PROPOSED SYSTEM MANAGEMENT LEGAL DRAFTING

This section contains the proposed legal text to give effect to the proposals. The proposed new text is colour coded according to the following key.

Key
1) Blue Text – From Grid Code
2) Black Text – Changes / Additional words
3) Orange/Brown text – From RfG
4) Purple – From HVDC Code
5) Green – From DCC
6) Highlighted Green text – Questions for Stakeholders / Consultation
7) Highlighted yellow text – Nomenclature / Table / Figure numbers – to be finalised when more detail has been added
8) Extracts from GC0100 and GC0101 Consultations (Note Existing Grid Code text has been deleted)

GLOSSARY AND DEFINITIONS

A complete review of the Glossary and Definitions will be required when the full suite of European Codes has been implemented. The current assumption is to use GB definitions where appropriate with use of European definitions where required. The current European definitions used in the text are summarised below but it should be stressed that this is very much work in progress and further revisions will be required in the future. It should be noted that consistency checks will be required between the terms used in the Grid Code and those used in the Distribution Code.

<table>
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<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Regulation (EU) 2016/1388</td>
<td>Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a network code on Demand Connection</td>
</tr>
</tbody>
</table>
EUROPEAN CONNECTION CONDITIONS (ECC)

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(This contents page does not form part of the Grid Code)

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<td>Error! Bookmark not defined.89</td>
</tr>
</tbody>
</table>
**ECC.1** INTRODUCTION

The **European Connection Conditions** ("ECC") specify both:

- The minimum technical, design and operational criteria which must be complied with by:
  - any **New User** connected to or seeking connection with the **National Electricity Transmission System**, or
  - **Generators** (other than in respect of **Small Power Stations**) or **HVDC System Converter-Station Owners** in respect of **Power Generating Modules** or **HVDC Equipment** connected to or seeking connection to a **User's System**, which is located in **Great Britain** or **Offshore**, and

- the minimum technical, design and operational criteria which must be complied with by **NGET** will comply in relation to the **National Electricity Transmission System** at the **Connection Site** with **Users**. In the case of any **OTSDUW Plant and Apparatus**, the **ECC** also specify the minimum technical, design and operational criteria which must be complied with by the **User** when undertaking **OTSDUW**.

**ECC.2** OBJECTIVE

The objective of the **ECC** is to ensure that by specifying minimum technical, design and operational criteria the basic rules for connection to the **National Electricity Transmission System** and (for certain **Users**) to a **User's System** are similar for all **Users** of an equivalent category and will enable **NGET** to comply with its statutory and **Transmission Licence obligations** and **European Commission Regulations**.

In the case of any **OTSDUW** the objective of the **ECC** is to ensure that by specifying the minimum technical, design and operational criteria the basic rules relating to an **Offshore Transmission System** designed and constructed by an **Offshore Transmission Licensee** and designed and/or constructed by a **User** under the **OTSDUW Arrangements** are equivalent.

**ECC.3** SCOPE

The **ECC** applies to **NGET** and to **New Users** which in the **ECC** means:

**Comment [A1]**: Suggests that we add a new comment that a **New User** is one who is caught by the EU requirements or has existing plan which has been modified.

**Comment [A2]**: We need to make a decision on what we are going to do with regard to Large, Medium and Small but it is assumed for the purposes of this drafting that we will retain the Status Quo with Large, Medium and Small with Large, Medium or Small Power Stations comprising of Type A, Type B, Type C and Type D Power Generating Modules.

**Comment [A3]**: House Keeping change - bold

**Comment [A4]**: Need to think about User's being New or Existing and the implications in the CP's, OC's and BC's.
(a) Generators (other than those which only have Embedded Small Power Stations), including those undertaking OTSOUW including Power Generating Modules or DC Connected Power Park Modules which do not satisfy the conditions specified in ECC.3.6.4 or DC Connected Power Park Modules which do not satisfy the conditions specified in ECC.3.6.4.

(b) Network Operators which do not satisfy the conditions specified in ECC.3.6.4.

(c) Non-Embedded Customers which do not satisfy the conditions specified in ECC.3.6.4.

(d) HVDC System Converter-Station Owners which do not satisfy the conditions specified in ECC.3.6.4, and

(e) BM Participants and Externally Interconnected System Operators in respect of ECC 6.5 only.

### ECC.3.2

The above categories of User will become bound by the ECC prior to them generating, distributing, supplying or consuming, as the case may be, and references to the various categories should, therefore, be taken as referring to them in that prospective role as well as to Users actually connected.

### ECC.3.3

Embedded Medium Power Stations not subject to a Bilateral Agreement and Embedded HVDC Systems Converter-Station Owners not subject to a Bilateral Agreement Provisions:

The following provisions apply in respect of Embedded Medium Power Stations not subject to a Bilateral Agreement and Embedded HVDC Systems Converter-Station Owners not subject to a Bilateral Agreement.

### ECC.3.3.1

The obligations within the ECC that are expressed to be applicable to Generators in respect of Embedded Medium Power Stations not subject to a Bilateral Agreement and HVDC System Converter-Station Owners in respect of Embedded HVDC Systems Converter Stations not subject to a Bilateral Agreement (where the obligations are in each case listed in CC.3.3.2) shall be read and construed as obligations that the Network Operator within whose System any such Medium Power Station or HVDC System Converter-Station is Embedded must ensure are performed and discharged by the Generator or the HVDC Converter-Station Owner. Embedded Medium Power Stations not subject to a Bilateral Agreement and Embedded HVDC Systems Converter Stations not subject to a Bilateral Agreement which are located Offshore and which are connected to an Offshore User System will be required to meet the applicable requirements of the Grid Code as though they are an Offshore Generator or Offshore HVDC System Converter-Station Owner connected to an Offshore User System Entry Point.

### ECC.3.3.2

The Network Operator within whose System a Medium Power Station not subject to a Bilateral Agreement is Embedded or a HVDC System Converter-Station not subject to a Bilateral Agreement is Embedded must ensure that the following obligations in the ECC are performed and discharged by the Generator in respect of each such Embedded Medium Power Station or the HVDC System Converter-Station Owner in the case of an Embedded HVDC System Converter-Station.
Issue 5 Revision 21

ECC 4
21 March 2017

**ECC.3.3** In the case of Embedded Medium Power Stations not subject to a Bilateral Agreement and Embedded HVDC Systems Connectors not subject to a Bilateral Agreement the requirements in:

- ECC.6.1.6
- ECC.6.3.8
- ECC.6.3.12
- ECC.6.3.15
- ECC.6.3.16

that would otherwise have been specified in a Bilateral Agreement will be notified to the relevant Network Operator in writing in accordance with the provisions of the CUSC and the Network Operator must ensure such requirements are performed and discharged by the Generator or the HVDC System Connector Station owner.

**ECC.3.4** In the case of Offshore Embedded Power Stations Power Generating Modules connected to an Offshore User’s System which directly connects to an Offshore Transmission System, any additional requirements in respect of such Offshore Embedded Power Generating Modules Stations may be specified in the relevant Bilateral Agreement with the Network Operator or in any Bilateral Agreement between NGET and such Offshore Generator Embedded Power Station.

**ECC.3.5** In the case of a Generator undertaking OTSDUW connecting to an Onshore Network Operator’s System, any additional requirements in respect of such OTSDUW Plant and Apparatus will be specified in the relevant Bilateral Agreement with the Generator. For the avoidance of doubt, requirements applicable to Generators undertaking OTSDUW and connecting to a Network Operator’s User System, shall be consistent with those applicable requirements of Generators undertaking OTSDUW and connecting to a Transmission Interface Point.

**ECC.3.6** The requirements of this ECC shall apply to Power Generating Modules (including DC Connected Power Park Modules), HVDC Systems and New User’s in respect of Transmission Connected Demand Facilities, Transmission Connected Distribution Facilities, Network Operators Systems and Demand Units used by a Demand Facility or Closed Distribution System to provide Demand Side Response Services. More specifically, these requirements apply as laid out in ECC.3.6.1, ECC.3.6.2 and ECC.3.6.3.
ECC.3.6.1 Power-Generating Facilities

(a) Generators whose Power-Generating Module(s) was already connected to the National Electricity Transmission System or Network Operator’s System before 17th May 2016; or

(b) Generators who had concluded a final and binding contract for the purchase of Main Generating Plant before 17th May 2018. The Generator must notify the Relevant System Operator and NGET (where it is not the Relevant System Operator) of the conclusion of this final and binding contract by 17th November 2018; or

(c) Generators who have been granted a relevant derogation by the Authority.

ECC.3.6.2 HVDC Systems or DC-Connected Power Park Modules

(a) HVDC System Owners whose HVDC System(s), or Generators whose DC-Connected Power Park Module(s) was already connected to the National Electricity Transmission System or Network Operator’s System before 28th September 2016; or

(b) HVDC System Owners whose HVDC System(s), or Generators whose DC-Connected Power Park Module(s) had not concluded a final and binding contract for the purchase of Plant and Apparatus by 28th September 2018. The HVDC System Owner must notify the Relevant System Operator and NGET (where it is not the Relevant System Operator) of conclusion of the contract by 28th May 2019; or

(c) HVDC System Owner or Generator who have been granted a relevant derogation by the Authority.

ECC.3.6.3 Demand Units or a User System

(a) Network Operators and Non Embedded Customers whose Plant and Apparatus was not already connected to the National Electricity Transmission System on 7th September 2018; or

(b) Demand Unit Owners whose Plant and Apparatus was not already connected to the National Electricity Transmission System or Network Operators System on 7th September 2018; or

(c) Network Operators, Non Embedded Customers and Demand Unit Owners who had not concluded a final and binding contract for the purchase of Plant and Apparatus by 7th September 2018. The Network Operator, Non Embedded Customer and Demand Unit Owner must notify the Relevant System Operator and NGET (where it is not the Relevant System Operator) of conclusion of the contract by 7th September 2019; or

(d) Network Operators, Non Embedded Customers and Demand Unit Owners not covered by a derogation granted by the Authority.

ECC.4 PROCEDURE
The CUSC contains certain provisions relating to the procedure for connection to the National Electricity Transmission System or, in the case of Embedded Power Stations or Embedded HVDC Systems Converter Stations, becoming operational and includes provisions relating to certain conditions to be complied with by Users prior to and during the course of NGET notifying the User that it has the right to become operational. The procedure for a User to become connected is set out in the Compliance Processes.

The provisions relating to connecting to the National Electricity Transmission System (or to a User’s System in the case of a connection of an Embedded Large Power Station or Embedded Medium Power Station or Embedded HVDC System Converter Station) are contained in:

(a) the CUSC and/or CUSC Contract (or in the relevant application form or offer for a CUSC Contract);

(b) or, in the case of an Embedded Development, the relevant Distribution Code and/or the Embedded Development Agreement for the connection (or in the relevant application form or offer for an Embedded Development Agreement),

and include provisions relating to both the submission of information and reports relating to compliance with the relevant Connection Conditions for that User, Safety Rules, commissioning programmes, Operation Diagrams and approval to connect (and their equivalents in the case of Embedded Medium Power Stations not subject to a Bilateral Agreement or Embedded HVDC Systems Converter Stations not subject to a Bilateral Agreement). References in the ECC to the “Bilateral Agreement” and/or “Construction Agreement” and/or “Embedded Development Agreement” shall be deemed to include references to the application form or offer therefor.

Prior to the Completion Date (or, where the Generator is undertaking OTSDUW, any later date specified) under the Bilateral Agreement and/or Construction Agreement, the following is submitted pursuant to the terms of the Bilateral Agreement and/or Construction Agreement:

(a) updated Planning Code data (both Standard Planning Data and Detailed Planning Data), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for Forecast Data items such as Demand, pursuant to the requirements of the Planning Code;

(b) details of the Protection arrangements and settings referred to in ECC.6;

(c) copies of all Safety Rules and Local Safety Instructions applicable at Users’ Sites which will be used at the NGET/User interface (which, for the purpose of OC8, must be to NGET’s satisfaction regarding the procedures for Isolation and Earthing. For User Sites in Scotland and Offshore NGET will consult the Relevant Transmission Licensee when determining whether the procedures for Isolation and Earthing are satisfactory);

(d) information to enable NGET to prepare Site Responsibility Schedules on the basis of the provisions set out in Appendix 1;
(e) an Operation Diagram for all HV Apparatus on the User side of the Connection Point as described in ECC.7;

(f) the proposed name of the User Site (which shall not be the same as, or confusingly similar to, the name of any Transmission Site or of any other User Site);

(g) written confirmation that Safety Co-ordinators acting on behalf of the User are authorised and competent pursuant to the requirements of OC8;

(h) RISSP prefixes pursuant to the requirements of OC8. NGET is required to circulate prefixes utilising a proforma in accordance with OC8;

(i) a list of the telephone numbers for Joint System Incidents at which senior management representatives nominated for the purpose can be contacted and confirmation that they are fully authorised to make binding decisions on behalf of the User, pursuant to OC9;

(j) a list of managers who have been duly authorised to sign Site Responsibility Schedules on behalf of the User;

(k) information to enable NGET to prepare Site Common Drawings as described in ECC.7;

(l) a list of the telephone numbers for the Users facsimile machines referred to in ECC.6.5.9; and

(m) for Sites in Scotland and Offshore a list of persons appointed by the User to undertake operational duties on the User’s System (including any OTSDUW prior to the OTSUA Transfer Time) and to issue and receive operational messages and instructions in relation to the User’s System (including any OTSDUW prior to the OTSUA Transfer Time); and an appointed person or persons responsible for the maintenance and testing of User’s Plant and Apparatus.

ECC.5.2.2 Prior to the Completion Date the following must be submitted to NGET by the Network Operator in respect of an Embedded Development:

(a) updated Planning Code data (both Standard Planning Data and Detailed Planning Data), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for Forecast Data items such as Demand, pursuant to the requirements of the Planning Code;

(b) details of the Protection arrangements and settings referred to in ECC.6;

(c) the proposed name of the Embedded Medium Power Station or Embedded DC Converter Station Site (which shall be agreed with NGET unless it is the same as, or confusingly similar to, the name of other Transmission Site or User Site).

ECC.5.2.3 Prior to the Completion Date contained within an Offshore Transmission Distribution Connection Agreement the following must be submitted to NGET by the Network Operator in respect of a proposed new Interface Point within its User System:

(a) updated Planning Code data (both Standard Planning Data and Detailed Planning Data), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for Forecast Data items such as Demand, pursuant to the requirements of the Planning Code;

(b) details of the Protection arrangements and settings referred to in ECC.6;
(c) the proposed name of the Interface Point (which shall not be the same as, or confusingly similar to, the name of any Transmission Site or of any other User Site);

ECC.5.2.4 In the case of OTSDUW Plant and Apparatus (in addition to items under ECC.5.2.1 in respect of the Connection Site), prior to the Completion Date (or any later date specified) under the Construction Agreement the following must be submitted to NGET by the User in respect of the proposed new Connection Point and Interface Point:

(a) updated Planning Code data (Standard Planning Data, Detailed Planning Data and OTSDUW Data and Information), with any estimated values assumed for planning purposes confirmed or, where practical, replaced by validated actual values and by updated estimates for the future and by updated forecasts for Forecast Data items such as Demand, pursuant to the requirements of the Planning Code;

(b) details of the Protection arrangements and settings referred to in CC.6;

(c) information to enable preparation of the Site Responsibility Schedules at the Transmission Interface Site on the basis of the provisions set out in Appendix 1.

(d) the proposed name of the Interface Point (which shall not be the same as, or confusingly similar to, the name of any Transmission Site or of any other User Site);

ECC.5.3 (a) Of the items ECC.5.2.1(c), (e), (g), (h), (k) and (m) need not be supplied in respect of Embedded Power Stations or Embedded HVDC Systems Converter-Stations,

(b) item ECC.5.2.1(i) need not be supplied in respect of Embedded Small Power Stations and Embedded Medium Power Stations or Embedded HVDC Systems Converter Stations with a Registered Capacity of less than 100MW, and

(c) items ECC.5.2.1(d) and (j) are only needed in the case where the Embedded Power Station or the Embedded HVDC Systems Converter Station is within a Connection Site with another User.

ECC.5.4 In addition, at the time the information is given under ECC.5.2(g), NGET will provide written confirmation to the User that the Safety Co-ordinators acting on behalf of NGET are authorised and competent pursuant to the requirements of OCB.

ECC.6 TECHNICAL, DESIGN AND OPERATIONAL CRITERIA

ECC.6.1 National Electricity Transmission System Performance Characteristics

ECC.6.1.1 NGET shall ensure that, subject as provided in the Grid Code, the National Electricity Transmission System complies with the following technical, design and operational criteria in relation to the part of the National Electricity Transmission System at the Connection Site with a User and in the case of OTSDUW Plant and Apparatus, a Transmission Interface Point (unless otherwise specified in ECC.6) although in relation to operational criteria NGET may be unable (and will not be required) to comply with this obligation to the extent that there are insufficient Power Stations or User Systems are not available or Users do not comply with NGET’s instructions or otherwise do not comply with the Grid Code and each User shall ensure that its Plant and Apparatus complies with the criteria set out in ECC.6.1.5.

ECC.6.1.2 Grid Frequency Variations

ECC.6.1.2.1 Grid Frequency Variations for all User's excluding HVDC Equipment

Comment [A15]: The Proposer recommends the current status quo on Large, Medium and Small until longer term provisions are put in place under GB Governance.
The Frequency of the National Electricity Transmission System shall be nominally 50Hz and shall be controlled within the limits of 49.5 - 50.5Hz unless exceptional circumstances prevail.

The System Frequency could rise to 52Hz or fall to 47Hz in exceptional circumstances. Design of User's Plant and Apparatus and OTSDUW Plant and Apparatus must enable operation of that Plant and Apparatus within that range in accordance with the following:

<table>
<thead>
<tr>
<th>Frequency Range (Hz)</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.5Hz - 52Hz</td>
<td>Operation for a period of at least 15 minutes is required each time the Frequency is above 51.5Hz.</td>
</tr>
<tr>
<td>51Hz - 51.5Hz</td>
<td>Operation for a period of at least 90 minutes is required each time the Frequency is above 51Hz.</td>
</tr>
<tr>
<td>49.0Hz - 51Hz</td>
<td>Continuous operation is required</td>
</tr>
<tr>
<td>47.5Hz - 49.0Hz</td>
<td>Operation for a period of at least 90 minutes is required each time the Frequency is below 49.0Hz.</td>
</tr>
<tr>
<td>47Hz - 47.5Hz</td>
<td>Operation for a period of at least 20 seconds is required each time the Frequency is below 47.5Hz.</td>
</tr>
</tbody>
</table>

For the avoidance of doubt, disconnection, by frequency or speed based relays is not permitted within the frequency range 47.5Hz to 51.5Hz. Generators should however be aware of combined voltage and frequency operating ranges as defined in ECC.6.3.12 and ECC.6.3.14X.

NGET in co-ordination with the Relevant Transmission Licensee and/or Network Operator and a User may agree on wider variations in frequency or longer minimum operating times to those set out in ECC.6.1.2.2 or specific requirements for combined frequency and voltage deviations. Any such requirements in relation to Power Generating Modules shall be in accordance with ECC.6.3.12. The User shall not unreasonably withhold consent to apply wider frequency ranges or longer minimum times for operation taking account of their economic and technical feasibility.

Grid Frequency variations for HVDC Systems and Remote End HVDC Converter Stations shall be capable of staying connected to the System and remaining operable within the frequency ranges and time periods specified in Table X1 below. This requirement shall continue to apply during the conditions defined in ECC.6.3.15 (Fault Ride Through) – This requirement backs off reference to Art 32(2).

<table>
<thead>
<tr>
<th>Frequency Range (Hz)</th>
<th>Time Period for Operation (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47.0 - 47.5Hz</td>
<td>60 seconds</td>
</tr>
<tr>
<td>47.5 - 49.0Hz</td>
<td>100 minutes</td>
</tr>
<tr>
<td>49.0 - 51.0Hz</td>
<td>Unlimited</td>
</tr>
<tr>
<td>51.0 - 51.5Hz</td>
<td>100 minutes</td>
</tr>
<tr>
<td>51.5Hz - 52Hz</td>
<td>20 minutes</td>
</tr>
</tbody>
</table>
ECC.6.1.2.2 NGET in coordination with the Relevant Transmission Licensee and a HVDC System Owner may agree wider frequency ranges or longer minimum operating times if required to preserve or restore system security. If wider frequency ranges or longer minimum times for operation are economically and technically feasible, the HVDC System Owner shall not unreasonably withhold consent.

ECC.6.1.2.2.3 Notwithstanding the requirements of ECC.6.1.2.2.1, an HVDC System or Remote End HVDC Converter Station shall be capable of automatic disconnection at frequencies specified by NGET and/or Relevant Network Operator. (Note – Art 11(4) not reflected in drafting as this is picked up by ECC.6.3.3 – Output Power with falling frequency).

ECC.6.1.2.2.4 In the case of Remote End HVDC Converter Stations where the Remote End DC Converter Station is operating at either nominal frequency other than 50Hz or a variable frequency, the requirements defined in ECC6.1.2.2.1 to ECC.6.1.2.2.3 apply to the Remote End HVDC Converter Station other than in respect of the frequency ranges and time periods.

ECC.6.1.2.3 Grid Frequency Variations for DC Connected Power Park Modules

ECC.6.1.2.3.1 DC Connected Power Park Modules shall be capable of staying connected to the Remote End DC Converter network and operating within the frequency ranges and time periods specified in Table X2 below. Where a nominal frequency other than 50Hz, or a Frequency variable by design is used as agreed with NGET and the Relevant Transmission Licensee, the applicable frequency ranges and time periods shall be specified in the Bilateral Agreement which shall (where applicable) reflect the requirements in Table X2.

