Constraint Panels (GCPs) are included in ST:TP18A.

1.4 The requirements for the connection of generation to Western power Distribution's (WPD's) network are specified in ENA EREC G83 and ENA EREC G59.

1.5 It should be noted that battery storage is considered to be a demand when consuming power and as a generator when emitting power. In this context it must satisfy the requirements of ENA EREC G83 and/or ENA EREC G59.

2.0 SCOPE

2.1 This document applies to customer owned **ELS**s that are used to limit the exported power from the customer's installation in order for the customer to satisfy i) their **Agreed Export Capacity** and ii) the terms of their Connection Agreement.

2.2 This document, which applies to connections at all voltage levels (i.e. LV to 132kV) is only relevant where the total installed generation capacity is greater than the **Agreed Export Capacity** of the connection.

2.3 **ELSs** may not be used to control/restrict the fault contribution from a customer's installation.

3.0 DEFINITIONS

3.1 **Active Power**: The product of voltage and the in-phase component of alternating current measured in units of Watts (W), kilowatts (kW) or megawatts (MW)

3.2 **Agreed Export Capacity**: The maximum amount of power (expressed in kVA) that is permitted at the **Connection Point** when the **Active Power** flows into the **Distribution System** through the **Connection Point**.

3.3 **Agreed Import Capacity**: The maximum amount of power (expressed in kVA) that is permitted at the **Connection Point** when the **Active Power** flows out of the **Distribution System** through the **Connection Point**.

3.4 **Apparent Power**: The product of voltage and current at fundamental frequency, and the square root of three (in the case of three phase systems) expressed in volt-amperes (VA), kilovolt-amperes (kVA) or megavolt-amperes (MVA).

3.5 **Connection Point**: A point on the distribution system that provides the customer with a connection allowing power to flow to or from the distribution system. Typically this would be the outgoing terminals of WPDs fused cut-out or metering circuit breaker.

3.6 **Export Limitation Scheme (ELS)**: The system comprising of one or more items of equipment, sensors, control systems and control signals that interfaces with the customer's generation and/or load to control the net flow of electricity into the distribution system to below an agreed value.

3.7 **Fail Safe**: A design requirement that enables **Export Limitation Scheme** to limit export to the **Agreed Export Capacity** irrespective of the failure of one or more its components.

3.8 **Power Factor**: The ratio of **Active Power** to **Apparent Power**

3.9 **Reactive Power**: The imaginary component of the **Apparent Power** at fundamental frequency expressed in vars (VARs), kilovars (kVAr) or Megavars (MVAr).

4.0 REQUIREMENTS

4.1 Scheme Design

4.1.1 An **ELS** measures the **Active Power** at points within the installation and then uses this information to either restrict generation output or increase customer demand in order to prevent the **Agreed Export Capacity** from being exceeded.

4.1.2 In order for this to be an acceptable solution, WPD must be satisfied that the **ELS** control schemes will meet the requirements of ENA EREC G100.

4.1.3 The **Agreed Export Capacity** is expressed as an **Apparent Power** (kVA) value at a given **Power Factor** (or over a **Power Factor** range) as measured at the **Connection Point**.

4.1.4 **ELSs** shall be designed to measure and limit the **Active Power** only since the customer is required to control the **Power Factor** and hence the **Apparent Power** and **Reactive Power** in accordance with the Connection Agreement.

4.1.5 The **ELS** may be formed of discrete units or integrated into a single packaged scheme. Where discrete units are used they should be interconnected using metallic cables or fibre optic cables. Radio links may only be used where they use licensed frequencies (i.e. licensed by OFCOM) and have a planned availability of 99.9% or higher. Irrespective of the media used for interconnecting between the discrete units, if the communication path fails the generation output shall immediately be reduced to prevent the **Agreed Export Capacity** from being exceeded.

4.1.6 **ELSs** installed at premises with an installed generation capacity exceeding 16A per phase shall be **Fail Safe** and shall fully restrict excess export if any single component, including the connections communication links between the discrete units, fail or lose their power supply.

4.1.7 Once installed and commissioned, the scheme settings should not be capable of being readily altered by the Customer and may only be changed with the written agreement of the DNO.

4.1.8 The exported **Active Power** at the **Connection Point** may be controlled by increasing the customer's demand within the installation, however the **ELS** must be designed to reduce or disconnect the generation should the demand not be available.