<table>
<thead>
<tr>
<th>Frequency Range (Hz)</th>
<th>Time Period for Operation (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47.0 – 47.5Hz</td>
<td>60 seconds</td>
</tr>
<tr>
<td>47.5 – 49.0Hz</td>
<td>100 minutes</td>
</tr>
<tr>
<td>49.0 – 51.0Hz</td>
<td>Unlimited</td>
</tr>
<tr>
<td>51.0 – 51.5Hz</td>
<td>100 minutes</td>
</tr>
<tr>
<td>51.5Hz – 52 Hz</td>
<td>20 minutes</td>
</tr>
</tbody>
</table>

Table X1 – Minimum time periods a DC Converter at a DC Converter Station shall be able to operate for different frequencies deviating from a nominal value without disconnecting from the National Electricity Transmission System

ECC.6.1.2.3.2 NGET in coordination with the Relevant Transmission Licensee and a Generator may agree wider frequency ranges or longer minimum operating times if required to preserve or restore system security and to ensure the optimum capability of the DC Connected Power Park Module. If wider frequency ranges or longer minimum times for operation are economically and technically feasible, the Generator shall not unreasonably withhold consent.
ECC.6.1.2.2.3 Not withstanding the requirements of ECC.6.1.2.3.1, a DC Connected Power Park Module shall be capable of automatic disconnection at frequencies specified by NGET. Such requirements (including the conditions and settings) for automatic disconnection shall be agreed between NGET and the Generator. *(Note – Art 11(4) not reflected in drafting as this is picked up by ECC.6.3.3 – Output Power with falling frequency).*

### ECC.6.1.3 Not Used

### ECC.6.1.4 Grid Voltage Variations

#### ECC.6.1.4.1 Grid Voltage Variations for all User’s excluding DC Connected Power Park Modules and Remote End DC Converters

Subject as provided below, the voltage on the 400kV part of the National Electricity Transmission System at each Connection Site with a User (and in the case of OTSDUW Plant and Apparatus, a Transmission Interface Point, excluding DC Connected Power Park Modules and Remote End DC Converters) will normally remain within ±5% of the nominal value unless abnormal conditions prevail. The minimum voltage is -10% and the maximum voltage is +10% unless abnormal conditions prevail, but voltages between ±5% and ±10% will not last longer than 15 minutes unless abnormal conditions prevail. Voltages on the 275kV and 132kV parts of the National Electricity Transmission System at each Connection Point (and in the case of OTSDUW Plant and Apparatus, a Transmission Interface Point) will normally remain within the limits ±10% of the nominal value unless abnormal conditions prevail. At nominal System voltages below 110kV the voltage of the National Electricity Transmission System at each Connection Site with a User (and in the case of OTSDUW Plant and Apparatus, a Transmission Interface Point), excluding Connection Sites for DC Connected Power Park Modules and Remote End DC Converters, will normally remain within the limits ±6% of the nominal value unless abnormal conditions prevail. Under fault conditions, the voltage may collapse transiently to zero at the point of fault until the fault is cleared. The normal operating ranges of the National Electricity Transmission System are summarised below:

<table>
<thead>
<tr>
<th>National Electricity Transmission System Nominal Voltage</th>
<th>Normal Operating Range</th>
<th>Time period for Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>400kV</td>
<td>400kV -10% to +5%</td>
<td>Unlimited</td>
</tr>
<tr>
<td></td>
<td>400kV +5% to +10%</td>
<td>15 minutes</td>
</tr>
<tr>
<td>275kV</td>
<td>275kV ±10%</td>
<td>Unlimited</td>
</tr>
<tr>
<td>132kV</td>
<td>132kV ±10%</td>
<td>Unlimited</td>
</tr>
<tr>
<td>110kV</td>
<td>110kV ±10%</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Below 110kV</td>
<td>Below 110kV ±6%</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

*NGET and a User may agree greater or lesser wider variations or longer minimum time periods of operation in voltage to those set out above in relation to a particular Connection Site, and insofar as a greater or lesser variation is agreed, the relevant figure set out above shall, in relation to that User at the particular Connection Site, be replaced by the figure agreed.*

#### ECC.6.1.4.2 Grid Voltage Variations for all DC Connected Power Park Modules

**Comment [A17]:** Agreement via NGET and the Relevant Transmission Licensee would be via the STC Proresses hence reference to Relevant Network Operator has been removed

**Comment [A18]:** Note - text extracted from GC0101 - Frequency
ECC.6.1.4.2.1 All DC Connected Power Park Modules shall be capable of staying connected to the Remote End HVDC Converter Station at the HVDC Interface Point and operating within the voltage ranges and time periods specified in Tables X1 and X2 below. The applicable voltage range and time periods specified are selected based on the reference 1pu voltage.

<table>
<thead>
<tr>
<th>Voltage Range (pu)</th>
<th>Time Period for Operation (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85pu – 0.9pu</td>
<td>60 minutes</td>
</tr>
<tr>
<td>0.9pu – 1.1pu</td>
<td>Unlimited</td>
</tr>
<tr>
<td>1.1pu – 1.15pu</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Table X1 – Minimum time periods for which DC Connected Power Park Modules shall be capable of operating for different voltages deviating from reference 1pu without disconnecting from the network where the nominal voltage base is 110kV or above and less than 300kV.

<table>
<thead>
<tr>
<th>Voltage Range (pu)</th>
<th>Time Period for Operation (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85pu – 0.9pu</td>
<td>60 minutes</td>
</tr>
<tr>
<td>0.9pu – 1.05pu</td>
<td>Unlimited</td>
</tr>
<tr>
<td>1.05pu – 1.15pu</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Table X2 – Minimum time periods for which DC Connected Power Park Modules shall be capable of operating for different voltages deviating from reference 1pu without disconnecting from the network where the nominal voltage base is from 300kV up to and including 400kV.

ECC.6.1.4.2.2 NGET and a Generator may agree greater voltage ranges or longer minimum operating times. If wider greater ranges or longer minimum times for operation are economically and technically feasible, the Generator shall not unreasonably withhold any agreement.

ECC.6.1.4.2.3 For DC Connected Power Park Modules which have an HVDC Interface Point to the Remote End HVDC Converter Station, NGET in coordination with the Relevant Transmission Licensee may specify voltage limits at the HVDC Interface Point at which the DC Connected Power Park Module is capable of automatic disconnection. ECC.6.1.4.2.4 For HVDC Interface Points which fall outside the scope of ECC.6.1.4.2.2, ECC.6.1.4.2.2 and ECC.6.1.4.2.3 NGET in coordination with the Relevant Transmission Licensee shall specify any applicable requirements at the Grid Entry Point or User System Entry Point.

ECC.6.1.4.2.5 Where the nominal frequency of the AC collector System which is connected to an HVDC Interface Point is at a value other than 50Hz, the voltage ranges and time periods specified by NGET in coordination with the Relevant Transmission Licensee shall be proportional to the values specified in Tables X1 and X2 of ECC.6.1.4.2.1.

ECC.6.1.4.3 Grid Voltage Variations for all Remote End HVDC Converters

Comment [A19]: User System Entry Point is not really relevant but added for completeness.
ECC.6.1.4.2.1 All Remote End HVDC Converter Stations shall be capable of staying connected to the HVDC Interface Point and operating within the voltage ranges and time periods specified in Tables X3 and X4 below. The applicable voltage range and time periods specified are selected based on the reference 1pu voltage.

<table>
<thead>
<tr>
<th>Voltage Range (pu)</th>
<th>Time Period for Operation (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85pu – 0.9pu</td>
<td>60 minutes</td>
</tr>
<tr>
<td>0.9pu – 1.1pu</td>
<td>Unlimited</td>
</tr>
<tr>
<td>1.1pu – 1.15pu</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Table X1 – Minimum time periods for which a Remote End HVDC Converter shall be capable of operating for different voltages deviating from reference 1pu without disconnecting from the network where the nominal voltage base is 110kV or above and less than 300kV.

<table>
<thead>
<tr>
<th>Voltage Range (pu)</th>
<th>Time Period for Operation (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.85pu – 0.9pu</td>
<td>60 minutes</td>
</tr>
<tr>
<td>0.9pu – 1.05pu</td>
<td>Unlimited</td>
</tr>
<tr>
<td>1.05pu – 1.15pu</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Table X2 – Minimum time periods for which a Remote End HVDC Converter shall be capable of operating for different voltages deviating from reference 1pu without disconnecting from the network where the nominal voltage base is from 300kV up to and including 400kV.

ECC.6.1.4.2.2 NGET and a Generator may agree greater voltage ranges or longer minimum operating times which shall be in accordance with the requirements of ECC.6.1.4.2.

ECC.6.1.4.2.4 For HVDC Interface Points which fall outside the scope of ECC.6.1.4.2.1 NGET, in coordination with the Relevant Transmission Licensee shall specify any applicable requirements at the Grid Entry Point or User System Entry Point.

ECC.6.1.4.2.5 Where the nominal frequency of the AC collector System which is connected to an HVDC Interface Point is at a value other than 50Hz, the voltage ranges and time periods specified by NGET in coordination with the Relevant Transmission Licensee shall be proportional to the values specified in Tables X3 and X4 of ECC.6.1.4.2.1.

Voltage Waveform Quality

ECC.6.1.5 All Plant and Apparatus connected to the National Electricity Transmission System, and that part of the National Electricity Transmission System at each Connection Site or, in the case of OTSDUW Plant and Apparatus, at each Interface Point, should be capable of withstanding the following distortions of the voltage waveform in respect of harmonic content and phase unbalance:

(a) Harmonic Content

Comment [A20]: Power quality - this needs checking with Power Quality Team to ensure the requirements of RfG, HVDC and DCC have been covered.
The Electromagnetic Compatibility Levels for harmonic distortion on the Onshore Transmission System from all sources under both Planned Outage and fault outage conditions, (unless abnormal conditions prevail) shall comply with the levels shown in the tables of Appendix A of Engineering Recommendation G5/4. The Electromagnetic Compatibility Levels for harmonic distortion on an Offshore Transmission System will be defined in relevant Bilateral Agreements.

Engineering Recommendation G5/4 contains planning criteria which NGET will apply to the connection of non-linear Load to the National Electricity Transmission System, which may result in harmonic emission limits being specified for these Loads in the relevant Bilateral Agreement. The application of the planning criteria will take into account the position of existing and prospective Users’ Plant and Apparatus (and OTSDUW Plant and Apparatus) in relation to harmonic emissions. Users must ensure that connection of distorting loads to their User Systems do not cause any harmonic emission limits specified in the Bilateral Agreement, or where no such limits are specified, the relevant planning levels specified in Engineering Recommendation G5/4 to be exceeded.

(b) Phase Unbalance

Under Planned Outage conditions, the weekly 95 percentile of Phase (Voltage) Unbalance, calculated in accordance with IEC 61000-4-30 and IEC 61000-3-13, on the National Electricity Transmission System for voltages above 150kV should remain, in England and Wales, below 1.5%, and in Scotland, below 2%, and for voltages of 150kV and below, across GB below 2%, unless abnormal conditions prevail and Offshore (or in the case of OTSDUW, OTSDUW Plant and Apparatus) will be defined in relevant Bilateral Agreements.

The Phase Unbalance is calculated from the ratio of root mean square (rms) of negative phase sequence voltage to rms of positive phase sequence voltage, based on 10-minute average values, in accordance with IEC 61000-4-30.

Across GB, under the Planned Outage conditions stated in ECC.6.1.5(b) infrequent short duration peaks with a maximum value of 2% are permitted for Phase (Voltage) Unbalance, for voltages above 150kV, subject to the prior agreement of NGET under the Bilateral Agreement and in relation to OTSDUW, the Construction Agreement. NGET will only agree following a specific assessment of the impact of these levels on Transmission Apparatus and other Users Apparatus with which it is satisfied.

Voltage Fluctuations

Voltage changes at a Point of Common Coupling on the Onshore Transmission System shall not exceed:

(a) The limits specified in Table ECC.6.1.7 with the stated frequency of occurrence, where:

\[
\%\Delta V_{\text{steadystate}} = 100 \times \frac{\Delta V_{\text{steadystate}}}{V_0}
\]

and

\[
\%\Delta V_{\text{max}} = 100 \times \frac{\Delta V_{\text{max}}}{V_0};
\]
(ii) $V_0$ is the initial steady state system voltage;

(iii) $V_{\text{steady state}}$ is the system voltage reached when the rate of change of system voltage over time is less than or equal to 0.5% over 1 second and $\Delta V_{\text{steady state}}$ is the absolute value of the difference between $V_{\text{steady state}}$ and $V_0$;

(iv) $\Delta V_{\text{max}}$ is the absolute value of the maximum change in the system voltage relative to the initial steady state system voltage of $V_0$;

(v) All voltages are the root mean square of the voltage measured over one cycle refreshed every half a cycle as per IEC 61000-4-30;

(vi) The voltage changes specified are the absolute maximum allowed, applied to phase to ground or phase to phase voltages whichever is the highest change;

(vii) Voltage changes in category 3 do not exceed the limits depicted in the time dependant characteristic shown in Figure ECC.6.1.7;

(viii) Voltage changes in category 3 only occur infrequently, typically not planned more than once per year on average over the lifetime of a connection, and in circumstances notified to NGET, such as for example commissioning in accordance with a commissioning programme, implementation of a planned outage notified in accordance with OC2 or an Operation or Event notified in accordance with OC7; and

(ix) For connections with a Completion Date after 1st September 2015 and where voltage changes would constitute a risk to the National Electricity Transmission System or, in NGET’s view, the System of any User, Bilateral Agreements may include provision for NGET to reasonably limit the number of voltage changes in category 2 or 3 to a lower number than specified in Table ECC.6.1.7 to ensure that the total number of voltage changes at the Point of Common Coupling across multiple Users remains within the limits of Table ECC.6.1.7.

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum number of Occurrences</th>
<th>%(\Delta V_{\text{max}}) &amp; %(\Delta V_{\text{steady state}})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Limit</td>
<td>[</td>
</tr>
</tbody>
</table>
A decrease in voltage of up to 12% is permissible for up to 80ms, as highlighted in the shaded area in Figure ECC.6.1.7, reducing to up to 10% after 80ms and to up to 3% after 2 seconds.

An increase in voltage of up to 5% is permissible if it is reduced to up to 3% after 0.5 seconds.

For voltages above 132kV, Flicker Severity (Short Term) of 0.8 Unit and a Flicker Severity (Long Term) of 0.6 Unit, for voltages 132kV and below, Flicker Severity (Short Term) of 1.0 Unit and a Flicker Severity (Long Term) of 0.8 Unit, as set out in Engineering Recommendation P28 as current at the Transfer Date.

Voltage fluctuations at a Point of Common Coupling with a fluctuating Load directly connected to an Offshore Transmission System (or in the case of OTSDUW, OTSDUW Plant and Apparatus) shall not exceed the limits set out in the Bilateral Agreement.

Generators in respect of DC Connected Power Park Modules and HVDC Equipment Owners in respect of Remote End DC Converters shall not exceed the limits at the Grid Entry Point or HVDC Interface Point (as applicable) for harmonic distortion and voltage fluctuations as set out in the Bilateral Agreement. To assess these requirements the User shall provide the Company (for onward transmission to the Relevant Transmission Licensee) with harmonic assessment information (as specified in PC.4.4.2, PC.4.5, PC.4.5.4.3.4, DRC.6.1.1 Schedule 1 and DRC.6.1.S Schedule 5 of the Grid Code) to permit harmonic voltage distortion and voltage fluctuation assessments. In addition, the process for the submission of necessary studies and mitigating actions shall be in accordance with the process detailed in ECC.6.1.X.

Sub-Synchronous Resonance and Sub-Synchronous Torsional Interaction (SSTI)
ECC.6.1.9 NGET shall ensure that Users' Plant and Apparatus will not be subject to unacceptable Sub-Synchronous Oscillation conditions as specified in the relevant License Standards.

ECC.6.1.10 NGET shall ensure where necessary, and in consultation with Transmission Licensees where required, that any relevant site specific conditions applicable at a User's Connection Site, including a description of the Sub-Synchronous Oscillation conditions considered in the application of the relevant License Standards, are set out in the User's Bilateral Agreement.

ECC.6.1.11 NGET shall specify the necessary extent of SSTI studies and provide input parameters, to the extent available, related to the equipment and relevant system conditions in its network. The SSTI studies shall be provided by the HVDC System Owner. The studies shall identify the conditions, if any, where SSTI exists and propose any necessary mitigation procedure. Member States may provide that the relevant TSOs are responsible for identifying the relevant conditions as well as the extent of agreement with the results of the studies.

ECC.6.1.12 All parties identified by NGET as relevant to each Grid Entry Point or User System Entry Point (if Embedded), connection point, including the Relevant TSO, Transmission Licensee, shall contribute to the studies and shall provide all relevant data and models as reasonably required to meet the purposes of the studies. NGET The relevant TSO shall collect this data input and, where applicable, pass it on to the party responsible for the studies in accordance with Article 10 of EU Regulation 2016/1447.

ECC.6.1.13 The NGET in coordination with the Relevant Transmission Licensee TSO shall assess the result of the SSTI studies. If necessary for the assessment, NGET in coordination with the Relevant Transmission Licensee TSO may request that the HVDC System Owner perform further SSTI studies in line with this same scope and extent.

ECC.6.1.14 The NGET in coordination with the Relevant Transmission Licensee TSO may review or replicate the study. The HVDC System Owner shall provide NGET the relevant TSO with all relevant data and models that allow such studies to be performed. Submission of this data to Relevant Transmission Licensee TSO shall be in accordance with the requirements of Article 10 of EU Regulation 2016/1447.

ECC.6.1.15 Any necessary mitigating actions identified by the studies carried out in accordance with paragraphs ECC.6.1.11 or ECC.6.1.12, and reviewed by NGET in coordination with the Relevant Transmission Licensee TSOs, shall be undertaken by the HVDC System Owner as part of the connection of the new HVDC Converter Station.

ECC.6.1.16 Interaction between HVDC Systems or other Plant and equipment

ECC.6.1.16.1 When several HVDC Converter Stations or other plants and User's equipment are within close electrical proximity, NGET the relevant TSO may specify that a study is required, and the scope and extent of that study, to demonstrate that no adverse interaction will occur. If adverse interaction is identified, the studies shall identify possible mitigating actions to be implemented to ensure compliance with the requirements of the Grid Code this Regulation.

ECC.6.1.16.2 The studies shall be carried out by the connecting HVDC System Owner with the participation of all other parties identified by NGET in coordination with Relevant Transmission Licensees and Network Operators the TSOs as relevant to each Connection Point. Member States may provide that the responsibility for undertaking the studies in accordance with this Article lies with the TSO. All parties shall be informed of the results of the studies.

Comment [A22]: This section needs to be updated to reflect the confidentiality requirements in Art 10.

Comment [A23]: Confidentiality issues as per CC.6.1.12.

Comment [A24]: This refers only to Transmission Connection Points. If we need to extend this to Distribution we need to consider this.

Comment [A25]: This issue requires further consideration.
ECC.6.1.16.3 All parties identified by NGET the relevant TSO as relevant to each Connection Point, including the Relevant Transmission Licensee’s and Network Operator’s TSO, shall contribute to the studies and shall provide all relevant data and models as reasonably required to meet the purposes of the studies. NGET the relevant TSO shall collect this input and, where applicable, pass it on to the party responsible for the studies in accordance with Article 10 of EU Regulation 2016/1447.

ECC.6.1.16.4 NGET in coordination with Relevant Transmission Licensees The relevant TSO shall assess the result of the studies based on their scope and extent as specified in accordance with ECC.6.1.16.1 paragraph 1. If necessary for the assessment, NGET in coordination with the Relevant Transmission Licensee may request the HVDC System Owner to perform further studies in line with the scope and extent specified in accordance with ECC.6.1.16.1 paragraph 1.

ECC.6.1.16.5 NGET in coordination with the Relevant Transmission Licensee The relevant TSO may review or replicate some or all of the studies. The HVDC System Owner shall provide NGET the relevant TSO all relevant data and models that allow such studies to be performed.

ECC.6.1.16.6 Any necessary mitigating actions identified by the studies carried out in accordance with ECC.6.1.16.2 to ECC.6.1.16.5 paragraphs 2 to 5 and reviewed by NGET in coordination with the Relevant Transmission Licensee the relevant TSO shall be undertaken by the HVDC System Owner as part of the connection of the new HVDC Converter Station.

ECC.6.1.16.7 NGET The relevant TSO may specify transient levels of performance associated with events for the individual HVDC System or collectively across commonly impacted HVDC Systems. This specification may be provided to protect the integrity of both the National Electricity Transmission System TSO equipment and that of grid Users in a manner consistent with its national Grid Code.

ECC.6.1.17 Fast Recovery from DC faults

ECC.6.1.17.1 HVDC Systems, including DC overhead lines, shall be capable of fast recovery from transient faults within the HVDC System. Details of this capability shall be subject to the Bilateral Agreement – coordination and agreements on and the protection requirements specified in ECC.6.2 schemes and settings pursuant to Article 34.

ECC.6.1.18 Maximum loss of Active Power

ECC.6.1.18.1 An HVDC System shall be configured in such a way that its loss of Active Power injection in the GB Synchronous Area shall be in accordance with the requirements of the SQSS limited to a value specified by NGET, the relevant TSOs for their respective load frequency control area, based on the HVDC System’s impact on the National Electricity Transmission System power system.

ECC.6.1.18.2 Where an HVDC System connects two or more control areas, the relevant TSOs shall consult each other in order to set a coordinated value of the maximum loss of active power injection as referred to in paragraph 1, taking into account common mode failures.

Comment [A26]: This only extends to Transmission Connection Points. If we need to extend this to Distribution we need to consider this.

Comment [A27]: We may need to removed references here to Network Operators

Comment [A28]: We need to look at this and include requirements in the Grid Code for data exchange and confidentiality. It probably best sits in the Planning Code

Comment [A29]: Under the current HVDC Interconnector reference is made to the RES (TS.3.24.90_RES). It is suggested that the new text remains in the Grid Code as is and the existing text in the Bilateral Agreement which refers to the RES retained.

Comment [A30]: I am not sure this is relevant in GB hence it has been deleted.
ECC.6.2 Plant and Apparatus relating to Connection Sites and Interface Points and HVDC Interface Points

The following requirements apply to Plant and Apparatus relating to the Connection Point, and OTSDUW Plant and Apparatus relating to the Interface Point (until the OTSUA Transfer Time), HVDC Interface Points relating to Remote End HVDC Converters and Connection Points which (except as otherwise provided in the relevant paragraph) each User must ensure are complied with in relation to its Plant and Apparatus and which in the case of ECC.6.2.2.2, ECC.6.2.3.1.1 and ECC.6.2.1.1(b) only, NGET must ensure are complied with in relation to Transmission Plant and Apparatus, as provided in those paragraphs.

ECC.6.2.1 General Requirements

ECC.6.2.1.1 (a) The design of connections between the National Electricity Transmission System and:

(i) any Power Generating Module Generating Unit (other than a CCGT Unit or Power Park Unit) HVDC Equipment Converter, Power Park Module or CCGT Module, or

(ii) any Network Operator’s User System, or

(iii) Non-Embedded Customers equipment;

will be consistent with the Licence Standards.

In the case of OTSDUW, the design of the OTSUA’s connections at the Interface Point and Connection Point will be consistent with Licence Standards.

(b) The National Electricity Transmission System (and any OTSDUW Plant and Apparatus) at nominal System voltages of 132kV and above is/shall be designed to be earthed with an Earth Fault Factor of, in England and Wales or Offshore, below 1.4 and in Scotland, below 1.5. Under fault conditions the rated Frequency component of voltage could fall transiently to zero on one or more phases or, in England and Wales, rise to 140% phase-to-earth voltage, or in Scotland, rise to 150% phase-to-earth voltage. The voltage rise would last only for the time that the fault conditions exist. The fault conditions referred to here are those existing when the type of fault is single or two phase-to-earth.

(c) For connections to the National Electricity Transmission System at nominal System voltages of below 132kV the earthing requirements and voltage rise conditions will be advised by NGET as soon as practicable prior to connection and in the case of OTSDUW Plant and Apparatus shall be advised to NGET by the User.

ECC.6.2.1.2 Substation Plant and Apparatus

(a) The following provisions shall apply to all Plant and Apparatus which is connected at the voltage of the Connection Point and OTSDUW Plant and Apparatus at the Interface Point and Remote End HVDC Converter Stations or HVDC Interface Points, and which is contained in equipment bays that are within the Transmission busbar Protection zone at the Connection Point. This includes circuit breakers, switch disconnectors, disconnectors, Earthing Devices, power transformers, voltage transformers, reactors, current transformers, surge arresters, bushings, neutral equipment, capacitors, line traps, coupling devices, external insulation and insulation co-ordination devices. Where necessary, this is as more precisely defined in the Bilateral Agreement.
(i) **Plant and/or Apparatus prior to 1st January 1999**

Each item of such **Plant and/or Apparatus** which at 1st January 1999 is either:

- installed, or
- owned (but is either in storage, maintenance or awaiting installation), or
- ordered,

and is the subject of a Bilateral Agreement with regard to the purpose for which it is in use or intended to be in use, shall comply with the relevant standards/specifications applicable at the time that the **Plant and/or Apparatus** was designed (rather than commissioned) and any further requirements as specified in the Bilateral Agreement.

(ii) **New Plant and/or Apparatus connecting post 1st January 1999 for to a new Connection Point (including OTSDUW Plant and Apparatus at the Interface Point and Remote End HVDC Converter Stations at the HVDC Interface Point)**

Each new item of such **Plant and/or Apparatus** installed in relation to a new **Connection Point** (or OTSDUW Plant and Apparatus at the **Interface Point** or Remote End HVDC Converter Station at the HVDC Interface Point) after 1st January 1999 shall comply with the relevant **Technical Specifications** and any further requirements identified by **NGET**, acting reasonably, to reflect the options to be followed within the **Technical Specifications** and/or to complement if necessary the **Technical Specifications** so as to enable **NGET** to comply with its obligations in relation to the **National Electricity Transmission System** or, in **Scotland or Offshore**, the **Relevant Transmission Licensee** to comply with its obligations in relation to its **Transmission System**. This information, including the application dates of the relevant **Technical Specifications**, will be as specified in the varied **Bilateral Agreement**.

(iii) **New Plant and/or Apparatus connecting post 1st January 1999 for to an existing Connection Point (including OTSDUW Plant and Apparatus at the Interface Point and Remote End HVDC Converter Stations at the HVDC Interface Point)**

Each new additional and/or replacement item of such **Plant and/or Apparatus** installed in relation to a change to an existing **Connection Point** (or OTSDUW Plant and Apparatus at the **Interface Point** and **Connection Point** or Remote End HVDC Converter Stations at the HVDC Interface Point) after 1st January 1999 shall comply with the standards/specifications applicable when the change was designed, or such other standards/specifications as necessary to ensure that the item of **Plant and/or Apparatus** is reasonably fit for its intended purpose having due regard to the obligations of **NGET**, the relevant **User** and, in **Scotland or Offshore**, also the **Relevant Transmission Licensee** under their respective **Licences**. Where appropriate this information, including the application dates of the relevant standards/specifications, will be as specified in the varied **Bilateral Agreement**.

(iv) **Used Plant and/or Apparatus being moved, re-used or modified**

If, after its installation, any such item of **Plant and/or Apparatus** is subsequently:

- moved to a new location; or
- used for a different purpose; or

Comment [A34]: Applicability of Remote End HVDC Converters see Comment A34

Comment [A35]: Issue for Onshore HVDC Connections with Generation connected behind them. This arrangement is not captured in the current GB arrangements. This requires further thought.

Comment [A36]: Check with Legal - applicability of Remote End HVDC Converters
otherwise modified;
then the standards/specifications as described in (i) or (ii) or (iii) above as applicable will apply as appropriate to such Plant and/or Apparatus, which must be reasonably fit for its intended purpose having due regard to the obligations of NGET, the relevant User and, in Scotland or Offshore, also the Relevant Transmission Licensee under their respective Licences.

(b) NGET shall at all times maintain a list of those Technical Specifications and additional requirements which might be applicable under this ECC.6.2.1.2 and which may be referenced by NGET in the Bilateral Agreement. NGET shall provide a copy of the list upon request to any User. NGET shall also provide a copy of the list to any new User upon receipt of an application form for a Bilateral Agreement for a new Connection Point.

(c) Where the User provides NGET with information and/or test reports in respect of Plant and/or Apparatus which the User reasonably believes demonstrate the compliance of such items with the provisions of a Technical Specification then NGET shall promptly and without unreasonable delay give due and proper consideration to such information.

(d) Plant and Apparatus shall be designed, manufactured and tested in premises with an accredited certificate in accordance with the quality assurance requirements of the relevant standard in the BS EN ISO 9000 series (or equivalent as reasonably approved by NGET) or in respect of test premises which do not include a manufacturing facility premises with an accredited certificate in accordance with BS EN 45001.

(e) Each connection between a User and the National Electricity Transmission System must be controlled by a circuit-breaker (or circuit breakers) capable of interrupting the maximum short circuit current at the point of connection. The Seven Year Statement gives values of short circuit current and the rating of Transmission circuit breakers at existing and committed Connection Points for future years.

(f) Each connection between a Generator undertaking OTSDUW or an Onshore Transmission Licensee, must be controlled by a circuit breaker (or circuit breakers) capable of interrupting the maximum short circuit current at the Transmission Interface Point. The Seven Year Statement gives values of short circuit current and the rating of Transmission circuit breakers at existing and committed Transmission Interface Points for future years.

ECC.6.2.2 Requirements at Connection Points or, in the case of OTSDUW at Interface Points that relate to Generators or OTSDUW Plant and Apparatus or HVDC Interface Points in the case of Remote End HVDC Converter Stations

ECC.6.2.2.1 Not Used.

ECC.6.2.2.2 Power Generating Module Generating Unit, OTSDUW Plant and Apparatus, HVDC Equipment and Power Station Protection Arrangements

ECC.6.2.2.1 Minimum Requirements
Protection of Power Generating Modules Generating Units (other than Power Park Units), HVDC Equipment Converters, OTSDUW Plant and Apparatus or Power Park Modules and their connections to the National Electricity Transmission System shall meet the requirements given below. These are necessary to reduce the impact on the National Electricity Transmission System of faults on OTSDUW Plant and Apparatus circuits or circuits owned by Generators (including DC Connected Power Park Modules) or HVDC Converter Station System Owners.

**ECC.6.2.2.2 Fault Clearance Times**

(a) The required fault clearance time for faults on the Generator’s (including DC Connected Power Park Modules) or HVDC System Converter Station Owner’s equipment directly connected to the National Electricity Transmission System or OTSDUW Plant and Apparatus and for faults on the National Electricity Transmission System directly connected to the Generator (including DC Connected Power Park Modules) or HVDC System Converter Station Owner’s equipment or OTSDUW Plant and Apparatus, from fault inception to the circuit breaker arc extinction, shall be set out in the Bilateral Agreement. The fault clearance time specified in the Bilateral Agreement shall not be shorter than the durations specified below:

- (i) 80ms at 400kV
- (ii) 100ms at 275kV
- (iii) 120ms at 132kV and below

but this shall not prevent the User or NGET or the Relevant Transmission Licensee or the Generator (including in respect of OTSDUW Plant and Apparatus and DC Connected Power Park Modules) from selecting a shorter fault clearance time on their own Plant and Apparatus provided Discrimination is achieved.

A longer fault clearance time may be specified in the Bilateral Agreement for faults on the National Electricity Transmission System. A longer fault clearance time for faults on the Generator or HVDC Converter Station System Owner’s equipment or OTSDUW Plant and Apparatus may be agreed with NGET in accordance with the terms of the Bilateral Agreement but only if System requirements, in NGET’s view, permit. The probability that the fault clearance time stated in the Bilateral Agreement will be exceeded by any given fault, must be less than 2%.

(b) In the event that the required fault clearance time is not met as a result of failure to operate on the Main Protection System(s) provided, the Generators or HVDC System Converter Station Owners or Generators in the case of OTSDUW Plant and Apparatus shall, except as specified below provide Independent Back-Up Protection. NGET will also provide Back-Up Protection and NGET and the User’s Back-Up Protections will be co-ordinated so as to provide Discrimination.
On a Power Generating Module Generating Unit (other than a Power Park Unit), HVDC Equipment Converter or Power Park Module or OTSDUW Plant and Apparatus in respect of which the Completion Date is after 30 January 2016 and connected to the National Electricity Transmission System at 400kV or 275kV and where two Independent Main Protections are provided to clear faults on the HV Connections within the required fault clearance time, the Back-Up Protection provided by the Generators (including in respect of OTSDUW Plant and Apparatus and DC Connected Power Park Modules) and HVDC Converter Station System Owners shall operate to give a fault clearance time of no longer than 300ms at the minimum infeed for normal operation for faults on the HV Connections. Where two Independent Main Protections are installed the Back-Up Protection may be integrated into one (or both) of the Independent Main Protection relays.

On a Power Generating Module Generating Unit (other than a Power Park Unit), HVDC Equipment Converter or Power Park Module or OTSDUW Plant and Apparatus in respect of which the Completion Date is after 20 January 2016 and connected to the National Electricity Transmission System at 132 kV and where only one Main Protection is provided to clear faults on the HV Connections within the required fault clearance time, the Independent Back-Up Protection provided by the Generator (including in respect of OTSDUW Plant and Apparatus and DC Connected Power Park Modules) and the HVDC System Converter Station Owner shall operate to give a fault clearance time of no longer than 300ms at the minimum infeed for normal operation for faults on the HV Connections.

On a Generating Unit (other than a Power Park Unit), DC Converter or Power Park Module or OTSDUW Plant and Apparatus connected to the National Electricity Transmission System and on Generating Units (other than a Power Park Unit), DC Converters or Power Park Modules or OTSDUW Plant and Apparatus connected to the National Electricity Transmission System at 400 kV or 275 kV or 132 kV, in respect of which the Completion Date is before the 20 January 2016, the Back-Up Protection or Independent Back-Up Protection shall operate to give a fault clearance time of no longer than 800ms in England and Wales or 300ms in Scotland at the minimum infeed for normal operation for faults on the HV Connections.

A Power Generating Module Generating Unit (other than a Power Park Unit), HVDC Equipment Converter or Power Park Module or OTSDUW Plant and Apparatus with Back-Up Protection or Independent Back-Up Protection will also be required to withstand, without tripping, the loading incurred during the clearance of a fault on the National Electricity Transmission System by breaker fail Protection at 400kV or 275kV or of a fault cleared by Back-Up Protection where the Generator (including in the case of OTSDUW Plant and Apparatus or DC Connected Power Park Module) or HVDC System Converter is connected at 132kV and below. This will permit Discrimination between the Generator in respect of OTSDUW Plant and Apparatus or DC Connected Power Park Modules or HVDC Converter Station System Owners’ Back-Up Protection or Independent Back-Up Protection and the Back-Up Protection provided on the National Electricity Transmission System and other Users’ Systems.
(c) When the Power Generating Module Generating Unit (other than Power Park Units), or the HVDC Equipment Converter or Power Park Module or OTSDUW Plant and Apparatus is connected to the National Electricity Transmission System at 400kV or 275kV, and in Scotland and Offshore also at 132kV, and a circuit breaker is provided by the Generator (including in respect of OTSDUW Plant and Apparatus or DC Connected Power Modules) or the HVDC Converter Station System owner, or NGET, as the case may be, to interrupt fault current interchange with the National Electricity Transmission System, or Generator’s System, or HVDC Converter Station System Owner’s System, as the case may be, circuit breaker fail Protection shall be provided by the Generator (including in respect of OTSDUW Plant and Apparatus or DC Connected Power Park Modules) or HVDC System Converter Station Owner, or NGET, as the case may be, on this circuit breaker. In the event, following operation of a Protection system, of a failure to interrupt fault current by these circuit-breakers within the Fault Current Interruption Time, the circuit breaker fail Protection is required to initiate tripping of all the necessary electrically adjacent circuit-breakers so as to interrupt the fault current within the next 200ms.

(d) The target performance for the System Fault Dependability Index shall be not less than 99%. This is a measure of the ability of Protection to initiate successful tripping of circuit breakers which are associated with the faulty item of Apparatus.

**ECC.6.2.2.3** Equipment including Protection equipment to be provided

NGET shall specify the Protection schemes and settings necessary to protect the National Electricity Transmission System network, taking into account the characteristics of the Power Generating Module or HVDC Equipment. The protection schemes needed for the Power Generating Module or HVDC Equipment and the National Electricity Transmission System network as well as the settings relevant to the Power Generating Module and/or HVDC Equipment shall be coordinated and agreed between NGET the relevant system operator and the Generator or HVDC System Owner power generating facility owner. The protection schemes and settings for internal electrical faults must not prevent jeopardise the performance of a Power Generating Module or HVDC Equipment from satisfying the requirements of the Grid Code power generating module, in line with the requirements set out in this Regulation;

electrical Protection of the Power Generating Module or HVDC Equipment shall take precedence over operational controls, taking into account the security of the National Electricity Transmission System and the health and safety of personnel staff and of the public, as well as mitigating any damage to the Power Generating Module or HVDC Equipment.

**ECC.6.2.3.1** Protection of Interconnecting Connections

The requirements for the provision of Protection equipment for interconnecting connections will be specified in the Bilateral Agreement. In this ECC the term “interconnecting connections” means the primary conductors from the current transformer accommodation on the circuit side of the circuit breaker to the Connection Point or the primary conductors from the current transformer accommodation on the circuit side of the OTSDUW Plant and Apparatus of the circuit breaker to the Transmission Interface Point.

**ECC.6.2.2.3.2** Circuit-breaker fail Protection

Comment [A40]: RfG Art 14(5)(b)(iii) - I have omitted this section from the drafting as I do not think it is necessary “Protection schemes may cover the following aspects” Discussion with legal we agree that there is no need to list all these protections due to the “may” statement
The Generator or HVDC Converter Station System Owner will install circuit breaker fail Protection equipment in accordance with the requirements of the Bilateral Agreement. The Generator or HVDC Converter Station System Owner will also provide a back-trip signal in the event of loss of air from its pressurised head circuit breakers, during the Power Generating Module Generating Unit (other than a CCGT Unit or Power Park Unit) or CCGT Module or HVDC Equipment Converter or Power Park Module run-up sequence, where these circuit breakers are installed.

**ECC.6.2.2.3.3  Loss of Excitation**

The Generator must provide Protection to detect loss of excitation in respect of each of its a Generating Unit within a Synchronous Power Generating Module to initiate a Generating Unit trip.

**ECC.6.2.2.3.4  Pole-Slipping Protection**

Where, in NGET’s reasonable opinion, System requirements dictate, NGET will specify in the Bilateral Agreement a requirement for Generators to fit pole-slipping Protection on their Generating Units within each Power Generating Module.

**ECC.6.2.2.3.5  Signals for Tariff Metering**

Generators and HVDC Converter Station System Owners will install current and voltage transformers supplying all tariff meters at a voltage to be specified in, and in accordance with, the Bilateral Agreement.

**ECC.6.2.2.4  Work on Protection Equipment**

No busbar Protection, mesh corner Protection, circuit-breaker fail Protection relays, AC or DC wiring (other than power supplies or DC tripping associated with the Power Generating Module Generating Unit, HVDC Equipment Converter or Power Park Module itself) may be worked upon or altered by the Generator or HVDC Converter Station System Owner personnel in the absence of a representative of NGET or in Scotland or Offshore, a representative of NGET, or written authority from NGET to perform such work or alterations in the absence of a representative of NGET.

**ECC.6.2.2.5  Relay Settings**

Protection and relay settings will be co-ordinated (both on connection and subsequently) across the Connection Point in accordance with the Bilateral Agreement and in relation to OTSDUW Plant and Apparatus, across the Interface Point and in relation to Remote End DC Converters, across the HVDC Interface Point in accordance with the Bilateral Agreement to ensure effective disconnection of faulty Apparatus.

**ECC.6.2.2.6  Changes to Protection Schemes and HVDC System Control Modes**

Any subsequent alterations to the protection settings (whether by NGET, the Relevant Transmission Licensee, the Generator or the HVDC System Owner) shall be agreed between NGET (in co-ordination with the Relevant Transmission Licensee) and the Generator or HVDC System Owner in accordance with the Grid Code (ECC.6.2.2.5). No alterations are to be made to any protection schemes unless agreement has been reached between NGET, the Relevant Transmission Licensee, the Generator or HVDC System Owner.
ECC.6.2.2.6.2 No Generator or HVDC System Owner equipment shall be energised until the Protection settings have been finalised. The Generator or HVDC System Owner shall agree with NGET (in coordination with the Relevant Transmission Licensee) and carry out a combined commissioning programme for the Protection systems, and generally, to a minimum standard as specified in the Bilateral Agreement.

ECC.6.2.2.6.3 The parameters of different control modes of the HVDC System shall be able to be changed in the HVDC Converter Station, if required by NGET in coordination with the Relevant Transmission Licensee and in accordance with the Bilateral Agreement.

ECC.6.2.2.6.4 Any change to the schemes or settings of parameters of the different control modes and protection of the HVDC System including the procedure shall be agreed with NGET in coordination with the Relevant Transmission Licensee and the HVDC System Owner.

ECC.6.2.2.6.5 The control modes and associated set points shall be capable of being changed remotely, as specified by NGET in coordination with the Relevant Transmission Licensee.

ECC.6.2.2.6.7 Control Schemes and Settings

ECC.6.2.2.7.1 The schemes and settings of the different control devices on the Power Generating Module and HVDC Equipment that are necessary for Transmission System stability and for taking emergency action shall be agreed with NGET in coordination with the Relevant Transmission Licensee and the Generator or HVDC System Owner.

ECC.6.2.2.7.2 Subject to the requirements of ECC.6.2.2.7.1 any changes to the schemes and settings, defined in ECC.6.2.2.7.1 of the different control devices of the Power Generating Module or HVDC Equipment shall be coordinated and agreed between NGET, the Relevant Transmission Licensee, the Generator and HVDC System Owner, in particular if they apply in the circumstances referred to in point (i) of paragraph 5(a);

ECC.6.2.2.8 Ranking of Protection and Control

ECC.6.2.2.8.1 Generators are required to organise their protection and control devices in accordance with the following priority ranking (from highest to lowest):

(i) The National Electricity Transmission System network and Power Generating Module or HVDC Equipment Protection; synthetic inertia, if applicable;
(ii) frequency control (active power adjustment);
(iii) power restriction; and
(iv) power gradient constraint;

ECC.6.2.2.8.2 A control scheme, specified by the HVDC System Owner consisting of different control modes, including the settings of the specific parameters, shall be coordinated and agreed between NGET in coordination with the Relevant Transmission Licensee the relevant TSO, the relevant system operator and the HVDC System Owner.

ECC.6.2.2.8.3 HVDC System Owners shall organise their protection and control devices in compliance with the following priority ranking, listed in decreasing order of importance, unless otherwise specified by NGET in coordination with the Relevant Transmission Licensee.

(i) the National Electricity Transmission System network and HVDC System Protection;
(ii) Active Power control for emergency assistance.
(iii) automatic remedial actions as specified in ECC.6.3.6.1.3.5
(iv) Limited Frequency Sensitive Mode (LFSM) of operation;
(v) Frequency Sensitive Mode of operation and Frequency control; and
(vi) power gradient constraint.

ECC.6.2.2.9 Synchronising

ECC.6.2.2.9.1 For any Power Generating Module directly connected to the National Electricity Transmission System or Type D Power Generating Module, synchronisation shall be performed by the Generator only after instruction by NGET in accordance with the requirements of BC.2.5.2.

ECC.6.2.2.9.2 Each Power Generating Module directly connected to the National Electricity Transmission System or Type D Power Generating Module shall be equipped with the necessary synchronisation facilities. Synchronisation shall be possible within the range of frequencies specified in ECC.6.1.2.

ECC.6.2.2.9.3 NGET and the Generator shall agree on the settings of the synchronising equipment prior to the Completion Date. The synchronisation settings shall include the following elements which shall be pursuant to the terms of the Bilateral Agreement.

(a) voltage
(b) Frequency
(c) phase angle range
(d) phase sequence
(e) deviation of voltage and Frequency

ECC.6.2.2.9.4 HVDC Equipment shall be required to satisfy the requirements of ECC.6.2.2.9.1 – ECC.6.2.2.9.3. In addition, unless otherwise specified by NGET, during the synchronisation of a DC Connected Power Park Module to the National Electricity Transmission System, any HVDC Equipment shall have the capability to limit any steady state voltage changes to the limits specified within ECC.6.1.8 which shall not exceed 5% of the pre-synchronisation voltage. NGET in coordination with the Relevant Transmission Licensee shall specify any additional requirements for the maximum magnitude, duration and measurement of the voltage transients over and above those defined in ECC.6.1.7 and ECC.6.1.8 in the Bilateral Agreement.

ECC.6.2.2.9.5 Generators in respect of DC Connected Power Park Modules shall also provide output synchronisation signals specified by NGET in co-ordination with the Relevant Transmission Licensee.

ECC.6.2.2.9.6 In addition to the requirements of ECC.6.2.2.9.1 to ECC.6.2.2.9.5, Generators and HVDC System Owners should also be aware of the requirements of ECC.6.5.10 relating to busbar voltage.

ECC.6.2.2.9.7 HVDC Parameters and Settings

Comment [A44]: We are not mandating Synthetic inertia so this has been switched off.

Comment [A45]: Workgroup comment are we comfortable that this requirement covers HVDC Art 28 and Art 41.
The parameters and settings of the main control functions of an HVDC System shall be agreed between the HVDC System owner and NGET, in coordination with the Relevant Transmission Licensee. The parameters and settings shall be implemented within such a control hierarchy that makes their modification possible if necessary. Those main control functions are at least:

(a) synthetic inertia, if applicable as referred to in Articles 14 and 41;
(b) Frequency Sensitive Modes (FSM, LFSM-O, LFSM-U) referred to in Articles 15, 16 and 17;
(c) Frequency control, if applicable, referred to in Article 16;
(d) Reactive Power control mode, if applicable as referred to in Article 22;
(e) power oscillation damping capability, referred to Article 30;
(f) subsynchronous torsional interaction damping capability, referred to Article 31.

Generators in respect of Type A, Type B, Type C and Type D Power Generating Modules (including DC Connected Power Park Modules) are not permitted to automatically reconnect to the Total System without instruction from NGET. NGET will issue instructions for re-connection or re-synchronisation in accordance with the requirements of BC2.5.2. Where synchronising is permitted in accordance with BC2.5.2, the voltage and frequency at the Grid Entry Point or User System Entry Point shall be within the limits defined in ECC6.1.2 and ECC.6.1.4 and the ramp rate limits pursuant to BC1.A.1.1. For the avoidance of doubt this requirement does not apply to Generators who are not required to satisfy the requirements of the Balancing Codes.

Fault Clearance Times

(a) The required fault clearance time for faults on Network Operator and Non-Embedded Customer equipment directly connected to the National Electricity Transmission System, and for faults on the National Electricity Transmission System directly connected to the Network Operator’s or Non-Embedded Customer’s equipment, from fault inception to the circuit breaker arc extinction, shall be set out in each Bilateral Agreement. The fault clearance time specified in the Bilateral Agreement shall not be shorter than the durations specified below:

(i) 80ms at 400kV
(ii) 100ms at 275kV

(iii) 120ms at 132kV and below

but this shall not prevent the User or NGET or Relevant Transmission Licensee from selecting a shorter fault clearance time on its own Plant and Apparatus provided Discrimination is achieved.

For the purpose of establishing the Protection requirements in accordance with ECC.6.2.3.1.1 only, the point of connection of the Network Operator or Non-Embedded Customer equipment to the National Electricity Transmission System shall be deemed to be the low voltage busbars at a Grid Supply Point, irrespective of the ownership of the equipment at the Grid Supply Point.

A longer fault clearance time may be specified in the Bilateral Agreement for faults on the National Electricity Transmission System. A longer fault clearance time for faults on the Network Operator and Non-Embedded Customers equipment may be agreed with NGET in accordance with the terms of the Bilateral Agreement but only if System requirements in NGET’s view permit. The probability that the fault clearance time stated in the Bilateral Agreement will be exceeded by any given fault must be less than 2%.