4.1.9 Additional reverse power protection shall be installed at all HV connections that include an **Export Limitation Scheme** to back up the **ELS**. The time delay associated with this protection shall be set at the maximum allowable operating time of the **ELS** (see section 4.6).

4.1.10 A functional description of the scheme, its settings, and a single line diagram shall be displayed on site.

4.2 Agreed Export Capacity

4.2.1 All connections with a site specific connection agreement will have an **Agreed Export Capacity**. In some circumstances, this may be zero.

4.2.2 At connections without a site specific connection agreement the **Agreed Export Capacity** is normally assumed to be 16A per phase unless otherwise agreed.

4.3 Maximum Installed Generation Capacity

4.3.1 **ELSs** allow the installed generation capacity at a site to exceed the **Agreed Export Capacity**, however, there is still a limit on the maximum capacity of generation that may be installed at the site. This is because an **ELS** takes a finite time (see section 4.6) to detect an excursion and then reduce the exported power below the **Agreed Export Capacity**.

4.3.2 The installed generation capacity shall be restricted in order to prevent (i) protection from mal-operating and (ii) voltage ratings of equipment from being exceeded during the operating time of the **ELS**. The assessment method is described below. Detailed examples of such calculations are included in Appendix E of ENA EREC G100.

4.3.2.1 Protection Assessment

In order to prevent mal-operation of cut-out fuses and/or over-current protection and other protection equipment the **Power Station Capacity** should typically be no greater than 1.25 x **Agreed Import Capacity** or 1.25 x **Agreed Export Capacity**, whichever is the higher. At some sites it may be possible for a **DNO** to agree a higher value depending upon WPD's fuse ratings / protection settings at the **Connection Point** and the installation's minimum demand. When assessing the minimum demand consideration must be given to shut-down / holiday periods etc.

Where the site does not have an **Agreed Import Capacity** or **Agreed Export Capacity** the assessment shall be based on the DNO's cut-out fuse rating or overcurrent protection settings applied to the metering circuit breaker, as applicable. In the absence of other information, the DNO's cut-out fuse should be assumed to be 80A.

4.3.2.2 Voltage Assessment

The installed generation capacity must also be limited to prevent the highest network voltage from exceeding the statutory voltage limit + 1% (of the nominal voltage).

For LV networks, the voltage during the operating time of the **ELS** shall be no higher than 253V + (1% of 230V) = 255.3V. Where WinDebut is used to check this requirement the LV network is modelled (including any existing demand and generation) and the generation capacity at the connection being considered is increased until a voltage rise of 2.4% (of 240V) is reached. At this point, the generation modelled at the connection is the maximum installed generation capacity for the **ELS** connection.

For 11kV and 6.6kV networks, the voltage during the operating time of the **ELS** shall not exceed the maximum network voltage (derived from POL: SD4) +1% (of nominal voltage). These limits are summarised in Table 1 and Table 2, below.

Location	Maximum Voltage from POL:SD4	Maximum Voltage During the ELS Operating Time
At 11kV Connections		
All	11.66kV	11.77kV
On the HV side of 11kV Distribution Transformers		
+7.5% Tap	11.66kV	11.77kV
+5% Tap	11.59kV	11.70kV
+2.5% Tap	11.31kV	11.42kV
Nominal Tap	11.04kV	11.15kV
-2.5% Tap	10.76kV	10.87kV
-5% Tap	10.49kV	10.60kV

Table 1 ELS Voltage Limits – 11kV Networks

Location	Maximum Voltage (from POL:SD4)	Maximum Voltage During the ELS Operating Time
At 6.6kV Connections		
All	7.00kV	7.07kV
On the HV side of 6.6kV Distribution Transformers		
+8.4% Tap	7.00kV	7.07kV
+5% Tap	6.95kV	7.02kV
+4.2% Tap	6.90kV	6.97kV
+2.5% Tap	6.79kV	6.86kV
Nominal Tap	6.62kV	6.69kV
-2.5% Tap	6.46kV	6.53kV
-4.2% Tap	6.35kV	6.42kV
-5% Tap	6.29kV	6.36kV
-8.4% Tap	6.07kV	6.14kV

Table 2 ELS Voltage Limits – 6.6kV Networks

4.3.3 Other Restrictions

It is possible that other factors may restrict the maximum installed generation capacity, for example fault level contribution, or possible transmission system related restrictions. Where this is the case the Planner shall notify the customer of the reason for the restriction.