(b) (i) For the event of failure of the Protection systems provided to meet the above fault clearance time requirements, Back-Up Protection shall be provided by the Network Operator or Non-Embedded Customer as the case may be.

(ii) NGET will also provide Back-Up Protection, which will result in a fault clearance time longer than that specified for the Network Operator or Non-Embedded Customer Back-Up Protection so as to provide Discrimination.

(iii) For connections with the National Electricity Transmission System at 132kV and below, it is normally required that the Back-Up Protection on the National Electricity Transmission System shall discriminate with the Network Operator or Non-Embedded Customer’s Back-Up Protection.

(iv) For connections with the National Electricity Transmission System at 400kV or 275kV, the Back-Up Protection will be provided by the Network Operator or Non-Embedded Customer, as the case may be, with a fault clearance time not longer than 300ms for faults on the Network Operator’s or Non-Embedded Customer’s Apparatus.

(v) Such Protection will also be required to withstand, without tripping, the loading incurred during the clearance of a fault on the National Electricity Transmission System by breaker fail Protection at 400kV or 275kV. This will permit Discrimination between Network Operator’s Back-Up Protection or Non-Embedded Customer’s Back-Up Protection, as the case may be, and Back-Up Protection provided on the National Electricity Transmission System and other User Systems. The requirement for and level of Discrimination required will be specified in the Bilateral Agreement.

(c) (i) Where the Network Operator or Non-Embedded Customer is connected to the National Electricity Transmission System at 400kV or 275kV, and in Scotland also at 132kV, and a circuit breaker is provided by the Network Operator or Non-Embedded Customer, or NGET, as the case may be, to interrupt the interchange of fault current with the National Electricity Transmission System or the System of the Network Operator or Non-Embedded Customer, as the case may be,
circuit breaker fail Protection will be provided by the Network Operator or Non-Embedded Customer, or NGET, as the case may be, on this circuit breaker.

(ii) In the event, following operation of a Protection system, of a failure to interrupt fault current by these circuit-breakers within the Fault Current Interruption Time, the circuit breaker fail Protection is required to initiate tripping of all the necessary electrically adjacent circuit-breakers so as to interrupt the fault current within the next 200ms.

(d) The target performance for the System Fault Dependability Index shall be not less than 99%. This is a measure of the ability of Protection to initiate successful tripping of circuit breakers which are associated with the faulty items of Apparatus.
ECC.6.2.3.2 Fault Disconnection Facilities

(a) Where no Transmission circuit breaker is provided at the User's connection voltage, the User must provide NGET with the means of tripping all the User's circuit breakers necessary to isolate faults or System abnormalities on the National Electricity Transmission System. In these circumstances, for faults on the User's System, the User's Protection should also trip higher voltage Transmission circuit breakers. These tripping facilities shall be in accordance with the requirements specified in the Bilateral Agreement.

(b) NGET may require the installation of a System to Generator Operational Intertripping Scheme in order to enable the timely restoration of circuits following power System fault(s). These requirements shall be set out in the relevant Bilateral Agreement.

ECC.6.2.3.3 Automatic Switching Equipment

Where automatic reclosure of Transmission circuit breakers is required following faults on the User's System, automatic switching equipment shall be provided in accordance with the requirements specified in the Bilateral Agreement.

ECC.6.2.3.4 Relay Settings

Protection and relay settings will be co-ordinated (both on connection and subsequently) across the Connection Point in accordance with the Bilateral Agreement to ensure effective disconnection of faulty Apparatus.

ECC.6.2.3.5 Work on Protection equipment

Where a Transmission Licensee owns the busbar at the Connection Point, no busbar Protection, mesh corner Protection relays, AC or DC wiring (other than power supplies or DC tripping associated with the Network Operator or Non-Embedded Customer's Apparatus itself) may be worked upon or altered by the Network Operator or Non-Embedded Customer personnel in the absence of a representative of NGET or in Scotland, a representative of NGET, or written authority from NGET to perform such work or alterations in the absence of a representative of NGET.

ECC.6.2.3.6 Equipment including Protection equipment to be provided

NGET in coordination with the Relevant Transmission Licensee shall specify the Protection schemes and settings required to protect the National Electricity Transmission System network in accordance with the characteristics of the Network Operators or Non Embedded Customers System. NGET in coordination with the Relevant Transmission Licensee and the Network Operator or Non Embedded Customer transmission-connected demand facility owner or the transmission-connected distribution system operator shall agree on the protection schemes and settings in respect of each Grid Supply Point relevant for the transmission-connected demand facility or the transmission-connected distribution system.

Electrical Protection of the Network Operators or Non Embedded Customers System shall take precedence over operational controls whilst respecting the security of the National Electricity Transmission System and the health and safety of personnel staff and of the public.

ECC.6.2.3.6.1 Protection of Interconnecting Connections

The requirements for the provision of Protection equipment for interconnecting connections will be specified in the Bilateral Agreement.
ECC.6.2.3.7  Changes to Protection Schemes

Any subsequent alterations to the protection settings (whether by NGET, the Relevant Transmission Licensee, the Network Operator or the Non Embedded Customer) shall be agreed between NGET (in co-ordination with the Relevant Transmission Licensee) and the Network Operator or Non Embedded Customer in accordance with the Grid Code (ECC.6.2.3.4). No alterations are to be made to any protection schemes unless agreement has been reached between NGET, the Relevant Transmission Licensee, the Network Operator or Non Embedded Customer.

No Network Operator or Non Embedded Customer equipment shall be energised until the Protection settings have been finalised. The Network Operator or Non Embedded Customer shall agree with NGET (in coordination with the Relevant Transmission Licensee) and carry out a combined commissioning programme for the Protection systems, and generally, to a minimum standard as specified in the Bilateral Agreement.

ECC.6.2.3.8  Control Requirements

ECC.6.2.3.8.1  NGET in coordination with the Relevant Transmission Licensee and the Network Operator or Non Embedded Customer shall agree on the control schemes and settings of the different control devices of the Network Operators or Non Embedded Customers System relevant for system security of the National Electricity Transmission System. Such requirements would be pursuant to the terms of the Bilateral Agreement which shall also cover at least the following elements:

(a) Isolated (National Electricity Transmission System) operation
(b) Damping of oscillations
(c) Disturbances to the National Electricity Transmission System
(d) Automatic switching to emergency supply and restoration to normal topology
(e) Automatic circuit breaker re-closure (on 1-phase faults)

ECC.6.2.3.9  Ranking of Protection and Control

ECC.6.2.3.9.1  With regard to priority ranking of protection and control, The Network Operator or the Non Embedded Customer shall set the Protection and control devices of its Network Operators or Non Embedded Customers System at each Grid Supply Point respectively, in compliance with the following priority ranking, organised in decreasing order of importance:

(a) National Electricity Transmission System Protection;
(b) Network Operators or Non Embedded Customers System Protection equipment at each Grid Supply Point;
(c) Frequency control (Active Power adjustment);
(d) Power restriction.

Comment [A49]: Legal comment - we will need to change the template (Appendix F) of the Bilateral Agreement to include these elements - in the majority of cases they would be switched off (ie not applicable).

Comment [A50]: Check DCC Art 17(4) to ensure consistency with GB Code
ECC.6.2.3.10  Synchronising

ECC.6.2.3.10.1  Each Network Operator or Non Embedded Customer directly connected to the National Electricity Transmission System shall be capable of synchronisation within the range of frequencies specified in ECC.6.1.2.

ECC.6.2.3.10.2  NGET and the Network Operator or Non Embedded Customer shall agree on the settings of the synchronisation equipment prior to the Completion Date. The synchronisation settings shall include the following elements which shall be pursuant to the terms of the Bilateral Agreement.
(a) voltage
(b) Frequency
(c) phase angle range
(d) deviation of voltage and Frequency

ECC.6.2.3.11  Automatic Reconnection

ECC.6.2.3.11.1  Generators in respect of Type A, Type B, Type C and Type D Power Generating Modules (including DC Connected Power Park Modules) are not permitted to automatically reconnect to the Total System without instruction from NGET. NGET will issue instructions for re-connection or re-synchronisation in accordance with the requirements of BC2.5.2. Where synchronising is permitted in accordance with BC2.5.2, the voltage and frequency at the Grid Entry Point or User System Entry Point shall be within the limits defined in ECC.6.2 and ECC.6.1.4, and the ramp rate limits pursuant to BC1.A.1.1. For the avoidance of doubt this requirement does not apply to Generators who are not required to satisfy the requirements of the Balancing Codes.

ECC.6.3  GENERAL POWER GENERATING MODULE, OTSDUW AND HVDC EQUIPMENT GENERATING UNIT (AND OTSDUW) REQUIREMENTS

ECC.6.3.1  This section sets out the technical and design criteria and performance requirements for Power Generating Modules and HVDC Equipment DC Converters and Power Park Modules (whether directly connected to the National Electricity Transmission System or Embedded) and (where provided in this section) OTSDUW Plant and Apparatus which each Generator or HVDC System Owner must ensure are complied with in relation to its Power Generating Modules, HVDC Equipment Generating and Power Park Modules and OTSDUW Plant and Apparatus but does not apply to Small Power Stations or individually to Power Park Units. References to Power Generating Modules Units, HVDC Equipment and Power Park Modules in this ECC.6.3 should be read accordingly.

ECC.6.3.2  REACTIVE CAPABILITY

ECC.6.3.2.1  Reactive Capability for Type B Synchronous Power Generating Modules

Comment [A51]: Need to check this with Mike / Sarah

Comment [A52]: This section is contingent upon the decision made on Large, Medium and Small. For the time being it is assumed that plant above a certain size would need to meet the requirements of the Grid Code and Distribution Code as per current practice but this needs to be tied up with the Large, Medium Small issue. In addition it is assumed that OTSDUW plant and Apparatus would subsumed into the new drafting otherwise Generators will need to refer to the existing CC’s for OTSDUW Plant and the ECC’s for Generation and HVDC Converters. This becomes even more confusing where you have different requirements between HVDC connections and AC connections.
ECC.6.3.2.1.1 When operating at **Maximum Capacity**, all **Type B Synchronous Power Generating Modules** must be capable of continuous operation at any points between the limits of **0.95 Power Factor** lagging and **0.95 Power Factor** leading at the **Grid Entry Point** or **User System Entry Point** unless otherwise agreed with NGET or relevant **Network Operator**.

At **Active Power** output levels other than **Maximum Capacity**, all **Generating Units** within a **Type B Synchronous Power Generating Module** must be capable of continuous operation at any point between the **Reactive Power** capability limits identified on the **HV Generator Performance Chart** unless otherwise agreed with NGET or relevant **Network Operator**.

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**ECC.6.3.2.2** Reactive Capability for **Type B Power Park Modules**

ECC.6.3.2.2.1 When operating at **Maximum Capacity**, all **Type B Power Park Modules** must be capable of continuous operation at any points between the limits of **0.95 Power Factor** lagging and **0.95 Power Factor** leading at the **Grid Entry Point** or **User System Entry Point** unless otherwise agreed with NGET or relevant **Network Operator**.

At **Active Power** output levels other than **Maximum Capacity**, each **Power Park Module** must be capable of continuous operation at any point between the **Reactive Power** capability limits identified on the **HV Generator Performance Chart** unless otherwise agreed with NGET or relevant **Network Operator**.

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**ECC.6.3.2.3** Reactive Capability for **Type C and D Synchronous Power Generating Modules**

ECC.6.3.2.3.1 In addition to meeting the requirements of ECC.6.3.2.3.2 – ECC.6.3.2.3.5, **Generators** which connect a **Type C** or **Type D Synchronous Power Generating Module(s)** to a **Non Embedded Customers System** or **Private Network**, may be required to meet additional reactive compensation requirements at the **Grid Supply Point** of that **Non Embedded Customer** or point of connection with the **Network Operator** where this is required for **System reasons**.

**ECC.6.3.2.3.3** All **Type C** and **Type D Synchronous Power Generating Modules** shall be capable of satisfying the **Reactive Power** capability requirements at the **Grid Entry Point** or **User System Entry Point** as defined in Figure X1 when operating at **Maximum Capacity**.

**ECC.6.3.2.3.4** At **Active Power** output levels other than **Maximum Capacity**, all **Generating Units** within a **Synchronous Power Generating Module** must be capable of continuous operation at any point between the **Reactive Power** capability limit identified on the **HV Generator Performance Chart** at least down to the **Minimum Stable Operating Level**.

At reduced **Active Power** output, **Reactive Power** supplied at the **Grid Entry Point** (or **User System Entry Point** if embedded) shall correspond to the **HV Generator Performance Chart** of the **Synchronous Power Generating Module**, taking the auxiliary supplies and the **Active Power** and **Reactive Power** losses of the **Generating Unit transformer** or **Station Transformer** into account.
In addition, to the requirements of ECC.6.3.2.3.1 – ECC.6.3.2.3.4 the short circuit ratio of all Onshore Synchronous Generating Units with an Apparent Power rating of less than 1600MVA shall not be less than 0.5. The short circuit ratio of Onshore Synchronous Generating Units with a rated Apparent Power of 1600MVA or above shall be not less than 0.4.

Reactive Capability for Type C and D Power Park Modules, HVDC Equipment and OTSUW Plant and Apparatus at the Interface Point

In addition to meeting the requirements of ECC.6.3.2.3.2 – ECC.6.3.2.3.5, Generators or HVDC System Owners which connect a Type C or Type D Power Park Module or HVDC Equipment to a Non Embedded Customers System or Private Network, may be required to meet additional reactive compensation requirements at the Grid Supply Point of that Non Embedded Customer or point of connection with the Network Operator where this is required for System reasons.

All Type C and Type D Power Park Modules, or DC Converters at a DC Converter Station with a Grid Entry Point or User System Entry Point voltage above 33kV, or Remote End HVDC Converters with an HVDC Interface Point voltage above 33kV, or OTSUW Plant and Apparatus with an Interface Point voltage above 33kV shall be capable of satisfying the Reactive Power capability requirements at the Grid Entry Point or User System Entry Point (or Interface Point in the case of OTSUW Plant and Apparatus, or HVDC Interface Point in the case of a Remote End HVDC Converter Station) as defined in Figure X2 when operating at Maximum Capacity (or Interface Point Capacity in the case of OTSUW Plant and Apparatus).

Comment [A55]: Test Updates - SC/AJ to discuss. Further discussion required on HVDC but believed to capture HVDC Code -Art 21(1)
ECC.6.3.2.6.3 All Type C or Type D Power Park Modules or HVDC Converters at a HVDC Converter Station with a Grid Entry Point or User System Entry Point voltage at or below 33kV or Remote End HVDC Converter Station with an HVDC Interface Point Voltage at or below 33kV shall be capable of satisfying the Reactive Power capability requirements at the Grid Entry Point or User System Entry Point as defined in Figure X3 when operating at Maximum Capacity.
ECC.6.3.2.6.4 All Type C and Type D Power Park Modules, HVDC Converters at a HVDC Converter Station including Remote End HVDC Converters or OTSDUW Plant and Apparatus, shall be capable of satisfying the Reactive Power capability requirements at the Grid Entry Point or User System Entry Point (or Interface Point Capacity in the case of OTSUW Plant and Apparatus or HVDC Interface Point in the case of Remote End HVDC Converter Stations) as defined in Figure X4 when operating below Maximum Capacity. With all Plant in service, the Reactive Power limits will reduce linearly below 50% Active Power output as shown in Figure X4 unless the requirement to maintain the Reactive Power limits defined at Maximum Capacity (or Interface Point Capacity in the case of OTSUW Plant and Apparatus) under absorbing Reactive Power conditions down to 20% Active Power output has been specified by NGET. These Reactive Power limits will be reduced pro rata to the amount of Plant in service.

Figure X4

ECC.6.3.2.7 Reactive Capability for Offshore Synchronous Power Generating Modules, Configuration 1 AC connected Offshore Power Park Modules and Configuration 2 DC Connected Power Park Modules.

ECC.6.3.2.7.1 The short circuit ratio of any Offshore Synchronous Generating Units within a Synchronous Power Generating Module shall not be less than 0.5. All Offshore Synchronous Generating Units, Configuration 1 AC connected Offshore Power Park Modules or Configuration 2 DC Connected Power Park Modules must be capable of maintaining zero transfer of Reactive Power at the Offshore Grid Entry Point. The steady state tolerance on Reactive Power transfer to and from an Offshore Transmission System expressed in MVAR shall be no greater than 5% of the Maximum Capacity.

ECC.6.3.2.7.2 For the avoidance of doubt if a Generator (including those in respect of DC Connected Power Park Modules) wishes to provide a Reactive Power capability in excess of the minimum requirements defined in ECC.6.3.2.7.1 then such capability (including steady state tolerance) shall be agreed. It could consider the use of a commercial agreement between the Generator, Offshore Transmission Licensee and NGET and/or the relevant Network Operator.

ECC.6.3.2.8 Reactive Capability for Configuration 2 AC connected Offshore Power Park Modules and Configuration 2 DC Connected Power Park Modules.
ECC.6.3.2.8.1 All Configuration 2 AC connected Offshore Power Park Modules and Configuration 2 DC Connected Power Park Modules shall be capable of satisfying the minimum Reactive Power capability requirements at the Offshore Grid Entry Point as defined in Figure X5 when operating at Maximum Capacity.

![Figure X5](image-url)

ECC.6.3.2.8.2 All AC Connected Configuration 2 Offshore Power Park Modules and Configuration 2 DC Connected Power Park Modules (where the HVDC Converter System or Transmission DC Converter is connected to one or more Onshore substations) shall be capable of satisfying the Reactive Power capability requirements at the Offshore Grid Entry Point as defined in Figure X6 when operating below Maximum Capacity. With all Plant in service, the Reactive Power limits will reduce linearly below 50% Active Power output as shown in Figure X6 unless the requirement to maintain the Reactive Power limits defined at Maximum Capacity (or Interface Point Capacity in the case of OTSDUW Plant and Apparatus) under absorbing Reactive Power conditions, down to 20% Active Power output has been specified with NGET. These Reactive Power limits will be reduced pro rata to the amount of Plant in service.
ECC.6.3.2.8.3 For the avoidance of doubt if a Generator (including Generators in respect of DC Connected Power Park Modules referred to in ECC.6.3.2.8.2) wishes to provide a Reactive Power capability in excess of the minimum requirements defined in ECC.6.3.2.8.1 then such capability (including any steady state tolerance) shall be agreed. It could consider the use of a commercial agreement between the Generator, Offshore Transmission Licensee and NGET and/or the relevant Network Operator.

ECC.6.3.3 OUTPUT POWER WITH FALLING FREQUENCY

ECC.6.3.3.1 Output power with falling frequency for Power Generating Modules and HVDC Equipment

CC.6.3.3.1.1 Each Power Generating Module and HVDC Equipment must be capable of:

- (a) continuously maintaining constant Active Power output for System Frequency changes within the range 50.5 to 49.5 Hz; and
- (b) (subject to the provisions of ECC.6.1.2) maintaining its Active Power output at a level not lower than the figure determined by the linear relationship shown in Figure X2 for System Frequency changes within the range 49.5 to 47 Hz for all ambient temperatures up to and including 25°C, such that if the System Frequency drops to 47 Hz the Active Power output does not decrease by more than 5%. In the case of a CCGT Module, the above requirement shall be retained down to the Low Frequency Relay trip setting of 48.8 Hz, which reflects the first stage of the Automatic Low Frequency Demand Disconnection scheme notified to Network Operators under ECC6.6.2. For System Frequency below that setting, the existing requirement shall be retained for a minimum period of 5 minutes while System Frequency remains below that setting, and special measure(s) that may be required to meet this requirement shall be kept in service during this period. After that 5 minutes period, if System Frequency remains below that setting, the special measure(s) must be discontinued if there is a materially increased risk of the Gas Turbine tripping. The need for special measures is linked to the inherent Gas Turbine Active Power output reduction caused by reduced shaft speed due to falling System Frequency. Where the need for special measures is identified in order to maintain output in line with the level identified in Figure X2 these measures should be still continued at ambient temperatures above 25°C maintaining as much of the Active Power achievable within the capability of the plant.
(c) For the avoidance of doubt, in the case of a Power Generating Module including a DC Connected Power Park Module Generating Unit or Power Park Module (or OTSDUW DC Converters at the Interface Point) using an Intermittent Power Source where the mechanical power input will not be constant over time, the requirement is that the Active Power output shall be independent of System Frequency under (a) above and should not drop with System Frequency by greater than the amount specified in (b) above.

(d) An HVDC System and a Remote End HVDC Converter must be capable of maintaining its Active Power input (i.e. when operating in a mode analogous to Demand) from the National Electricity Transmission System (or User System in the case of an Embedded HVDC System) at a level not greater than the figure determined by the linear relationship shown in Figure 3 for System Frequency changes within the range 49.5 to 47 Hz, such that if the System Frequency drops to 47.8 Hz the Active Power input decreases by more than 60%.

(d) In the case of an Offshore Generating Unit or Offshore Power Park Module or DC Connected Power Park Module or Remote End HVDC Converter or Transmission DC Converter (legal check does this include OTSDUW DC Converter?) Offshore DC Converter and OTSDUW DC Converter, the Generator shall comply with the requirements of ECC.6.3.3. Generators should be aware that Section K of the STC places requirements on Offshore Transmission Licensees which utilise a Transmission DC Converter as part of their Offshore Transmission System to make appropriate provisions to enable Generators to fulfil their obligations.

Comment [A57]: We may not need this as Remote End DC Converter is subsumed into the definition of an HVDC System.
In the case of Transmission DC Converters and Remote End HVDC Converters, the OTSDUW shall provide a continuous signal indicating the real time frequency measured at the Interface Point to the Offshore Grid Entry Point or HVDC Interface Point for the purpose of Offshore Generators or DC Connected Power Park Modules to respond to changes in System Frequency on the Main Interconnected Transmission System. A DC Connected Power Park Module or Offshore Power Generating Module shall be capable of receiving and processing this signal within 100ms.

**ECC.6.3.4 ACTIVE POWER OUTPUT UNDER SYSTEM VOLTAGE VARIATIONS**

**ECC.6.3.4.1** At the Grid Entry Point or User System Entry Point, the Active Power output under steady state conditions of any Power Generating Module or HVDC Equipment directly connected to the National Electricity Transmission System or in the case of OTSDUW, the Active Power transfer at the Interface Point, under steady state conditions of any OTSDUW Plant and Apparatus should not be affected by voltage changes in the normal operating range specified in paragraph ECC.6.1.4 by more than the change in Active Power losses at reduced or increased voltage.

**ECC.6.3.5 BLACK START**

**ECC.6.3.5.1** Black Start is not a mandatory requirement, however Users may wish to notify NGET of their ability to provide a Black Start facility and the cost of the service. NGET will then consider whether it wishes to contract with the User for the provision of a Black Start service which would be specified via a Black Start Contract. Where a User does not offer to provide a cost for the provision of a Black Start Capability, NGET may make such a request if it considers System security to be at risk due to a lack of Black Start capability.

**ECC.6.3.5.2** It is an essential requirement that the National Electricity Transmission System must incorporate a Black Start Capability. This will be achieved by agreeing a Black Start Capability at a number of strategically located Power Stations and HVDC Systems. For each Power Station or HVDC System NGET will state in the Bilateral Agreement whether or not a Black Start Capability is required.

**ECC.6.3.5.3** Where a User has entered into a Black Start Contract to provide a Black Start Capability in respect of a Type C and Type D Power Generating Module including DC Connected Power Park Modules the following requirements shall apply:

- **(i)** The Power-Generating Module or DC Connected Power Park Module shall be capable of starting from shutdown without any external electrical energy supply within a time frame specified by NGET in the Black Start Contract.
- **(ii)** Each Power Generating Module or DC Connected Power Park Module shall be able to synchronise within the frequency limits defined in ECC 6.1.2 laid down in point (a) of Article 13(1) and, where applicable, voltage limits specified by the relevant system operator or in Article 16(2) in ECC.6.1.4;
- **(iii)** The Power Generating Module or DC Connected Power Park Module shall be capable of connecting on to an unenergised System.
- **(iv)** The Power-Generating Module or DC Connected Power Park Module shall be capable of automatically regulating dips in voltage caused by connection of demand.
- **(v)** The Power Generating Module or DC Connected Power Park Module shall be capable of Block Load Capability.

Comment [AS8]: Need to check with the Black Start team the specification of times between each incremental step and where this information is provided.
be capable of operating in LFSM-O and LFSM-U, as specified in point (a) of paragraph 2 and Article 13(2), XXX (subnote – include ECC refs to LFSM-O and LFSM-U).

Control Frequency in case of overfrequency and underfrequency within the whole Active Power output range between the Minimum Regulating Level and Maximum Capacity as well as at Houseload Operation level.

be capable of parallel operation of a few Power Generating Modules including DC Connected Power Park Modules within an isolated part of the Total System that is still supplying Customers, and control voltage automatically during the system restoration phase;

ECC.6.3.5.4 Each HVDC System or Remote End HVDC Converter Station and has a Black Start Capability shall be capable of energising the busbar of an AC substation to which another DC Converter Station is connected. The timeframe after shutdown of the HVDC System prior to energisation of the AC substation shall be pursuant to the terms of the Black Start Contract. The HVDC System shall be able to synchronise within the Frequency limits defined in ECC.6.1.2.1.2 and voltage limits defined in ECC.6.1.4.1 unless otherwise specified in the Black Start Contract. Wider Frequency and voltage ranges can be specified in the Black Start Contract in order to restore System security. (Art 37(3) – Not reflected as these elements should be covered by the Black Start Contract)

ECC.6.3.5.4 With regard to the capability to take part in operation of an isolated part of the Total System that is still supplying Customers:

(i) Power Generating Modules including DC Connected Power Park Modules shall be capable of taking part in island operation if specified in the Black Start Contract required by NGET and:

the Frequency limits for island operation shall be those specified in ECC.6.1.2 established in accordance with point (a) of Article 13(1)

the voltage limits for island operation shall be those defined in ECC.6.1.4 (Need to ensure consistency with Art 15(3) established in accordance with Article 15(3) or Article 16(2), where applicable)

(ii) Power Generating Modules including DC Connected Power Park Modules shall be able to operate in Frequency Sensitive Mode during island operation, as specified in ECC 6.3.7 (point (d)) of paragraph 2. In the event of a power surplus, Power Generating Modules including DC Connected Power Park Modules shall be capable of reducing the Active Power output from a previous operating point to any new operating point within the Generator Performance Chart and the Active Power output as much as inherently technically feasible, but to at least 55% of its Maximum Capacity.
The method for detecting a change from interconnected system operation to island operation shall be agreed between the Generator power generating facility owner NGET and the Relevant Transmission Licensee the relevant system operator in coordination with the relevant TSO. The agreed method of detection must not rely solely on NGET, Relevant Transmission Licensee’s or Network Operators system operator’s switchgear position signals.

(iv) Power Generating Modules including DC Connected Power Park Modules shall be able to operate in LFSM-D and LFSM-U during island operation, as specified in ECC 6.3.7.X point (e) of paragraph 2 and ECC 6.3.X.X Article 21(2).

ECC 6.3.5.5 With regard to quick re-synchronisation capability:

(iii) In case of disconnection of the Power Generating Module including DC Connected Power Park Modules from the System, the Power Generating Module shall be capable of quick re-synchronisation in line with the Protection strategy agreed between NGET and/or Network Operator in coordination with the Relevant Transmission Licensee the relevant system operator in coordination with the relevant TSO and the Generator power generating facility.

(iv) A Power Generating Module including a DC Connected Power Module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be capable of HouseLoad Operation from any operating point on its P-Q Capability Diagram Generator Performance Chart. In this case, the identification of HouseLoad Operation must not be based solely on the System switchgear position signals.

(v) Power Generating Modules including DC Connected Power Park Modules shall be capable of HouseLoad Operation, irrespective of any auxiliary connection to the System external network. The minimum operation time shall be specified by NGET the relevant system operator in coordination with the relevant TSO. Taking into consideration the specific characteristics of prime mover technology.

CONTROL ARRANGEMENTS

ECC 6.3.6.1 ACTIVE POWER CONTROL

ECC 6.3.6.1.2 Active Power control in respect of Power Park Modules including DC Connected Power Park Modules

ECC 6.3.6.1.2.1 Type A Power Generating Modules shall be equipped with a logic interface (input port) in order to cease Active Power output within five seconds following an instruction being received at the input port. NGET may specify any additional requirements (including remote operation).

ECC 6.3.6.1.2.2 Type B Power Generating Modules shall be equipped with an interface (input port) in order to be able to reduce Active Power output following an instruction at the input port. NGET may specify any additional requirements (including remote operation).

ECC 6.3.6.1.2.3 Type C and Type D Power Generating Modules and DC Connected Power Park Modules shall be capable of adjusting the Active Power setpoint in accordance with instructions issued by NGET. In the event the load controller or related control system is out of service, manual local measures may be permitted. In such cases NGET shall notify The Authority of the time required to reach any new Active Power setpoint together with the tolerance for the Active Power.
ECC.6.3.6.1.3 Acti
g Power control in respec
t of HVDC Systems and Remote End HVDC Converter
Stations.

ECC.6.3.6.1.3.1 NG
t shall specify the minimum duty with which the HVDC System and Remote End
HVDC Converter Station may be required to modify the transmitted Active Power upon
receipt of request from NGET.

ECC.6.3.6.1.3.2 The requirements for fast Active Power reversal (if required) shall be specified by NGET.
Where Active Power reversal is specified, each HVDC System and Remote End HVDC
Converter Station shall be capable of operating from maximum import to maximum export
in a time no greater than 2 seconds except where a HVDC Converter Station Owner has
justified to NGET that a longer reversal time is required.

ECC.6.3.6.1.3.3 Where an HVDC System connects various Control Areas or Synchronous Areas, each HVDC
System or Remote End HVDC Converter Station shall be capable of responding to
instructions issued by NGET under the Balancing Code to modify the transmitted Active
Power for the purposes of cross-border balancing. (Note Article 13(2) and 13(3) get picked
up as part of the OC’s and BC’s)

ECC.6.3.6.1.3.4 An HVDC System shall be capable of limiting the varying rate of Active Power variations
issued sent by NGET relevant TSOs consistent with the generation of Active Power supplied to
HDC System and/or Remote End HVDC Converter Station. Each condition described in points (b) and (c) of paragraph 4
shall be subject to notification to the regulatory authority. The modalities of that notification shall be determined in accordance with the
applicable national regulatory framework.

ECC.6.3.6.2 MODULATION OF ACTIVE AND REACTIVE POWER

ECC.6.3.6.2.1 Each Power Generating Module and HVDC Equipment must be capable of contributing to
Frequency control by continuous modulation of Active Power supplied to the National
Electricity Transmission System. For the avoidance of doubt each HVDC System and/or
OTSDUW DC Converter shall provide each User in respect of its Offshore Power Stations
connected to and/or using an Offshore Transmission System a continuous signal indicating the real time Frequency measured at the Transmission Interface Point. A DC Connected
Power Park Module or Offshore Power Generating Module shall be capable of receiving
and processing this signal within 100ms.

ECC.6.3.6.3 MODULATION OF ACTIVE AND REACTIVE POWER

ECC.6.3.6.3.1 Each Power Generating Module or HVDC Equipment (and OTSDUW Plant and Apparatus
at a Transmission Interface Point and Remote End HVDC Converter at an HVDC Interface
Point) must be capable of contributing to voltage control by continuous changes to the
Reactive Power supplied to the National Electricity Transmission System or the User
System in which it is Embedded.

ECC.6.3.7 FREQUENCY RESPONSE

ECC.6.3.7.1 Limited Frequency Sensitive Mode – Overfrequency (LFSM-O)
ECC.6.3.7.1.1 Each Power Generating Module and HVDC Equipment shall be capable of reducing Active Power output in response to System Frequency when this rises above 50.4Hz. For the avoidance of doubt, the provision of this reduction in Active Power output is not an Ancillary Service. Such provision is known as Limited High Frequency Response. The Power Generating Module or HVDC Equipment shall be capable of operating stably during LFSDO operation. However for a Power Generating Module or HVDC Equipment operating in Frequency Sensitive Mode the requirements of LFSDO shall apply when the frequency exceeds 50.5Hz.

ECC.6.3.7.1.2 (i) The rate of change of Active Power output must be at a minimum a rate of 2 percent of output per 0.1 Hz deviation of System Frequency above 50.4Hz (ie a Droop of 10%) as shown in Figure X1 below. For the avoidance of doubt, this would not preclude a Generator or HVDC System Owner from designing their Power Generating Module with a lower Droop setting, for example between 3 – 5%.

(ii) The reduction in Active Power output must be continuously and linearly proportional, as far as is practicable, to the excess of Frequency above 50.4 Hz and must be provided increasingly with time over the period specified in (iii) below.

(iii) As much as possible of the proportional reduction in Active Power output must result from the frequency control device (or speed governor) action and must be achieved within 10 seconds of the time of the Frequency increase above 50.4 Hz. The Power Generating Module or HVDC Equipment shall be capable of initiating a Power Frequency response with an initial delay that is as short as possible. If the delay exceeds 2 seconds the Generator or DC Converter Station Owner shall justify the delay providing technical evidence to NGET.

(v) The residue of the proportional reduction in Active Power output which results from automatic action of the Power Generating Module or HVDC Equipment output control devices other than the frequency control devices (or speed governors) must be achieved within 3 minutes for the time of the Frequency increase above 50.4Hz.

Figure X1 – $P_{ref}$ is the reference Active Power to which $\Delta P$ is related and. $\Delta P$ is the change in Active Power output from the Power Generating Module or HVDC Equipment. $F_n$ is the...
nominal frequency (50Hz) in the network and Δf is the Frequency deviation in the network. At overfrequencies where Δf is below Δf1, the Power Generating Module or HVDC Equipment has to provide a negative Active Power output change according to droop S, which shall be no greater than 10%.

ECC.6.3.7.1.3 Each Power Generating Module or HVDC Equipment which is providing Limited High Frequency Response (LFSM-O) must continue to provide it until the Frequency has returned to or below 50.4Hz or until otherwise instructed by NGET. Generators in respect of Gensets and HVDC Converter Station Owners in respect of an HVDC System should also be aware of the requirements in BC.3.7.2.

ECC.6.3.7.1.4 Steady state operation below Minimum Generation in the case of Power Generating Modules including DC Connected Power Park Modules or minimum Active Power transfer capability in the case of HVDC Systems is not expected but if System operating conditions cause operation below Minimum Generation or minimum Active Power transfer capability which give rise to operational difficulties for the Power Generating Module including a DC Connected Power Park Module or HVDC Systems then the Generator or DC Converter Station Owner shall be able to return the output of the Power Generating Module including a DC Connected Power Park Module to an output of not less than the Minimum Generation or HVDC System to an output of not less than the minimum transfer capability.

ECC.6.3.7.1.5 All reasonable efforts should in the event be made by the Generator or DC Converter Station Owner to avoid such tripping provided that the System Frequency is below 52Hz in accordance with the requirements of ECC.6.1.3. If the System Frequency is at or above 52Hz, the requirement to make all reasonable efforts to avoid tripping does not apply and the Generator or DC Converter Station Owner is required to take action to protect its Power Generating Modules including DC Connected Power Park Modules or HVDC Converter Stations as specified in ECC.6.3.13.

ECC.6.3.7.2 Limited Frequency Sensitive Mode – Underfrequency (LFSM-U)

ECC.6.3.7.2.1 Each Type C and Type D Power Generating Module or HVDC Equipment operating in Limited Frequency Sensitive Mode shall be capable of increasing Active Power output in response to System Frequency when this falls below 49.5Hz. For the avoidance of doubt, the provision of this increase in Active Power output is not a mandatory Ancillary Service and it is not anticipated Power Generating Modules or HVDC Equipment are operated in an inefficient mode to facilitate delivery of LFSM-U response, but any inherent capability should be made available without undue delay. The Power Generating Module or HVDC Equipment shall be capable of stable operation during LFSM-U Mode.

ECC.6.3.7.2.2 The rate of change of Active Power output must be at a minimum a rate of 2 percent of output per 0.1 Hz deviation of System Frequency below 49.5Hz (ie a Droop of 10%) as shown in Figure X2 below. This requirement only applies if the Power Generating Module has headroom and the ability to increase Active Power output. In the case of a Power Park Module or DC Connected Power Park Module the requirements of Figure X2 shall be reduced pro-rata to the amount of Power Park Units in service and available to generate. For the avoidance of doubt, this would not preclude a Generator or HVDC Station Owner from designing their Power Generating Module with a lower Droop setting, for example between 3 – 5%.

(i) As much as possible of the proportional increase in Active Power output must result from the Frequency control device (or speed governor) action and must be achieved...
for Frequencies below 49.5 Hz. The Power Generating Module or HVDC Equipment shall be capable of initiating a power Frequency response with minimal delay. If the delay exceeds 2 seconds the Generator or DC Converter Station Owner shall justify the delay, providing technical evidence to NGET.

(iii) The actual delivery of Active Power Frequency Response in LFSM-U mode shall take into account:

- The ambient conditions when the response is to be triggered.
- The operating conditions of the Power Generating Module or HVDC Equipment in particular limitations on operation near Maximum Capacity or maximum transfer capacity at low frequencies and the respective impact of ambient conditions as detailed in ECC.6.3.3.
- The availability of primary energy sources.

(iv) In LFSM-U Mode the Power Generating Module, DC Converter at a DC Converter Station, DC Connected Power Park Module or Remote End DC Converter shall be capable of providing a power increase up to its Registered Maximum Capacity.

Active Power Frequency Response Capability of Power Park Modules and HVDC Equipment operating in LFSM-U Mode

Figure X2 –Limited Frequency Sensitive Mode – Underfrequency capability of Power Generating Modules and HVDC Equipment.

ECC.6.3.7.3 Frequency Sensitive Mode – (FSM)

ECC.6.3.7.3.1 In addition to the requirements of ECC.6.3.7.1 and ECC.6.3.7.2 each Type C and Type D Power Generating Module or HVDC Equipment must be fitted with a fast acting proportional Frequency control device (or turbine speed governor) and unit load controller or equivalent control device to provide Frequency response under normal operational conditions in accordance with Balancing Code 3 (BC3). In the case of a Power Park Module including a DC Connected Power Park Module, the Frequency or speed control device(s) may be on the Power Park Module (including a DC Connected Power Park Module) or on each individual Power Park Unit (including a Power Park Unit within a DC Connected Power Park Module) or be a combination of both. The Frequency control device(s) (or speed governor(s)) must be designed and operated to the appropriate:

Comment [A77]: This diagram will need to be updated in respect of DC Converters

Comment [A78]: Diagram updated to reflect GB interpretation. Droop set at 10% on maximum capacity which is the same for Power Park Modules and Synchronous Power Generating Modules - note this is capability on full output not based on loading level. Will need to be raised as part of Stakeholder consultation.
(i) European Specification: or

(ii) in the absence of a relevant European Specification, such other standard which is in common use within the European Community (which may include a manufacturer specification),

as at the time when the installation of which it forms part was designed or (in the case of modification or alteration to the Frequency control device (or turbine speed governor)) when the modification or alteration was designed.

The European Specification or other standard utilised in accordance with sub paragraph ECC.6.3.7.3.1 (a) (ii) will be notified to NGET by the Generator or DC Converter Station Owner:

(i) as part of the application for a Bilateral Agreement; or

(ii) as part of the application for a varied Bilateral Agreement; or

(iii) as soon as possible prior to any modification or alteration to the Frequency control device (or governor); and

ECC.6.3.7.3.2 The Frequency control device (or speed governor) in co-ordination with other control devices must control each Type C and Type D Power Generating Module or HVDC Equipment Active Power Output or Active Power transfer capability with stability over the entire operating range of the Power Generating Module or HVDC Equipment; and

ECC.6.3.7.3.3 Type C and Type D Power Generating Modules and DC Connected Power Park Modules shall also meet the following minimum requirements:

(i) capable of providing Active Power Frequency response in accordance with the performance characteristic shown in Figure X3 and parameters in Table X1.

Comment [A79]: Removed - LEEMPS clause though further discussion required on Large, Medium and Small issue.

Comment [A80]: Diagram to be changed to remove the difference between Synchronous and Power Park Modules. - Capability is based on Maximum Capacity - further discussion required with Generator Compliance.
<table>
<thead>
<tr>
<th>Table X1 – Parameters for Active Power Frequency response in Frequency Sensitive Mode including the mathematical expressions in Figure X3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Power as a percentage of Maximum Capacity ((</td>
</tr>
<tr>
<td>Frequency Response Insensitivity in mHz ((</td>
</tr>
<tr>
<td>Frequency Response Insensitivity as a percentage of nominal frequency ((</td>
</tr>
<tr>
<td>Frequency Response Deadband in mHz</td>
</tr>
<tr>
<td>Droop (%)</td>
</tr>
</tbody>
</table>

(ii) In satisfying the performance requirements specified in ECC.6.3.7.3(ii) Generators in respect of each Type C and Type D Power Generating Modules and DC Connected Power Park Module should be aware:

- In the case of overfrequency, the Active Power Frequency response is limited by the Minimum Regulating Level.
- In the case of underfrequency, the Active Power Frequency response is limited by the Maximum Capacity.
- The actual delivery of Active Power frequency response depends on the operating and ambient conditions of the Power Generating Module (including DC Connected Power Park Modules) when this response is triggered, in particular limitations on operation near Maximum Capacity at low Frequencies as specified in ECC.6.3.3 and available primary energy sources.
- The frequency control device (or speed governor) must also be capable of being set so that it operates with an overall speed Droop of between 3 – 5%. The Frequency Response Deadband and Droop must be able to be reselected repeatedly. For the avoidance of doubt, in the case of a Power Park Module (including DC Connected Power Park Modules) the speed Droop should be equivalent of a fixed setting between 3% and 5% applied to each Power Park Unit in service.

(iii) In the event of a Frequency step change each Type C and Type D Power Generating Module and DC Connected Power Park Module shall be capable of activating full and stable Active Power Frequency response (without undue power oscillations), in accordance with the performance characteristic shown in Figure X4 and parameters in Table X2.
Active Power Frequency Response capability. \( P_{\text{max}} \) is the Maximum Capacity to which \( \Delta P \) relates. \( \Delta P \) is the change in Active Power output from the Power Generating Module including DC Connected Power Park Modules. The Power Generating Module including DC Connected Power Park Modules has to provide Active Power output \( \Delta P \) up to the point \( \Delta P_1 \) in accordance with the times \( t_1 \) and \( t_2 \) with the values of \( \Delta P_1 \), \( t_1 \) and \( t_2 \) being specified in Table X2. \( t_1 \) is the initial delay. \( t_2 \) is the time for full activation.

Comment [A81]: This could be simplified with just the parameters inserted and references to \( t_1 \) and \( t_2 \) removed.

### Table X2: Parameters for full activation of Active Power Frequency response resulting from a Frequency step change

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Power as a percentage of Maximum Capacity (frequency response range)(</td>
<td>10%</td>
</tr>
<tr>
<td>Maximum admissible initial delay ( t_1 ) for Power Generating Modules (including DC Connected Power Park Modules) with inertia unless justified as specified in ECC.6.3.7.3.3 (iv)</td>
<td>2 seconds</td>
</tr>
<tr>
<td>Maximum admissible initial delay ( t_1 ) for Power Generating Modules (including DC Connected Power Park Modules) which do not contribute to System inertia unless justified as specified in ECC.6.3.7.3.3 (iv)</td>
<td>1 second</td>
</tr>
<tr>
<td>Activation time ( t_2 )</td>
<td>10 seconds</td>
</tr>
</tbody>
</table>
(iv) The initial activation of Active Power Primary Frequency response required shall not be unduly delayed. For Type C and Type D Power Generating Modules (including DC Connected Power Park Modules) with inertia the delay in initial Active Power Frequency response shall not be greater than 2 seconds. For Type C and Type D Power Generating Modules (including DC Connected Power Park Modules) without inertia, the delay in initial Active Power Frequency response shall not be greater than 1 second. If the Generator cannot meet this requirement they shall provide technical evidence to NGET demonstrating why a longer time is needed for the initial activation of Active Power Frequency response.

(v) In the case of Type C and Type D Power Generating Modules (including DC Connected Power Park Modules) other than the Steam Unit within a CCGT Module the combined effect of the Frequency Response Insensitivity and Frequency Response Deadband of the Frequency control device (or speed governor) should be no greater than 0.03Hz (±0.015Hz). In the case of the Steam Unit within a CCGT Module, the Frequency Response Deadband should be set to an appropriate value consistent with the requirements of ECC.6.3.7(c)(i) and the requirements of BC3.7.2 for the provision of LFSM-O taking account of any Frequency Response Insensitivity of the Frequency control device (or speed governor).

ECC.6.3.7.3.4 HVDC Systems and Remote End HVDC Converter Stations shall also meet the following minimum requirements:

(i) HVDC Systems and Remote End HVDC Converter Stations shall be capable of responding to Frequency deviations in each connected AC System by adjusting their Active Power import or export as shown in Figure X4 with the corresponding parameters in Table X2.

![Figure X4 – Active Power frequency response capability of a HVDC System or Remote End HVDC Converter Station operating in Frequency Sensitive Mode (FSM) illustrating the case of zero deadband and insensitivity with a positive active power setpoint (import mode). ΔP is the change in active power output from the HVDC System. fn is the target frequency in the AC network where the FSM service is provided and Δf is the frequency deviation in the AC network where the FSM service is provided.]

Comment [A82]: Diagram needs to be re-drawn - with GB parameters. There needs to be a reduction in the equations.

Comment [A83]: The title and Figure will require updating.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Response Deadband</td>
<td>0</td>
</tr>
<tr>
<td>Droop S1 (upward regulation)</td>
<td>3 – 5%</td>
</tr>
<tr>
<td>Droop S2 (downward regulation)</td>
<td>3 – 5%</td>
</tr>
<tr>
<td>Frequency Response Insensitivity</td>
<td>±15mHz</td>
</tr>
</tbody>
</table>

Table X2 – Parameters for Active Power Frequency response in FSM including the mathematical expressions in Figure X3

(ii) Each HVDC System and Remote End HVDC Converter Station shall be capable of adjusting the Droop for both upward and downward regulation, the frequency response deadband, and the Active Power range over which Frequency Sensitive Mode of operation is available as defined in ECC.6.3.7.3.4.