4.4 Maximum Capacity of Actively Controlled Demand

4.4.1 Where the **Agreed Export Capacity** is limited by actively controlling flexible on-site demand the **Agreed Import Capacity** could be exceeded if the generation is suddenly disconnected, for example if the G59 protection operates. This could potentially cause thermal (load) ratings to be exceeded or voltage disturbance (flicker or rapid voltage change) limits to be breached. In order to prevent these issues the maximum demand of the site, including any actively controlled demand, shall not exceed 1.25 x the **Agreed Import Capacity of the site.**

4.4.2 Where a site does not have an **Agreed Import Capacity** the maximum demand of the site, including any actively controlled demand, shall be based on the rating of the cut-out fuse or the overcurrent protection settings applied to the metering circuit breaker. In the absence of other data an 80A cut-out fuse shall be assumed.

4.5 Power Quality

4.5.1 The installation shall comply with all relevant power quality requirements including but not limited to:

- ENA EREC P28 (voltage disturbances)
- ENA EREC G5 (voltage distortion / harmonics)
- ENA EREC P29 (voltage unbalance)
- BS EN 61000-3-2 (voltage distortion limits for ≤ 16A/phase equipment)
- BS EN 61000-3-3 (voltage disturbance limits for ≤ 16A/phase equipment)
- BS EN 61000-3-11 (voltage disturbance limits for ≤75A/phase equipment)
- BS EN 61000-3-12 (voltage distortion limits for ≤ 75A/phase equipment)

4.5.2 Compliance of individual components does not guarantee the installation as a whole will satisfy the power quality requirements.

4.5.3 Customers shall provide suitable information at the time of application to allow the planner to assess for power quality before connection. Further guidance can be found in ST: SD6J, which covers equipment rated ≤ 75A per phase and ST: SD6F, which applies to equipment rated greater than 75A per phase.

4.5.4 If single phase generating units are installed within a 3 poly-phase installation the generation shall, as far as possible, be balanced across the phases. The difference in generation output between each pair of phases shall not exceed 16A, in accordance with Section 7.5 of ENA EREC G59.

4.5.5 The installation shall maintain the agreed **Power Factor** and **Power Factor** range at the **Connection Point**.

4.6 Accuracy, Thresholds and Response Rates

4.6.1 The overall accuracy of **ELS** with regard to measurement and control of **Active Power** and, where applicable, voltage, shall be determined by the manufacturer of the system and published within its operating manual. These tolerances should, as far as possible, take account of sensing / measurement errors, processing errors, communication errors and control errors. Consideration should also be given to environmental factors (e.g. the expected ambient temperature range).

4.6.2 The settings applied to the **ELS** shall take account of the published tolerances to ensure the required export limits and voltage limits are maintained. For example, if an **ELS** is required to limit the export to 100kW and it has an overall tolerance of +/-5% at this value, it should be set to limit the **Active Power** to 95kW (i.e. 95% of the required value).

4.6.3 The **ELS** should detect an excursion and reduce the export to the **Agreed Export Capacity** or less, within 5 seconds.

4.6.4 At LV connections with an installed generation capacity exceeding 16A per phase, where communication delays (between the **ELS** and the generating units or inverters) mean that the 5 second operating time cannot be guaranteed, reverse power protection shall be installed that operates within 5s and trips the generation.

4.6.5 At HV, EHV and 132kV connections, back up reverse power protection that operates within 5s is required, irrespective of the maximum operating time of the **ELS**.

4.6.6 Where backup reverse power protection is installed it should be measure the **Active Power** at the intake position/s and trip the generation if the **Agreed Export Capacity** is exceeded for more than 5s. This backup system should have an **Active Power** accuracy of +/-3% or better.

4.6.7 Where an **ELS** relies on a backup disconnection systems to achieve the 5s requirement the arrangement must satisfy the power quality requirements, including the voltage disturbance requirements in EREC P28.

5.0 APPLICATION AND ACCEPTANCE

5.1 Customers / installers shall provide WPD with information on the proposed **ELS** to enable the impact on the network to be assessed. An application form is provided in Appendix B. In addition, the following information is required:

- Single line diagram of **ELS** that shows the position and function of each component of the **ELS**.
- An explanation of the **ELS** operation
- Description of any **Failsafe** functionality (i.e. interruption of sensor signals, load, loss of power, internal fault detection etc.)