(iii) In addition to the requirements in ECC.6.3.7.4(i) and ECC.6.3.7.4(ii) each HVDC System and Remote End HVDC Converter Station shall be capable of:
- delivering the response as soon as technically feasible
- delivering the response on or above the solid line in Figure X2 in accordance with the parameters shown in Table X3
- initiating the delivery of Primary Response in no less than 0.5 seconds unless otherwise agreed with NGET. Where the initial delay time (t₁ – as shown in Figure X2) is longer than 0.5 seconds the DC Converter Station Owner shall reasonably justify it to NGET.

Figure X2 Active Power Frequency Response capability of a HVDC System and Remote End HVDC Converter Station. ΔP is the change in Active Power triggered by the step change in frequency.
Active Power as a percentage of Maximum Capacity (frequency response range) ($\frac{|\Delta P|}{P_{\text{max}}}$) | 10%
---|---
Maximum admissible delay $t_1$ | 0.5 seconds
Maximum admissible time for full activation $t_2$, unless longer activation times are agreed with NGET | 10 seconds

Table X3 – Parameters for full activation of Active Power Frequency response resulting from a Frequency step change.

(iv) For HVDC Systems connecting various Synchronous Areas, each HVDC System and Remote End HVDC Converter Station shall be capable of adjusting the full Active Power Frequency Response when operating in Frequency Sensitive Mode at any time and for a continuous time period. In addition, the Active Power controller of each HVDC System or Remote End DC Converter Station shall not have any adverse impact on the delivery of frequency response.

ECC.6.3.7.3.5 For HVDC Systems and Remote End HVDC Converter Stations and Type C and Type D Power Generating Modules (including DC Connected Power Park Modules), other than the Steam Unit within a CCGT Module the combined effect of the Frequency Response Insensitivity and Frequency Response Deadband of the Frequency control device (or speed governor) should be no greater than 0.03Hz (for the avoidance of doubt, ±0.015Hz). In the case of the Steam Unit within a CCGT Module, the Frequency Response Deadband should be set to an appropriate value consistent with the requirements of ECC.6.3.7(c)(i) and the requirements of BC3.7.2 for the provision of LFSM-O taking account of any Frequency Response Insensitivity of the Frequency control device (or speed governor).

(vi) With regard to disconnection due to underfrequency, Generators responsible for Type C and Type D Power Generating Modules (including DC Connected Power Park Modules) capable of acting as a load, including but not limited to Pumped Storage and tidal Power Generating Modules, HVDC Systems and Remote End HVDC Converter Stations, hydro pump-storage power-generating facilities, shall be capable of disconnecting their load in case of underfrequency which will be agreed with NGET. For the avoidance of doubt this requirement does not apply to station auxiliary supplies. Generators in respect of Type C and Type D Pumped Storage Power Generating Modules should also be aware of the requirements in OC.6.6.6.
(vii) Where a Type C or Type D Power Generating Module, DC Connected Power Park Module, HVDC System or Remote End HVDC Converter Station becomes isolated from the rest of the Total System but is still supplying Customers, the Frequency control device (or speed governor) must also be able to control System Frequency below 52Hz unless this causes the Type C or Type D Power Generating Module or DC Connected Power Park Module to operate below its Minimum Regulating Level when it is possible that it may, as detailed in BC 3.7.3, trip after a time. For the avoidance of doubt Power Generating Modules and HVDC Equipment are only required to operate within the System Frequency range 47 - 52 Hz as defined in ECC.6.1.3 and for converter based technologies, the remaining island contains sufficient fault level for effective commutation.

ECC.6.3.7.3.4 In addition to the requirements of ECC.6.3.7.3 each Type C and Type D Power Generating Module and HVDC Equipment shall be capable of meeting the minimum Frequency response requirement profile subject to and in accordance with the provisions of Appendix 3.

ECC.6.3.7.3.5 For the avoidance of doubt, the requirements of Appendix 3 do not apply to Type A and Type B Power Generating Modules.

ECC.6.3.8 EXCITATION AND VOLTAGE CONTROL PERFORMANCE REQUIREMENTS

ECC.6.3.8.1 Excitation Performance Requirements for Type B Synchronous Power Generating Modules

ECC.6.3.8.1.1 Each Synchronous Generating Unit within a Type B Synchronous Power Generating Module shall be equipped with a permanent automatic excitation control system that can provide constant terminal voltage at a selectable setpoint without instability over the entire operating range of the Type B Synchronous Power Generating Module.

ECC.6.3.8.1.2 In addition to the requirements of ECC.6.3.8.1.1, NGET or the relevant Network Operator will specify if the control system of the Type B Synchronous Power Generating Module shall contribute to voltage control or Reactive Power control or Power Factor control at the Grid Entry Point or User System Entry Point (or other defined busbar). The performance requirements of the control system including droop (where applicable) shall be agreed between NGET and/or the relevant Network Operator and the Generator.

ECC.6.3.8.2 Voltage Control Requirements for Type B Power Park Modules

ECC.6.3.8.2.1 NGET or the relevant Network Operator will specify if the control system of the Type B Power Park Module shall contribute to voltage control or Reactive Power control or Power Factor control at the Grid Entry Point or User System Entry Point (or other defined busbar). The performance requirements of the control system including droop (where applicable) shall be agreed between NGET and/or the relevant Network Operator and the Generator.

ECC.6.3.8.3 Excitation Performance Requirements for Type C and Type D Onshore Synchronous Power Generating Modules

Comment [A84]: For DC Converters they are bi-directional so reference to HVDC Systems has been removed. Discussion point? Need to make sure these terms work equally well for DC Converters.

Comment [A85]: droop is an undefined term here as it refers to the voltage control system not the frequency control system.

Comment [A86]: Check

Comment [A87]: droop is not defined here as this relates to the voltage control system.
ECC.6.3.8.3.1 Each Synchronous Generating Unit within a Type C and Type D Onshore Synchronous Power Generating Modules shall be equipped with a permanent automatic excitation control system that can provide constant terminal voltage control at a selectable setpoint without instability over the entire operating range of the Synchronous Power Generating Module.

ECC.6.3.8.3.2 The requirements for excitation control facilities are specified in ECC.A.6. Any site specific requirements shall be specified by NGET or the relevant Network Operator.

ECC.6.3.8.3.3 Unless otherwise required for testing in accordance with OC5.A.2, the automatic excitation control system of an Onshore Synchronous Power Generating Module shall always be operated such that it controls the Onshore Synchronous Generating Unit terminal voltage to a value that is:
- equal to its rated value: or
- only where provisions have been made in the Bilateral Agreement, greater than its rated value.

ECC.6.3.8.3.4 In particular, other control facilities including constant Reactive Power output control modes and constant Power Factor control modes (but excluding VAR limiters) are not required. However if present in the excitation or voltage control system they will be disabled unless otherwise agreed with NGET or the relevant Network Operator. Operation of such control facilities will be in accordance with the provisions contained in BC2.

ECC.6.3.8.3.5 The excitation performance requirements for Offshore Synchronous Power Generating Modules with an Offshore Grid Entry Point shall be specified by NGET.

ECC.6.3.8.4 Voltage Control Performance Requirements for Type C and Type D Onshore Power Park Modules, HVDC Equipment and OTSDUW Plant and Apparatus at the Interface Point

ECC.6.3.8.4.1 Each Type C and Type D Power Park Module, HVDC Equipment and OTSDUW Plant and Apparatus shall be fitted with a continuously acting automatic control system to provide control of the voltage at the Grid Entry Point or User System Entry Point (or Interface Point in the case of OTSDUW Plant and Apparatus or HVDC Interface Point in the case of a Remote End HVDC Converter Station) without instability over the entire operating range of the Onshore Power Park Module, or HVDC Equipment or OTSDUW Plant and Apparatus. Any Plant or Apparatus used in the provisions of such voltage control within a Power Park Module (including a DC Connected Power Park Module) may be located at the Power Park Unit terminals, an appropriate intermediate busbar or the Grid Entry Point or User System Entry Point. In the case of an HVDC Converter at a HVDC Converter Station or a Remote End HVDC Converter Station any Plant or Apparatus used in the provisions of such voltage control may be located at any point within the User’s Plant and Apparatus including the Grid Entry Point or User System Entry Point (or HVDC Interface Point in the case of Remote End HVDC Converter Stations). OTSDUW Plant and Apparatus used in the provision of such voltage control may be located at the Offshore Grid Entry Point an appropriate intermediate busbar or at the Interface Point. When operating below 20% Maximum Capacity the automatic control system may continue to provide voltage control using any available reactive capability, If voltage control is not being provided the automatic control system shall be designed to ensure a smooth transition between the shaded area bound by CD and the non-shaded area bound by AB in Figures X4 of ECC.6.3.2.6.4.
ECC.6.3.8.4.2 The performance requirements for a continuously acting automatic voltage control system that shall be complied with by the User in respect of Onshore Power Park Modules, HVDC Converters at an HVDC Converter Station, OTSDUW Plant and Apparatus at the Interface Point and Remote End HVDC Converter Stations at an HVDC Interface Point are defined in ECC.A.7.

ECC.6.3.8.4.3 In particular, other control facilities, including constant Reactive Power output control modes and constant Power Factor control modes (but excluding VAR limiters) are not required. However if present in the voltage control system they will be disabled unless otherwise agreed with NGET or the relevant Network Operator. Operation of such control facilities will be in accordance with the provisions contained in BC2. Where Reactive Power output control modes and constant Power Factor control modes have been fitted within the voltage control system they shall be required to satisfy the requirements of ECC.A.7.3.1.

ECC.6.3.8.5 Excitation Control Performance requirements applicable to AC Connected Offshore Synchronous Power Generating Modules and voltage control performance requirements applicable to AC connected Offshore Power Park Modules and DC Connected Power Park Modules

ECC.6.3.8.5.1 A continuously acting automatic control system is required to provide control of Reactive Power (as specified in ECC.6.3.2.7) at the Offshore Grid Entry Point (or HVDC Interface Point in the case of Configuration 1 DC Connected Power Park Modules) without instability over the entire operating range of the AC connected Offshore Synchronous Power Generating Module or Configuration 1 AC connected Offshore Power Park Module or Configuration 1 DC Connected Power Park Modules. The performance requirements for this automatic control system will be specified by NGET.

ECC.6.3.8.5.2 A continuously acting automatic control system is required to provide control of Reactive Power (as specified in ECC.6.3.2.8) at the Offshore Grid Entry Point (or HVDC Interface Point in the case of Configuration 2 DC Connected Power Park Modules) without instability over the entire operating range of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Modules, otherwise the requirements of ECC.6.3.2.7 shall apply. The performance requirements for this automatic control system are specified in ECC.A.8.

ECC.6.3.8.5.3 In addition to ECC.6.3.8.5.1 and ECC.6.3.8.5.2 the requirements for excitation or voltage control facilities, including Power System Stabilisers, where these are necessary for system reasons, will be specified by NGET. Reference is made to on-load commissioning witnessed by NGET in BC2.11.2.

ECC.6.3.9 STEADY STATE LOAD INACCURACIES

ECC.6.3.9.1 The standard deviation of Load error at steady state Load over a 30 minute period must not exceed 2.5 per cent of a Type C or Type D Power Generating Modules (including a DC Connected Power Park Module) Genset Maximum Capacity. Where a Type C or Type D Power Generating Module (including a DC Connected Power Park Module) Genset is instructed to Frequency sensitive operation, allowance will be made in determining whether there has been an error according to the governor droop characteristic registered under the PC. For the avoidance of doubt in the case of a Power Park Module allowance will be made for the full variation of mechanical power output.
ECC.6.3.10 NEGATIVE PHASE SEQUENCE LOADING

In addition to meeting the conditions specified in ECC.6.1.5(b), each Synchronous Power Generating Module Unit will be required to withstand, without tripping, the negative phase sequence loading incurred by clearance of a close-up phase-to-phase fault, by System Back-Up Protection on the National Electricity Transmission System or User System located Offshore in which it is Embedded.

ECC.6.3.11 NEUTRAL EARTHING

At nominal System voltages of 110kV and above the higher voltage windings of a transformer of a Power Generating Module or HVDC Equipment Generating Unit or transformer resulting from OTSDUW must be star connected with the star point suitable for connection to earth. The earthing and lower voltage winding arrangement shall be such as to ensure that the Earth Fault Factor requirement of paragraph ECC.6.2.1.1 (b) will be met on the National Electricity Transmission System at nominal System voltages of 110kV and above.

ECC.6.3.12 FREQUENCY AND VOLTAGE DEVIATIONS

As stated in ECC.6.1.3, the System Frequency could rise to 52Hz or fall to 47Hz. Each Power Generating Module (including DC Connected Power Park Modules) Generating Unit, DC Converter, OTSDUW Plant and Apparatus, Power Park Module or any constituent element must continue to operate within this Frequency range for at least the periods of time given in ECC.6.1.3 unless NGET has specified any requirements for combined Frequency and voltage deviations which are required to ensure the best use of technical capabilities of Power Generating Modules (including DC Connected Power Park Modules) if required to preserve or restore system security. Frequency level relays and/or rate of change of Frequency relays which will trip such Power Generating Module Generating Unit, DC Converter, OTSDUW Plant and Apparatus, Power Park Module and any constituent element within this Frequency range, under the Bilateral Agreement. Notwithstanding this requirement, Generators should also be aware of the requirements of ECC.6.3.14X.

ECC.6.3.13 GENERATOR FREQUENCY, RATE OF CHANGE OF FREQUENCY AND VOLATGE PROTECTION SETTING ARRANGEMENTS

Generators (including in respect of OTSDUW Plant and Apparatus) and HVDC System Owners will be responsible for protecting all their Power Generating Modules Generating Units (and OTSDUW Plant and Apparatus) or HVDC Equipment Power Park Modules against damage should Frequency excursions outside the range 52Hz to 47Hz ever occur. Should such excursions occur, it is up to the Generator or HVDC System to decide whether to disconnect his Apparatus for reasons of safety of Apparatus, Plant and/or personnel.

Each Power Generating Module when connected and synchronised to the System, shall be capable of withstanding without tripping a rate of change of Frequency up to and including 1 Hz per second as measured over a rolling 500 milliseconds period. Voltage dips may cause localised rate of change of Frequency values in excess of 1 Hz per second for short periods, and in these cases, the requirements under ECC.6.3.15 (fault ride through) supercedes this clause. For the avoidance of doubt, this requirement relates to the capabilities of Power Generating Modules only and does not impose the need for rate of change of Frequency protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays.
ECC.6.3.13.3 Each HVDC System and Remote End HVDC Converter Station when connected and synchronised to the System, shall be capable of withstanding without tripping a rate of change of Frequency up to and including ±2.5 Hz per second as measured over the previous 1 second period. Voltage dips may cause localised rate of change of Frequency values in excess of ±2.5 Hz per second for short periods, and in these cases, the requirements under ECC.6.3.15 (fault ride through) supersedes this clause. For the avoidance of doubt, this requirement relates to the capabilities of HVDC Systems and Remote End HVDC Converter Stations only and does not impose the need for rate of change of Frequency protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays.

ECC.6.3.13.4 Each DC Connected Power Park Module when connected to the System, shall be capable of withstanding without tripping a rate of change of Frequency up to and including ±2.0 Hz per second as measured over the previous 1 second period. Voltage dips may cause localised rate of change of Frequency values in excess of ±2.0 Hz per second for short periods, and in these cases, the requirements under ECC.6.3.15 (fault ride through) supersedes this clause. For the avoidance of doubt, this requirement relates to the capabilities of DC Connected Power Park Modules only and does not impose the need for rate of change of Frequency protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays.

ECC.6.3.13.5 SIMULTANEOUS OVER VOLTAGE AND UNDERFREQUENCY OR SIMULTANEOUS UNDERVOLTAGE AND OVERFREQUENCY

ECC.6.3.13.5 As stated in ECC.6.1.23, the System Frequency could rise to 52 Hz or fall to 47 Hz and the System voltage at the Grid Entry Point or User System Entry Point could rise or fall within the values outlined in ECC.6.1.4. Each Type C and Type D Power Generating Module (including DC Connected Power Park Modules) Generating Unit, DC Converter, or OTSDUW Plant and Apparatus, Power Park Module or any constituent element must continue to operate within this Frequency range for at least the periods of time given in ECC.6.1.23 and voltage range as defined in ECC.6.1.4 unless NGET has agreed to any simultaneous overvoltage and underfrequency relays and/or simultaneous undervoltage and overfrequency relays or Frequency level relays and/or rate of change of Frequency relays which will trip such Power Generating Module (including DC Connected Power Park Modules), Generating Unit, DC Converter Power Park Module and any constituent element within this Frequency or voltage range.

ECC.6.3.15X RATE OF CHANGE OF FREQUENCY WITHSTAND CAPABILITY

ECC.6.3.15X.1 Each Power Generating Module when connected and synchronised to the System, shall be capable of withstanding without tripping a rate of change of Frequency up to and including 1 Hz per second as measured over a rolling 500 milliseconds period. Voltage dips may cause localised rate of change of Frequency values in excess of 1 Hz per second for short periods, and in these cases, the requirements under ECC.6.3.15 (fault ride through) supersedes this clause. For the avoidance of doubt, this requirement relates to the capabilities of Power Generating Modules only and does not impose the need for rate of change of Frequency protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays.

ECC.6.3.15X.2 Each HVDC System and Remote End HVDC Converter Station when connected and synchronised to the System, shall be capable of withstanding without tripping a rate of change of Frequency up to and including ±2.5 Hz per second as measured over the previous 1 second period. Voltage dips may cause localised rate of change of Frequency values in excess of ±2.5 Hz per second for short periods, and in these cases, the requirements under ECC.6.3.15 (fault ride through) supersedes this clause.
For the avoidance of doubt, this requirement relates to the capabilities of HVDC Systems and Remote End HVDC Converter Stations only and does not impose the need for rate of change of Frequency protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays.

ECC.6.3.15X.1 Each DC Connected Power Park Module when connected to the System, shall be capable of withstanding without tripping a rate of change of Frequency up to and including ±2.0Hz per second as measured over the previous 1 second period. Voltage dips may cause localized rate of change of Frequency values in excess of ±2.0 Hz per second for short periods, and in these cases, the requirements under ECC.6.3.15 (fault ride through) supersedes this clause. For the avoidance of doubt, this requirement relates to the capabilities of DC Connected Power Park Modules only and does not impose the need for rate of change of Frequency protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays.

ECC.6.3.14 FAST START CAPABILITY

ECC.6.3.16X.1 It may be agreed in the Bilateral Agreement that a Genset shall have a Fast-Start Capability. Such Gensets may be used for Operating Reserve and their Start-Up may be initiated by Frequency-level relays with settings in the range 49Hz to 50Hz as specified pursuant to OC2.

ECC.6.3.15 FAULT RIDE THROUGH

ECC.6.3.15.1 General Fault Ride Through requirements, principles and concepts applicable to Type B, Type C and Type D Power Generating Modules and OTSDUW Plant and Apparatus subject to faults up to 140ms in duration.

ECC.6.3.15.1.1 ECC.6.3.15 – 6.3.15.8 section sets out the Fault Ride Through requirements on Type B, Type C and Type D Power Generating Modules, OTSDUW Plant and Apparatus and HVDC Equipment that shall apply in the event of a fault lasting up to 140ms in duration.

ECC.6.3.15.1.2 Each Power Generating Module, Power Park Module, HVDC Equipment and OTSDUW Plant and Apparatus is required to remain connected and stable for any balanced and unbalanced fault where the voltage at the Grid Entry Point or User System Entry Point (or HVDC Interface Point in the case of Remote End DC Converter Stations or Interface Point in the case of OTSDUW Plant and Apparatus) remains on or above the heavy black line shown in sections ECC.6.3.15.4 – ECC.6.3.15.10 Figures below.

ECC.6.3.15.1.3 The voltage against time curves defined in ECC.6.3.15.2 – ECC.6.3.15.6 expresses the lower limit (expressed as the ratio of its actual value and its reference 1pu) of the actual course of the phase to phase voltage (or phase to earth voltage in the case of asymmetrical/unbalanced faults) on the System voltage level at the Grid Entry Point or User System Entry Point (or HVDC Interface Point in the case of Remote End HVDC Converter Stations or Interface Point in the case of OTSDUW Plant and Apparatus) during a symmetrical or asymmetrical/unbalanced fault, as a function of time before, during and after the fault.

ECC.6.3.15.2 Voltage against time curve and parameters applicable to Type B Synchronous Power Generating Modules.
Figure X - Voltage against time curve applicable to Type B Synchronous Power Generating Modules

<table>
<thead>
<tr>
<th>Voltage parameters (pu)</th>
<th>Time parameters (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uret</td>
<td>0.3</td>
</tr>
<tr>
<td>Uclear</td>
<td>0.7</td>
</tr>
<tr>
<td>Urec1</td>
<td>0.7</td>
</tr>
<tr>
<td>Urec2</td>
<td>0.9</td>
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Table X Voltage against time parameters applicable to Type B Synchronous Power Generating Modules

ECC.6.3.15.3 Voltage against time curve and parameters applicable to Type C and D Synchronous Power Generating Modules connected below 110kV

Figure X - Voltage against time curve applicable to Type C and D Synchronous Power Generating Modules connected below 110kV

<table>
<thead>
<tr>
<th>Voltage parameters (pu)</th>
<th>Time parameters [seconds]</th>
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<tr>
<td>Uret</td>
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<td>tclear</td>
<td>0.14</td>
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Table X Voltage against time parameters applicable to Type C and D Synchronous Power Generating Modules connected below 110kV

<table>
<thead>
<tr>
<th>Uclear</th>
<th>0.7</th>
<th>trec1</th>
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<tr>
<td>Urec2</td>
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</table>

ECC.6.3.15.4 Voltage against time curve and parameters applicable to Type D Synchronous Power Generating Modules connected at or above 110kV

Figure X - Voltage against time curve applicable to Type D Synchronous Power Generating Modules connected at or above 110kV

Table X Voltage against time parameters applicable to Type D Synchronous Power Generating Modules connected at or above 110kV

<table>
<thead>
<tr>
<th>Voltage parameters (pu)</th>
<th>Time parameters (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uret</td>
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<tr>
<td>Urec1</td>
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<tr>
<td>Urec2</td>
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</tr>
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</table>

ECC.6.3.15.5 Voltage against time curve and parameters applicable to Type B, C and D Power Park Modules connected below 110kV

Table X Voltage against time parameters applicable to Type D Synchronous Power Generating Modules connected at or above 110kV
Figure X - Voltage against time curve applicable to Type B, C and D Power Park Modules connected below 110kV

<table>
<thead>
<tr>
<th>Voltage parameters (pu)</th>
<th>Time parameters (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uret</td>
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<tr>
<td>Urec1</td>
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<tr>
<td>Urec2</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Table X Voltage against time parameters applicable to Type B, C and D Power Park Modules connected below 110kV

ECC.6.3.15.6 Voltage against time curve and parameters applicable to Type D Power Park Modules with a Connection Point at or above 110kV, DC Connected Power Park Modules or OTSDUW Plant and Apparatus at the Interface Point.
Figure X - Voltage against time curve applicable to a **Type D Power Park Modules with a Connection Point at or above 110kV, DC Connected Power Park Modules or OTSDUW Plant and Apparatus at the Interface Point**.

<table>
<thead>
<tr>
<th>Voltage parameters (pu)</th>
<th>Time parameters (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_{ret}$</td>
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<tr>
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<td>$U_{rec2}$</td>
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</table>

Table X Voltage against time parameters applicable to a **Type D Power Park Modules with a Connection Point at or above 110kV, DC Connected Power Park Modules or OTSDUW Plant and Apparatus at the Interface Point**.

ECC.6.3.15.7 **Voltage against time curve and parameters applicable to HVDC Systems and Remote End HVDC Converter Station**

![Figure X - Voltage against time curve applicable to HVDC Systems and Remote End HVDC Converter Station](image)

<table>
<thead>
<tr>
<th>Voltage parameters (pu)</th>
<th>Time parameters (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_{ret}$</td>
<td>$t_{clear}$</td>
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<tr>
<td>$U_{clear}$</td>
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<tr>
<td>$U_{rec1}$</td>
<td>$t_{rec2}$</td>
</tr>
<tr>
<td>$U_{rec2}$</td>
<td>$t_{rec3}$</td>
</tr>
</tbody>
</table>

Table X Voltage against time parameters applicable to **HVDC Systems and Remote End HVDC Converter Station**.

ECC.6.3.15.8. In addition to the requirements in ECC.6.3.15.1 – ECC.6.3.15.7:

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ECC  
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21 March 2017
(i) Each Type B, Type C and Type D Power Generating Module at the Grid Entry Point or User System Entry Point, HVDC Equipment (or OTSDUW Plant and Apparatus at the Interface Point) shall be capable of satisfying the above requirements when operating at Rated MW output and maximum leading Power Factor.

(ii) NGET will specify upon request by the User the pre-fault and post-fault short circuit capacity (in MVA) at the Grid Entry Point or User System Entry Point (or HVDC Interface Point in the case of a remote and HVDC Converter Stations or Interface Point in the case of OTSDUW Plant and Apparatus).

(iii) The pre-fault voltage shall be taken to be 1.0pu and the post-fault voltage shall not be less than 0.9pu.

(iv) To allow a User to model the Fault Ride Through performance of its Type B, Type C and Type D Power Generating Modules or HVDC Equipment, NGET will provide additional network data as may reasonably be required by the User to undertake such study work in accordance with PC.A.8. Alternatively, NGET may provide generic values derived from typical cases.

(v) NGET will publish fault level data under maximum and minimum demand conditions in the Electricity Ten Year Statement.

(vi) Each Generator (in respect of Type B, Type C, Type D Power Generating Modules and DC Connected Power Park Modules) and DC Converter Station Owners (in respect of HVDC Systems) shall satisfy the requirements in ECC.6.3.15.8(i) – (iv) unless the protection schemes and settings for internal electrical faults trips the Type B, Type C and Type D Power Generating Module, HVDC Equipment (or OTSDUW Plant and Apparatus) from the network. The protection schemes and settings should not jeopardise Fault Ride Through performance as specified in ECC.6.3.15.8(i) – (iv). The undervoltage protection at the Grid Entry Point or User System Entry Point (or HVDC Interface Point in the case of a Remote End HVDC Converter Stations or Interface Point in the case of OTSDUW Plant and Apparatus) shall be set by the Generator (or HVDC Converter Station Owner or OTSDUA in the case of OTSDUW Plant and Apparatus) according to the widest possible range unless NGET and the User have agreed to narrower settings. All protection settings associated with undervoltage protection shall be agreed between the Generator and/or HVDC System Owner with NGET and Relevant Transmission Licensee’s and Relevant Network Operator (as applicable).

(vii) Each Type B, Type C and Type D Power Generating Module, HVDC Equipment and OTSDUW Plant and Apparatus at the Interface Point shall be designed such that upon clearance of the fault on the Onshore Transmission System and within 0.5 seconds of restoration of the voltage at the Grid Entry Point or User System Entry Point or HVDC Interface Point in the case of a Remote End HVDC Converter Stations or Interface Point in the case of OTSDUW Plant and Apparatus to 90% of nominal voltage or greater, Active Power output (or Active Power transfer capability in the case of OTSDW Plant and Apparatus or Remote End HVDC Converter Stations) shall be restored to at least 90% of the level immediately before the fault. Once Active Power output (or Active Power transfer capability in the case of OTSDUW Plant and Apparatus or Remote End HVDC Converter Stations) has been restored to the required level, Active Power oscillations shall be acceptable provided that:

- The total Active Energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant;
- The oscillations are adequately damped.
For AC Connected Onshore and Offshore Power Park Modules Plant and Apparatus installed on or after 1 December 2017, comprising switched reactive compensation equipment (such as mechanically switched capacitors and reactors), such switched reactive compensation equipment shall be controlled such that it is not switched in or out of service during the fault but may act to assist in post fault voltage recovery.

**ECC.6.3.15.8.2**

**ECC.6.3.15.9** General Fault Ride Through requirements for faults in excess of 140ms in duration.

**ECC.6.3.15.9.1** General Fault Ride Through requirements applicable to HVDC Equipment and OTSDUW DC Converters subject to faults and voltage dips in excess of 140ms.

**ECC.6.3.15.9.1.1** The requirements applicable to HVDC Equipment including OTSDUW DC Converters subject to faults and voltage disturbances at the Grid Entry Point or User System Entry Point or Interface Point or HVDC Interface Point, including Active Power transfer capability shall be specified in the Bilateral Agreement.

**ECC.6.3.15.9.2** The Fault Ride Through requirements for Type C and Type D Synchronous Power Generating Modules subject to faults and voltage disturbances on the Onshore Transmission System in excess of 140ms are defined in ECC.6.3.15.9.2(a) and the Fault Ride Through Requirements for Power Park Modules and OTSDUW Plant and Apparatus subject to faults and voltage disturbances on the Onshore Transmission System greater than 140ms in duration are defined in ECC.6.3.15.9.2(b).

(a) Requirements applicable to Synchronous Power Generating Units-Modules subject to Supergrid Voltage dips on the Onshore Transmission System greater than 140ms in duration:

In addition to the requirements of ECC.6.3.15.1 – ECC.6.3.15.8.1(a) each Synchronous Power Generating Module Unit, each with a Completion Date on or after 1 April 2005 shall:

(i) remain transiently stable and connected to the System without tripping of any Synchronous Power Generating Module Unit for balanced Supergrid Voltage dips and associated durations on the Onshore Transmission System (which could be at the Interface Point) anywhere on or above the heavy black line shown in Figure X5a. Appendix X4A and Figures ECC.A.4A.3.2 (a), (b) and (c) provide an explanation and illustrations of Figure 5a; and
(ii) provide **Active Power** output at the **Grid Entry Point**, during **Supergrid Voltage** dips on the **Onshore Transmission System** as described in Figure 5a, at least in proportion to the retained balanced voltage at the **Onshore Grid Entry Point** (for **Onshore Synchronous Power Generating Modules Units**) or **Interface Point** (for **Offshore Synchronous Power Generating Modules Units**) (or the retained balanced voltage at the **User System Entry Point if Embedded**) and shall generate maximum reactive current (where the voltage at the **Grid Entry Point** is outside the limits specified in ECC.6.1.4) without exceeding the transient rating limits of the **Synchronous Power Generating Module Unit** and,

(iii) restore **Active Power** output following **Supergrid Voltage** dips on the **Onshore Transmission System** as described in Figure 5a, within 1 second of restoration of the voltage to 1.0pu of the nominal voltage at the:

- **Onshore Grid Entry Point** for directly connected **Onshore Synchronous Power Generating Modules Units** or,

- **Interface Point** for **Offshore Synchronous Power Generating Modules Units** as,

- **User System Entry Point** for **Embedded Onshore Synchronous Power Generating Modules Units** or,

- **User-System-Entry-Point** for **Embedded Medium-Power Stations** not subject to a **Bilateral Agreement** which comprise **Synchronous Generating Units** and with an **Onshore User System Entry Point** (irrespective of whether they are located Onshore or Offshore)

...to at least 90% of the level available immediately before the occurrence of the dip. Once the **Active Power** output has been restored to the required level, **Active Power** oscillations shall be acceptable provided that:

- the **total Active Energy** delivered during the period of the oscillations is at least that which would have been delivered if the **Active Power** was constant

- the oscillations are adequately damped.

For the avoidance of doubt a balanced **Onshore Transmission System Supergrid Voltage** meets the requirements of ECC.6.1.5 (b) and ECC.6.1.6.
(b) Requirements applicable to Type C and Type D OTSDUW Plant and Apparatus and Power Park Modules and OTSDUW Plant and Apparatus subject to Supergrid Voltage dips on the Onshore Transmission System greater than 140ms in duration.

In addition to the requirements of ECC.6.3.15.1 (a) each OTSDUW Plant and Apparatus or each Power Park Module and / or any constituent Power Park Unit, each with a Completion Date on or after the 1 April 2005 shall:

(i) remain transiently stable and connected to the System without tripping of any OTSDUW Plant and Apparatus, or Power Park Module and / or any constituent Power Park Unit, for balanced Supergrid Voltage dips and associated durations on the Onshore Transmission System (which could be at the Interface Point) anywhere on or above the heavy black line shown in Figure 5b. Appendix 4A and Figures ECC.A.4A.3.4 (a), (b) and (c) provide an explanation and illustrations of Figure 5b; and

(ii) provide Active Power output at the Grid Entry Point or in the case of an OTSDUW, Active Power transfer capability at the Transmission Interface Point, during Supergrid Voltage dips on the Onshore Transmission System as described in Figure 5b, at least in proportion to the retained balanced voltage at the Onshore Grid Entry Point (for Onshore Power Park Modules) or Interface Point (for OTSDUW Plant and Apparatus and Offshore Power Park Modules) (or the retained balanced voltage at the User System Entry Point if Embedded) except in the case of a Non-Synchronous Generating Unit or OTSDUW Plant and Apparatus or Power Park Module where there has been a reduction in the Intermittent Power Source or in the case of OTSDUW Active Power transfer capability in the time range in Figure 5b that restricts the Active Power output or in the case of an OTSDUW Active Power transfer capability below this level.

(iii) restore Active Power output (or, in the case of OTSDUW, Active Power transfer capability), following Supergrid Voltage dips on the Onshore Transmission System as described in Figure 5b, within 1 second of restoration of the voltage at the Onshore Grid Entry Point for directly connected Onshore Power Park Modules or...
Interface Point for OTSDUW Plant and Apparatus and Offshore Power Park Modules or,

User System Entry Point for Embedded Onshore Power Park Modules, User System Entry Point for Embedded Medium Power Stations which comprise Power Park Modules not subject to a Bilateral Agreement and with an Onshore User System Entry Point (irrespective of whether they are located Onshore or Offshore)

to the minimum levels specified in ECC.6.1.4 to at least 90% of the level available immediately before the occurrence of the dip except in the case of a Non-Synchronous Generating Unit, OTSDUW Plant and Apparatus or Power Park Module where there has been a reduction in the Intermittent Power Source in the time range in Figure 5b that restricts the Active Power output or, in the case of OTSDUW, Active Power transfer capability below this level. Once the Active Power output or, in the case of OTSDUW, Active Power transfer capability has been restored to the required level, Active Power oscillations shall be acceptable provided that:

- the total Active Energy delivered during the period of the oscillations is at least that which would have been delivered if the Active Power was constant
- the oscillations are adequately damped

For the avoidance of doubt a balanced Onshore Transmission System Supergrid Voltage meets the requirements of ECC.6.1.5 (b) and ECC.6.1.6.

ECC.6.3.15.10 Other Fault Ride Through Requirements

(i) In the case of a Power Park Module including a DC Connected Power Park Module (comprising of wind-turbine generator units), the requirements in ECC.6.3.15.X and CC.6.3.15.2 do not apply when the Power Park Module (including a DC Connected Power Park Module) is operating at less than 5% of its Rated MW or during very high primary energy source conditions wind speed conditions when more than 50% of the wind-turbine generator Power Park Units in a Power Park Module have been shut down or disconnected under an emergency shutdown sequence to protect User’s Plant and Apparatus.

(ii) In addition to meeting the conditions specified in ECC.6.1.5(b) and ECC.6.1.6, each Non-Synchronous Generating Unit, OTSDUW Plant and Apparatus or Power Park Module or DC Connected Power Park Module with a Completion Date after 1 April 2005 and any constituent Power Park Unit thereof will be required to withstand, without tripping, the negative phase sequence loading incurred by clearance of a close-up phase-to-phase fault, by System Back-Up Protection on the Onshore Transmission System operating at Supergrid Voltage.
(iii) In the case of an Onshore Power Park Module in Scotland with a Completion Date before 1 January 2004 and a Registered Capacity less than 30MW the requirements in CC.6.3.15.1 (a) do not apply. In the case of an Onshore Power Park Module in Scotland with a Completion Date on or after 1 January 2004 and before 1 July 2005 and a Registered Capacity of 30MW and above the requirements in CC.6.3.15.1 (a) are relaxed from the minimum Onshore Transmission System Supergrid Voltage of zero to a minimum Onshore Transmission System Supergrid Voltage of 15% of nominal. In the case of an Onshore Power Park Module in Scotland with a Completion Date before 1 January 2004 and a Registered Capacity less than 30MW the requirements in CC.6.3.15.1 (a) are relaxed from the minimum Onshore Transmission System Supergrid Voltage of zero to a minimum Onshore Transmission System Supergrid Voltage of 15% of nominal.

(iv) For the avoidance of doubt the requirements specified in ECC.6.3.15 do not apply to Power Generating Modules connected to an unhealthy circuit and islanded from the Transmission System even for delayed auto reclosure times.

ECC.6.3.15.11

HVDC System Robustness

ECC.6.3.15.11.1

The HVDC System shall be capable of finding stable operation points with a minimum change in Active Power flow and voltage level, during and after any planned or unplanned change in the HVDC System or AC System network to which it is connected. NGET shall specify the changes in the System conditions for which the HVDC Systems shall remain in stable operation.

ECC.6.3.15.11.2

The HVDC System owner shall ensure that the tripping or disconnection of an HVDC Converter Station, as part of any multi-terminal or embedded HVDC System, does not result in transients at the Grid Entry Point or User System Entry Point beyond the limit specified by NGET in co-ordination with the Relevant Transmission Licensee.

ECC.6.3.15.11.3

The HVDC System shall withstand transient faults on HVAC lines in the network adjacent or close to the HVDC System, and shall not cause any of the equipment in the HVDC System to disconnect from the network due to autoreclosure of lines in the System network.

ECC.6.3.15.11.4

The HVDC System Owner shall provide information to NGET on the resilience of the HVDC System to AC System disturbances.

ECC.6.3.16

FAST FAULT CURRENT INJECTION

ECC.6.3.16.1

General Fast Fault Current injection, principles and concepts applicable to Type B, Type C and Type D Power Park Modules and HVDC Equipment. DC Converters at a DC Converter Station, DC Connected Power Park Modules and Remote End DC Converters.

ECC.6.3.16.1.1

This section sets out the Fast Fault Current injection requirements for Type B, Type C and Type D Power Park Modules, DC Converters at a DC Converter Station, DC Connected Power Park Modules and Remote End DC Converters, Generators and DC Converter Station Owners who own Type B, Type C and Type D Power Park Modules, DC Converters at a DC Converter Station shall have the option of meeting either the requirements of

(d) ECC.6.3.16.2 or

(a) ECC.6.3.16.3
ECC.6.3.13.1.2 Generators or DC Converter Station Owners should notify NGET which option they wish to select within 28 days of signing a Connection Agreement or such longer period as NGET may agree, in any event this being no later than 3 months before the Completion Date of the offer for a final CUSC Contract. For the avoidance of doubt, the requirements defined under ECC.6.3.16.3 shall only be available to Generators and DC Converter Station Owners which have a Completion Date before 1 January 2021.

ECC.6.3.13.1.3 In the case of a DC Connected Power Park Module or Remote End HVDC Converter, the requirements of ECC.6.3.16.2 or ECC.6.3.16.3 shall apply unless NGET has agreed to an alternative requirement which would be pursuant to the terms of the Bilateral Agreement. Any alternative agreed would still need to comply with the requirements defined under the HVDC Code ((Regulation EU) 2016/1447).

ECC.6.3.16.1 Fast Fault Current Injection – Option 3

ECC.6.3.16.1.1 For Generators and DC Converter Station Owners selecting to satisfy the Fast Fault Current Injection requirements – Option 3 Each Type B, Type C and Type D Power Park Module or HVDC Equipment Converter Station Owner shall be required to satisfy the following requirements. Generators and DC Converter Station Owners should be aware that this option is only available to Type B, Type C and Type D Power Park Modules and DC Converter Station Owners with a Contract Date before 1 January 2021 unless otherwise specified in the Bilateral Agreement.

(i) For any balanced or unbalanced fault which results in the voltage on one or more phases falling to zero at the Grid Entry Point or User System Entry Point each Type B, Type C and Type D Power Park Module or HVDC Equipment Converter Station shall be required to inject a reactive current above the shaded red area shown in Figure 4(a) and Figure 4(b).
The converter of each Type B, Type C and Type D Power Park Module or HVDC Equipment Converter at a DC Converter Station is permitted to block upon fault clearance in order to mitigate against the risk of instability that would otherwise occur due to transient overvoltage excursions. Figure X.4.3(a) and Figure X.4.3(b) shows the impact of variations in fault clearance time which shall be no greater than 140ms. Where the User is able to demonstrate to NGET that blocking is required in order to prevent the risk of transient over voltage excursions as specified in ECC.6.3.16.4.2.1(iv), Generators and HVDC System Converter Station Owners are required to both advise and agree with NGET of the control strategy in accordance with the terms of the Bilateral Agreement, which must also include the approach taken to de-blocking. Not withstanding this requirement, Generators and HVDC Converter Station System Owners should be aware of their requirement to fully satisfy the requirements of ECC.6.3.15 (fault ride through).

In addition, the reactive current injected from each Power Park Module or HVDC Equipment Converter Station Owner shall be injected in proportion and remain in phase to the change in System voltage at the Connection Point or User System Entry Point during the period of the fault. For the avoidance of doubt, a small delay time of no greater than 20ms from the point of fault inception is permitted before injection of the in phase reactive current. For voltage depressions of 0.65p.u or below, reactive current injection shall take priority over active current injection up to a maximum of 1.025p.u. of the rating of the Power Park Module or HVDC Converter Equipment at a DC Converter Station.
Each Type B, Type C and Type D Power Park Module or HVDC Equipment Converter at a DC Converter Station shall be designed to reduce the risk of transient over voltage levels arising following clearance of the fault. Generators or HVDC Converter Station System Owners shall be permitted to block where the anticipated transient overvoltage would not otherwise exceed the maximum permitted values specified in ECC.6.1.7. Any additional requirements relating to transient overvoltage performance will be specified by NGET in the Bilateral Agreement.

In addition to the requirements of ECC.6.3.15.X.X (Fault Ride Through) Generators in respect of Type B, Type C and Type D Power Park Modules and HVDC System Converter Stations Owners are required to confirm to NGET, their repeated ability to supply Fast Fault Current to the System each time the voltage at the Grid Entry Point or User System Entry Point falls outside the limits specified in ECC.6.1.4. Generators and HVDC Converter Station Equipment Owners should inform NGET of the maximum number of repeated operations that can be performed under such conditions and any limiting factors to repeated operation such as protection or thermal rating; and

An illustration and examples of the performance requirements expected are illustrated in Appendix 4EC.

ECC.6.3.17 Subsynchronous Torsional Interaction Damping Capability

ECC.6.3.17.1 Not withstanding the requirements of ECC6.1.9 and ECC6.1.10, HVDC System Owners, or Generators in respect of OTSDUW DC Converters or Network Operators in the case of an Embedded HVDC Systems not subject to a Bilateral Agreement must ensure that any of their Onshore HVDC Systems or OTSDUW DC Converters will not cause a sub-synchronous resonance problem on the Total System. Each HVDC System or OTSDUW DC Converter is required to be provided with sub-synchronous resonance damping control facilities. HVDC System Owners and Generators in respect of OTSDUW DC Converters should also be aware of the requirements in ECC.6.1.9.

ECC.6.3.17.2 Where specified in the Bilateral Agreement, each DC Converter or OTSDUW DC Converter is required to be provided with power oscillation damping or any other identified additional control facilities.

ECC.6.3.17.3 Each HVDC System shall be capable of contributing to the damping of power oscillations on the National Electricity Transmission System in connected AC networks. The control system of the HVDC System shall not reduce the damping of power oscillations. NGET in coordination with the Relevant Transmission Licensee. The relevant TSO shall specify a frequency range of oscillations that the control scheme shall positively damp and the System network conditions when this occurs, at least accounting for any dynamic stability assessment studies undertaken by NGET in coordination with the Relevant Transmission Licensee to identify the stability limits and potential stability problems on the National Electricity Transmission System in their transmission systems. The selection of the control parameter settings shall be agreed with NGET in coordination with the Relevant Transmission Licensee between the relevant TSO and the HVDC System Owner.
ECC.6.3.17.14 **NGET** shall specify the necessary extent of SSTI studies and provide input parameters, to the extent available, related to the equipment and relevant system conditions in its network. The SSTI studies shall be provided by the HVDC System Owner. The studies shall identify the conditions, if any, where SSTI exists and propose any necessary mitigation procedure. Member States may provide that the responsibility for undertaking the studies is, in accordance with these requirements, allocated to the TSO. All parties shall be informed of the results of the studies.

ECC.6.3.17.15 All parties identified by NGET as relevant to each Grid Entry Point or User System Entry Point (if Embedded) connection point, including the Relevant TSO-Transmission Licensee, shall contribute to the studies and shall provide all relevant data and models as reasonably required to meet the purposes of the studies. NGET the relevant TSO shall collect this data input and, where applicable, pass it on to the party responsible for the studies in accordance with Article 10 of EU Regulation 2016/1447.

ECC.6.3.17.16 The NGET in coordination with the Relevant Transmission Licensee TSO shall assess the result of the SSTI studies. If necessary for the assessment, NGET in coordination with the Relevant Transmission Licensee TSO may request that the HVDC System Owner perform further SSTI studies in line with this same scope and extent.

ECC.6.3.17.17 The NGET in coordination with the Relevant Transmission Licensee TSO may review or replicate the study. The HVDC System Owner shall provide NGET the relevant TSO with all relevant data and models that allow such studies to be performed. Submission of this data to Relevant Transmission Licensee’s shall be in accordance with the requirements of Article 10 of EU Regulation 2016/1447.

ECC.6.3.17.18 Any necessary mitigating actions identified by the studies carried out in accordance with paragraphs ECC.6.3.17.14 or ECC.6.3.17.16, and reviewed by NGET in coordination with the Relevant Transmission Licensees TSOs, shall be undertaken by the HVDC System Owner as part of the connection of the new HVDC Converter Station.

ECC.6.3.17.2 Interaction between HVDC Systems or other Plant and equipment

ECC.6.3.17.2.1 Not withstanding the requirements of ECC.6.3.9 and ECC.6.3.10, when several HVDC Converter Stations or other plants and User’s equipment are within close electrical proximity, NGET the relevant TSO may specify that a study is required, and the scope and extent of that study, to demonstrate that no adverse interaction will occur. If adverse interaction is identified, the studies shall identify possible mitigating actions to be implemented to ensure compliance with the requirements of the Grid Code/Distribution Regulations.

ECC.6.3.17.2.2 The studies shall be carried out by the connecting HVDC System Owner with the participation of all other parties identified by NGET in coordination with Relevant Transmission Licensees and Network Operators the TSOs as relevant to each Connection Point.