5.2 WPD will assess the **ELS** using the process described in Appendix C and, where an **ELS** is acceptable will determine the maximum installed generation capacity.

6.0 ELS COMMISSIONING, TESTING AND WITNESSING

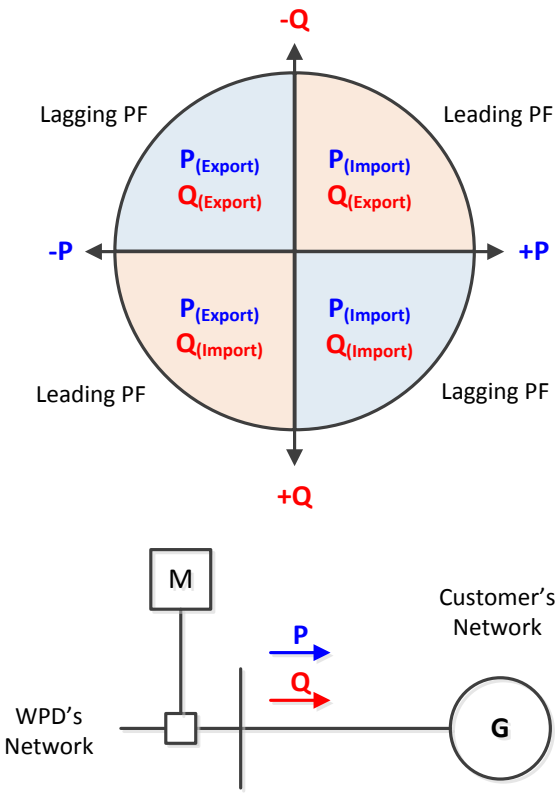
6.1 **ELS** commissioning requirements and recommended test sequences are specified in ENA EREC G100. In addition to these requirements, generator commissioning, test and witnessing requirements (defined in ENA EREC G83 and G59) must be satisfied.

6.2 Where the installed generation capacity is less than 16A per phase, ENA EREC G100 relaxes the **ELS** commissioning and witnessing requirements. In this case the installer should follow the manufacturer's installation and commissioning instructions. It is not necessary for the installer to submit **ELS** commissioning test results to WPD. Note, the generator requirements defined in ENA EREC G83 and G59 still apply

6.3 Where the installed generation capacity is above 16A per phase but no greater than 50kW (3 phase) or 17kW (1 phase) WPD do not normally witness the **ELS** commissioning tests, however we reserve the right do so. The installer shall carry out the **ELS** tests specified in ENA EREC G100 and fill in, sign and submit the Commissioning Form provided in Appendix D of this document to WPD with 7 working days of carrying out the tests.

6.4 Where the installed generation capacity is above 50kW (3 phase) or 17kW (1 phase) WPD normally witness the **ELS** commissioning tests carried out by the installer, however, this may be waived at WPD's discretion. Where witnessing is waived the installer shall carry out the **ELS** tests specified in ENA EREC G100 and fill in, sign and submit the Commissioning Form provided in Appendix D of this document to WPD, within 7 working days of carrying out the tests.

POWER FLOW CONVENTION



P = Active Power (kW)
Q = Reactive Power (kVAr)

Active Power (P) is deemed to be positive (+ve) when it flows into the customer's installation from the distribution system.

Reactive Power (Q) is deemed to be positive (+ve) when lagging VARs flow into the customer's installation from the distribution system.

APPENDIX B

EXPORT LIMITATION SCHEME APPLICATION FORM

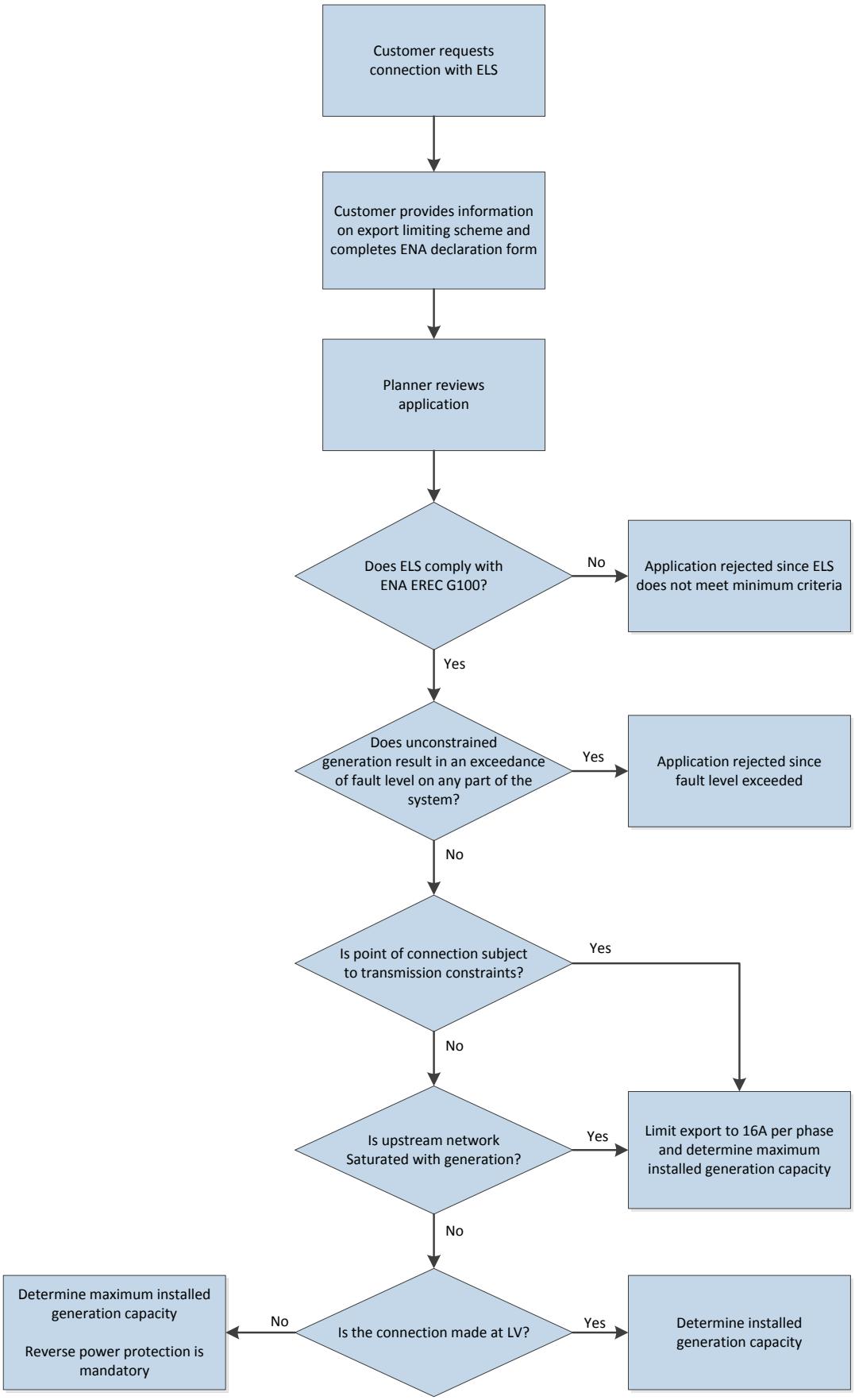
This form should be used by all applicants considering installing an **ELS** as part of their connection application. This form should accompany the application for a connection.

Customer Name	**Project Name** :
Application Submission Date: _ _ / _ _ / _ _ _ _	**WPD CROWN Ref No**

The following information shall be submitted with the enquiry:

Copy of Single Line Diagram of **Export Limitation Scheme**
Explanation / description of **Export Limitation Scheme** operation including a description of the fail-safe functionality e.g. the response of the scheme following failure of a: • **Power Monitoring Unit** • **Control Unit** • **Generator Interface Unit** • **Demand Control Unit** • **Communication Equipment** *Note, fail-safe operation is not mandatory where the installation has an aggregate **Generating Unit** capacity of 16A (i.e. 3.68kW) per phase or less.*
Is additional reverse power protection to be provided (mandatory for connection voltages above 1,000V) Yes / No* * (delete as necessary)
Required Import Capacity (kW):
Proposed Export Capacity (kW) if known:
Total **Power Station Capacity**** (kW): ** aggregate kW rating of all the electrical energy sources (**Generating Units** including storage)

EXPORT LIMITATION SCHEME ACCEPTABILITY CRITERIA



APPENDIX D

EXPORT LIMITATION SCHEME INSTALLATION AND COMMISSIONING TESTS

Commissioning test requirements for **ELS**, in addition to generation tests required by ENA EREC G83 or G59.

WPD CROWN Ref. No.: _ _ _ _ _ _ _	**MPAN[1] (21/13-digits):** __ ___ ___ __ ____ ____ ___
Customer Name	……
Address of ELS (where equipment will be used)	…….. …….. …….. ……..
Installer	……
Installer Address	…….. …….. …….. ……..

Information to be Provided

Description	Confirmation
Final copy of Single Line Diagram of **Export Limitation Scheme**	Yes / No*
Explanation of **Export Limitation Scheme** operation	Yes / No*
Description of the fail-safe functionality (Interruption of sensor signals, disconnection of load, loss of power, internal fault detection etc.) *Note, fail-safe operation is not mandatory where the installation has an aggregate **Generating Unit** capacity of 16A (i.e. 3.68kW) per phase or less.*	Yes / No*
Agreed Export Capacity as provided by the **DNO**	_____kW
Export Limitation Scheme export setting	_____kW
The **Export Limitation Scheme** has secure communication links between the various component parts of the **Export Limitation Scheme** as specified in section 5.1.3 of ENA EREC G100	Yes / No*

Commissioning Checks	
The **Export Limitation Scheme** is fail-safe and limits export if any of the discrete units or communication links that comprise the **Export Limitation Scheme** fail or lose their source of power. All components have been tested in line with section 7 of ENA EREC G100	Yes / No*
When the **Export Limitation Scheme** operates it reduces the exported **Active Power** to a value that is equal to, or less than, the **Agreed Export Capacity** within 5s.	Yes / No*
A reverse power relay is fitted which will disconnect the generation if the export goes 5% above the **Agreed Export Capacity** for longer than 5s (not required for fail-safe **LV** metered connections).	Yes / N/A Setting Power: _____kW Time: _____Sec
On completion of commissioning, all settings are restored to normal operating values and password protected or sealed to prevent **Customer** access. A description of the scheme, its settings, and a single line diagram is displayed on site.	Yes / No*

* Circle as appropriate. If "No" is selected the **Power Station** is deemed to have failed the commissioning tests and the **Generating Units** shall not be put in service.

Additional Comments / Observations:

Insert here any additional tests which have been carried out

Declaration – to be completed by Generator or Generators' Appointed Technical Representative.	
I declare that the **Export Limiting Scheme** and the installation comply with the requirements of ENA EREC G100 and the additional commissioning checks noted above have been successfully completed in addition to those required by EREC G83 or G59	
Signature:	Date:
Position:	
Declaration – to be completed by DNO Witnessing Representative	
I confirm that I have witnessed the tests specified in this document on behalf of _____and that the results are an accurate record of the tests.	
Signature:	Date:

This form should be appended to those provided in appendix 3 of EREC G83 or appendix 13.2 and 13.3 in EREC G59.

APPENDIX E

SUPERSEDED DOCUMENTATION

This document supersedes ST:SD1E/1 dated November 2016 which has now been withdrawn.

APPENDIX F

ASSOCIATED DOCUMENTATION

POL:SD4	11kV and 6.6kV System Design
ST:SD6F	Dealing with Potentially Disturbing Electrical Loads/Equipment
ST:SD6J	Connection design – potentially disturbing electrical equipment rated ≤75A/phase subject to conditional connection
Engineering Recommendation G5	Planning levels for harmonic voltage distortion and connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom
Engineering Recommendation G59	Recommendations for the connection of generation plant to the distribution systems of licensed distribution network operators
Engineering Recommendation G83	Requirements for the connection of small scale embedded generators (up to 16A per phase) in parallel with Public Low Voltage Distribution Networks
Engineering Recommendation G100	Technical Requirements for Customer Export Limiting Schemes
Engineering Recommendation P28	Planning Limits for Voltage Fluctuations Caused By Industrial, Commercial and Domestic Equipment in the UK
Engineering Recommendation P29	Planning Limits for Voltage Unbalance in the United Kingdom
BS EN 61000-3-2	Limits for harmonic current emissions (equipment input current ≤16 A per phase)
BS EN 61000-3-3	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
BS EN 61000-3-11	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75A and subject to conditional connection
BS EN 61000-3-12	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤ 75 A per phase.

APPENDIX G

KEY WORDS

Connection, Generator, SSEG, Export Limiting Device, ELS, Reverse Power Restriction, G100.