ECC.6.3.17.2.3 All parties identified by NGET the relevant TSO as relevant to each Connection Point, including the Relevant Transmission Licensee’s and Network Operators TSO, shall contribute to the studies and shall provide all relevant data and models as reasonably required to meet the purposes of the studies. NGET the relevant TSO may request that the HVDC System Owner review or replicate the study. If necessary for the assessment, NGET the relevant TSO shall collect this data input and, where applicable, pass it on to the party responsible for the studies in accordance with Article 10 of EU Regulation 2016/1447.

**Comment [A98]:** This section needs to be updated to reflect the confidentiality requirements in Art 10.

**Comment [A99]:** Confidentiality issues as per CC.6.1.12.

**Comment [A100]:** This only extends to Transmission Connection Points. If we need to extend this to Distribution we need to consider this.

**Comment [A101]:** This only extends to Transmission Connection Points. If we need to extend this to Distribution we need to consider this.

**Comment [A102]:** We may need to remove the references to Transmission Connection Points. If we need to extend this to Distribution we need to consider this.

**Comment [A103]:** We need to look at this and include requirements in the Grid Code for data exchange and confidentiality. It probably best sits in the Planning Code.
**ECC.6.1.17.2.4** NGET in coordination with Relevant Transmission Licensees The relevant TSO shall assess the result of the studies based on their scope and extent as specified in accordance with ECC.6.1.17.2.5 ECC.6.1.16.1 paragraph 1. If necessary for the assessment, NGET in coordination with the Relevant Transmission Licensee may request the HVDC System Owner to perform further studies in line with the scope and extent specified in accordance with ECC.6.1.17.2.1 ECC.6.1.16.1 paragraph 1.

**ECC.6.1.17.2.5** NGET in coordination with the Relevant Transmission Licensee The relevant TSO may review or replicate some or all of the studies. The HVDC System Owner shall provide NGET the relevant TSO all relevant data and models that allow such studies to be performed.

**ECC.6.1.17.2.6** Any necessary mitigating actions identified by the studies carried out in accordance with ECC.6.1.17.2.2 ECC.6.1.16.1 paragraphs 2 to 5 and reviewed by NGET in coordination with the Relevant Transmission Licensee the relevant TSO shall be undertaken by the HVDC System Owner as part of the connection of the new HVDC Converter Station.

**ECC.6.1.17.2.7** NGET The relevant TSO may specify transient levels of performance associated with events for the individual HVDC System or collectively across commonly impacted HVDC Systems. This specification may be provided to protect the integrity of both the National Electricity Transmission System TSO equipment and that of grid Users in a manner consistent with its national the Grid Code.

**ECC.6.1.17.3** Fast Recovery from DC faults

**ECC.6.1.17.3.1** HVDC Systems, including DC overhead lines, shall be capable of fast recovery from transient faults within the HVDC System. Details of this capability shall be subject to the Bilateral Agreement – coordination and agreements on and the protection requirements specified in ECC.6.2 schemes and settings pursuant to Article 34.

**ECC.6.1.17.4** Maximum loss of Active Power

**ECC.6.1.14.4.1** An HVDC System shall be configured in such a way that its loss of Active Power injection in the GB Synchronous Area shall be in accordance with the requirements of the SQSS , the...

**ECC.6.18** SYSTEM TO GENERATOR OPERATIONAL INTERTRIPPING SCHEMES

**ECC.6.18.1** NGET may require that a System to Generator Operational Intertipping Scheme be installed as part of a condition of the connection of the Generator. Scheme specific details shall be included in the relevant Bilateral Agreement and shall, in respect of Bilateral Agreements entered into on or after 16th March 2009 include the following information:

1. the relevant category(ies) of the scheme (referred to as Category 1 Intertipping Scheme, Category 2 Intertipping Scheme, Category 3 Intertipping Scheme and Category 4 Intertipping Scheme);

2. the Generating Unit(s) or CCGT Module(s) or Power Park Module(s) to be either permanently armed or that can be instructed to be armed in accordance with BC2.8;

3. the time within which the Generating Unit(s) or CCGT Module(s) or Power Park Module(s) circuit breaker(s) are to be automatically tripped;

4. the location to which the trip signal will be provided by NGET. Such location will be provided by NGET prior to the commissioning of the Generating Unit(s) or CCGT Module(s) or Power Park Module(s).
Where applicable, the Bilateral Agreement shall include the conditions on the National Electricity Transmission System during which NGET may instruct the System to Generator Operational Intertripping Scheme to be armed and the conditions that would initiate a trip signal.

ECC.6.3.18.2 The time within which the Power Generating Module(s) Generating Unit(s) or CCGT Module or Power Park Module circuit breaker(s) need to be automatically tripped is determined by the specific conditions local to the Generator. This ‘time to trip’ (defined as the time from provision of the trip signal by NGET to the specified location, to circuit breaker main contact opening) can typically range from 100ms to 10sec. A longer time to trip may allow the initiation of an automatic reduction in the Power Generating Module(s) Generating Unit(s) or CCGT Module(s) or Power Park Module(s) output prior to the automatic tripping of the Generating Unit(s) or CCGT Module(s) or Power Park Module(s) Power Generating Module(s) circuit breaker. Where applicable NGET may provide separate trip signals to allow for either a longer or shorter ‘time to trip’ to be initiated.

ECC.6.4 General Network Operator And Non-Embedded Customer Requirements

ECC.6.4.1 This part of the Grid Code describes the technical and design criteria and performance requirements for Network Operators and Non-Embedded Customers.
Neutral Earthing

**ECC.6.4.2** At nominal System voltages of 132kV and above the higher voltage windings of three phase transformers and transformer banks connected to the National Electricity Transmission System must be star connected with the star point suitable for connection to earth. The earthing and lower voltage winding arrangement shall be such as to ensure that the Earth Fault Factor requirement of paragraph **ECC.6.2.1.1 (6)** will be met on the National Electricity Transmission System at nominal System voltages of 132kV and above.

Frequency Sensitive Relays

**ECC.6.4.3** As explained under OC6, each Network Operator and Non Embedded Customer, will make arrangements that will facilitate automatic low Frequency Disconnection of Demand (based on Annual ACS Conditions). **ECC.A.5.5** of Appendix 5 includes specifications of the local percentage Demand that shall be disconnected at specific frequencies. The manner in which Demand subject to low Frequency disconnection will be split into discrete MW blocks is specified in **OC6.6**. Technical requirements relating to Low Frequency Relays are also listed in Appendix 5.

Operational Metering

**ECC.6.4.4** Where NGET can reasonably demonstrate that an Embedded Medium Power Station or Embedded HVDC System Converter Station has a significant effect on the National Electricity Transmission System, it may require the Network Operator within whose System the Embedded Medium Power Station or Embedded HVDC System Converter Station is situated to ensure that the operational metering equipment described in **ECC.6.5.6** is installed such that NGET can receive the data referred to in **ECC.6.5.6**. In the case of an Embedded Medium Power Station subject to, or proposed to be subject to a Bilateral Agreement NGET shall notify such Network Operator of the details of such installation in writing within 3 months of being notified of the application to connect under CUSC and in the case of an Embedded Medium Power Station not subject to, or not proposed to be subject to a Bilateral Agreement in writing as a Site Specific Requirement in accordance with the timescales in CUSC 6.5.5. In either case the Network Operator shall ensure that the data referred to in **ECC.6.5.6** is provided to NGET.

Communications Plant

**ECC.6.5**

**ECC.6.5.1** In order to ensure control of the National Electricity Transmission System, telecommunications between Users and NGET must (including in respect of any OTSDUW Plant and Apparatus at the OTSUA Transfer Time), if required by NGET, be established in accordance with the requirements set down below.

**ECC.6.5.2** Control Telephony and System Telephony

**ECC.6.5.2.1** Control Telephony is the principal method by which a User’s Responsible Engineer/Operator and NGET Control Engineers speak to one another for the purposes of control of the Total System in both normal and emergency operating conditions. Control Telephony provides secure point to point telephony for routine Control Calls, priority Control Calls and emergency Control Calls.

**ECC.6.5.2.2** System Telephony is an alternate method by which a User’s Responsible Engineer/Operator and NGET Control Engineers speak to one another for the purposes of control of the Total System in both normal operating conditions and where practicable, emergency operating conditions. System Telephony uses the Public Switched Telephone Network to provide telephony for Control Calls, inclusive of emergency Control Calls.
Calls made and received over Control Telephony and System Telephony may be recorded and subsequently replayed for commercial and operational reasons.

### Supervisory Tones

**Control Telephony** supervisory tones indicate to the calling and receiving parties dial, engaged, ringing, secondary engaged (signifying that priority may be exercised) and priority disconnect tones.

**System Telephony** supervisory tones indicate to the calling and receiving parties dial, engaged and ringing tones.

### Obligations in respect of Control Telephony and System Telephony

**Where NGET requires Control Telephony, Users are required to use the Control Telephony with NGET in respect of all Connection Points with the National Electricity Transmission System and in respect of all Embedded Large Power Stations and Embedded HVDC Systems Converter Stations. NGET will install Control Telephony at the User’s Control Point where the User’s telephony equipment is not capable of providing the required facilities or is otherwise incompatible with the Transmission Control Telephony. Details of and relating to the Control Telephony required are contained in the Bilateral Agreement.**

**Where in NGET’s sole opinion the installation of Control Telephony is not practicable at a User’s Control Point(s), NGET shall specify in the Bilateral Agreement whether System Telephony is required. Where System Telephony is required by NGET, the User shall ensure that System Telephony is installed.**

**Where System Telephony is installed, Users are required to use the System Telephony with NGET in respect of those Control Point(s) for which it has been installed. Details of and relating to the System Telephony required are contained in the Bilateral Agreement.**

**Where Control Telephony or System Telephony is installed, routine testing of such facilities may be required by NGET (not normally more than once in any calendar month). The User and NGET shall use reasonable endeavours to agree a test programme and where NGET requests the assistance of the User in performing the agreed test programme the User shall provide such assistance.**

**Control Telephony and System Telephony shall only be used for the purposes of operational voice communication between NGET and the relevant User.**

**Control Telephony contains emergency calling functionality to be used for urgent operational communication only. Such functionality enables NGET and Users to utilise a priority call in the event of an emergency. NGET and Users shall only use such priority call functionality for urgent operational communications.**

### Technical Requirements for Control Telephony and System Telephony

Detailed information on the technical interfaces and support requirements for Control Telephony applicable in NGET’s Transmission Area is provided in the Control Telephony Electrical Standard identified in the Annex to the General Conditions. Where additional information, or information in relation to Control Telephony applicable in Scotland, is requested by Users, this will be provided, where possible, by NGET.
**ECC.6.5.5.2** System Telephony shall consist of a dedicated Public Switched Telephone Network telephone line that shall be installed and configured by the relevant User. NGET shall provide a dedicated free phone number (UK only), for the purposes of receiving incoming calls to NGET, which Users shall utilise for System Telephony. System Telephony shall only be utilised by the NGET Control Engineer and the User’s Responsible Engineer/Operator for the purposes of operational communications.

**ECC.6.5.6** Operational Metering

**ECC.6.5.6.1** It is an essential requirement for NGET and Network Operators to have visibility of the real time output and status of indications of User's Plant and Apparatus so they can control the operation of the System.

**ECC.6.5.6.2** Type B, Type C and Type D Power Park Modules, HVDC Equipment, Network Operators and Non Embedded Customers are required to be capable of exchanging operational metering data with NGET and Relevant Transmission Licensees (as applicable) with time stamping as specified by NGET.

**ECC.6.5.6.3** NGET in coordination with the Relevant Transmission Licensee shall specify in the Bilateral Agreement the operational metering signals to be provided by the Generator, HVDC System Owner, Network Operator or Non-Embedded Customer. In the case of Network Operators and Non-Embedded Customers detailed specifications relating to the operational metering standards and the data required are published as Electrical Standards in the Annex to the General Conditions.

**ECC.6.5.6.4**

(a) NGET shall provide system control and data acquisition (SCADA) outstation interface equipment. Subject to the requirements of ECC.6.5.6.5, the User shall provide such voltage, current, Frequency, Active Power and Reactive Power measurement outputs and plant status indications and alarms to the Transmission SCADA outstation interface equipment as required by NGET in accordance with the terms of the Bilateral Agreement. In the case of OTSDUW, the User shall provide such SCADA outstation interface equipment and voltage, current, Frequency, Active Power and Reactive Power measurement outputs and plant status indications and alarms to the SCADA outstation interface equipment as required by NGET in accordance with the terms of the Bilateral Agreement.

(b) For the avoidance of doubt, for Active Power and Reactive Power measurements, circuit breaker and disconnector status indications from:

(i) CCGT Modules from Type B, Type C and Type D Power Generating Modules at Large Power Stations, the outputs and status indications must each be provided to NGET on an individual CCGT Unit basis. In addition, where identified in the Bilateral Agreement, Active Power and Reactive Power measurements from Unit Transformers and/or Station Transformers must be provided.

(ii) DC Converters at DC Converter Stations and OTSDUW DC Converters, the outputs and status indications must each be provided to NGET on an individual DC Converter basis. In addition, where identified in the Bilateral Agreement, Active Power and Reactive Power measurements from converter and/or station transformers must be provided.

(iii) Type B, Type C and Type D Power Park Modules at Embedded Large Power Stations and at directly connected Power Stations, the outputs and status indications must each be provided to NGET on an individual Power Park Module basis. In addition, where identified in the Bilateral Agreement, Active Power and

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Comment [A107]: We need to add this in as an additional electrical standard.
Reactive Power measurements from station transformers must be provided.

(iv) In respect of OTSDUW Plant and Apparatus, the outputs and status indications must be provided to NGT for each piece of electrical equipment. In addition, where identified in the Bilateral Agreement, Active Power and Reactive Power measurements at the Interface Point must be provided.

(c) For the avoidance of doubt, the requirements of ECC.6.5.6.4(a) in the case of a Cascade Hydro Scheme will be provided for each Generating Unit forming part of that Cascade Hydro Scheme. In the case of Embedded Generating Units forming part of a Cascade Hydro Scheme the data may be provided by means other than a NGT SCADA outstation located at the Power Station, such as, with the agreement of the Network Operator in whose system such Embedded Generating Unit is located, from the Network Operator’s SCADA system to NGT. Details of such arrangements will be contained in the relevant Bilateral Agreements between NGT and the Generator and the Network Operator.

(d) In the case of a Power Park Module, additional energy input signals (e.g. wind speed, and wind direction) may be specified in the Bilateral Agreement. For Power Park Modules with a Completion Date on or after 1st April 2016 A Power Available signal will also be specified in the Bilateral Agreement. The signals would be used to establish the potential level of energy input from the Intermittent Power Source for monitoring pursuant to ECC.6.6.1 and Ancillary Services and will, in the case of a wind farm, be used to provide NGT with advanced warning of excess wind speed shutdown and to determine the level of Headroom available from Power Park Modules for the purposes of calculating response and reserve. For the avoidance of doubt, the Power Available signal would be automatically provided to NGT and represent the sum of the potential output of all available and operational Power Park Units within the Power Park Module. The refresh rate of the Power Available signal shall be specified in the Bilateral Agreement.

ECC.6.5.6.5 In addition to the requirements of the Balancing Codes With regard to instrumentation for the operation, each HVDC Converter unit of an HVDC system shall be equipped with an automatic controller capable of receiving instructions from NGT the relevant system operator and from the relevant TSO. This automatic controller shall be capable of operating the HVDC Converter units of the HVDC System in a coordinated way. NGT The relevant system operator shall specify the automatic controller hierarchy per HVDC Converter unit.

ECC.6.5.6.6 The automatic controller of the HVDC System referred to in paragraph ECC.6.5.6.5 shall be capable of sending the following signal types to NGT the relevant system operator:

(a) operational metering signals, providing at least the following:
   (i) start-up signals;
   (ii) AC and DC voltage measurements;
   (iii) AC and DC current measurements;
   (iv) Active and Reactive Power measurements on the AC side;
   (v) DC power measurements;
   (vi) HVDC Converter unit level operation in a multi-pole type HVDC Converter;
   (vii) elements and topology status; and

(b) alarm signals, providing at least the following:

(i) emergency blocking;
(ii) ramp blocking;
(iii) fast Active Power reversal

ECC.6.5.6.7 The automatic controller referred to in ECC.6.5.6.5 paragraph 1 shall be capable of receiving the following signal types from NGET the relevant system operator:

(a) operational metering signals, receiving at least the following:

(i) start-up command;
(ii) Active Power setpoints;
(iii) Frequency Sensitive Mode settings;
(iv) Reactive Power, voltage or similar setpoints;
(v) Reactive Power control modes;
(vi) power oscillation damping control; and
(vii) synthetic inertia.

(b) alarm signals, receiving at least the following:

(i) emergency blocking command;
(ii) ramp blocking command;
(iii) Active Power flow direction; and
(iv) fast Active Power reversal command.

ECC.6.5.8 With regards to each operational metering signal, NGET the relevant system operator may will specify the resolution and refresh rate quality of the supplied signal.

Instructor Facilities

ECC.6.5.7 The User shall accommodate Instructor Facilities provided by NGET for the receipt of operational messages relating to System conditions.

Electronic Data Communication Facilities

ECC.6.5.8 (a) All BM Participants must ensure that appropriate electronic data communication facilities are in place to permit the submission of data, as required by the Grid Code, to NGET.

(b) In addition,

(1) any User that wishes to participate in the Balancing Mechanism;

or

(2) any BM Participant in respect of its BM Units at a Power Station where the Construction Agreement and/or a Bilateral Agreement has a Completion Date on or after 1 January 2013 and the BM Participant is required to provide all Part 1 System Ancillary Services in accordance with ECC.8.1 (unless NGET has otherwise
must ensure that appropriate automatic logging devices are installed at the Control Points of its BM Units to submit data to and to receive instructions from NGET, as required by the Grid Code. For the avoidance of doubt, in the case of an Interconnector User the Control Point will be at the Control Centre of the appropriate Externally Interconnected System Operator.

(c) Detailed specifications of these required electronic facilities will be provided by NGET on request and they are listed as Electrical Standards in the Annex to the General Conditions.

Facsimile Machines

ECC.6.5.9 Each User and NGET shall provide a facsimile machine or machines:
(a) in the case of Generators, at the Control Point of each Power Station and at its Trading Point;
(b) in the case of NGET and Network Operators, at the Control Centre(s); and
(c) in the case of Non-Embedded Customers and HVDC Equipment Converter Station owners at the Control Point.

Each User shall notify, prior to connection to the System of the User's Plant and Apparatus, NGET of its or their telephone number or numbers, and will notify NGET of any changes. Prior to connection to the System of the User's Plant and Apparatus NGET shall notify each User of the telephone number or numbers of its facsimile machine or machines and will notify any changes.

ECC.6.5.10 Busbar Voltage

NGET shall, subject as provided below, provide each Generator or HVDC System Converter Station Owner at each Grid Entry Point where one of its Power Stations or HVDC Converter Stations Systems is connected with appropriate voltage signals to enable the Generator or HVDC Converter System Station owner to obtain the necessary information to permit its Power Generating Modules (including DC Connected Power Park Modules) or Gensets or HVDC System Converters to be Synchronised to the National Electricity Transmission System. The term "voltage signal" shall mean in this context, a point of connection on (or wire or wires from) a relevant part of Transmission Plant and/or Apparatus at the Grid Entry Point, to which the Generator or HVDC System Converter Station Owner, with NGET's agreement (not to be unreasonably withheld) in relation to the Plant and/or Apparatus to be attached, will be able to attach its Plant and/or Apparatus (normally a wire or wires) in order to obtain measurement outputs in relation to the busbar.

ECC.6.5.11 Bilingual Message Facilities

(a) A Bilingual Message Facility is the method by which the User's Responsible Engineer/Operator, the Externally Interconnected System Operator and NGET Control Engineers communicate clear and unambiguous information in two languages for the purposes of control of the Total System in both normal and emergency operating conditions.
(b) A Bilingual Message Facility, where required, will provide up to two hundred pre-defined messages with up to five hundred and sixty characters each. A maximum of one minute is allowed for the transmission to, and display of, the selected message at any destination. The standard messages must be capable of being displayed at any combination of locations and can originate from any of these locations. Messages displayed in the UK will be displayed in the English language.

(c) Detailed information on a Bilingual Message Facility and suitable equipment required for individual User applications will be provided by NGET upon request.

ECC.6.6 System Monitoring

ECC.6.6.1 System Monitoring

ECC.6.6.1.1 with regard to instrumentation Each Type C and Type D Power Generating Module facilities including DC Connected Power Park Modules shall be equipped with a facility to provide fault recording and monitoring of dynamic system behaviour. These requirements are necessary to record conditions during System faults and detect poorly damped power oscillations. This facility shall record the following parameters:

- voltage,
- Active Power,
- Reactive Power, and
- Frequency.

ECC.6.6.1.2 Detailed specifications for fault recording and dynamic system monitoring equipment including triggering criteria and sample rates will be provided by NGET on request and they are listed as Electrical Standards in the Annex to the General Conditions. For Dynamic System Monitoring, the specification for the communication protocol and recorded data shall also be included in the Electrical Standard.

ECC.6.6.1.3 NGET in coordination with the Relevant Transmission Licensee shall specify any requirements for Power Quality Monitoring in the Bilateral Agreement. The power quality parameters to be monitored, the communication protocols for the recorded data and the time frames for compliance shall be agreed between NGET, the Relevant Transmission Licensee and Generator.

ECC.6.6.1.4 HVDC Systems shall be equipped with a facility to provide fault recording and dynamic system behaviour monitoring of the following parameters for each of its HVDC Converter Stations:

- AC and DC voltage;
- AC and DC current;
- Active Power;
- Reactive Power; and
- Frequency.

ECC.6.6.1.5 NGET in coordination with the Relevant Transmission Licensee may specify quality of supply parameters to be complied with by the HVDC System, provided a reasonable prior notice is given.
ECC.6.6.1.6 The particulars of the fault recording equipment referred to in ECC.6.6.1.4, including analogue and digital channels, the settings, including triggering criteria and the sampling rates, shall be agreed between the HVDC System Owner and NGET in coordination with the Relevant Transmission Licensee.

ECC.6.6.1.7 All dynamic system behaviour monitoring equipment shall include an oscillation trigger, specified by NGET, in coordination with the Relevant Transmission Licensee, with the purpose of detecting poorly damped power oscillations.

ECC.6.6.1.8 The facilities for quality of supply and dynamic system behaviour monitoring shall include arrangements for the HVDC System Owner and NGET and/or Relevant Transmission Licensee to access the information electronically. The communications protocols for recorded data shall be agreed between the HVDC System Owner, NGET and the Relevant Transmission Licensee.

ECC.6.6.2 Frequency Response Monitoring

ECC.6.6.2.1 Each Type C and Type D Power Generating Module including DC Connected Power Park Modules shall be fitted with equipment capable of monitoring the real time Active Power output of a Power Generating Module when operating in Frequency Sensitive Mode.

ECC.6.6.2.2 with regard to real-time monitoring of FSM: (i) To monitor the operation of Active Power Frequency response, as detailed in ECC.6.6.2.1, each Generator shall be equipped with a communication interface capable of being interfacing to the network control centre of the relevant system operator or the relevant TSO. At the request of NGET the relevant system operator or the relevant TSO, the Generator should provide at least the following signals:

- status signal of FSM (on/off),
- scheduled Active Power output,
- actual value of the Active Power output,
- actual parameter settings for Active Power Frequency response,
- droop and deadband;

the relevant system operator or the relevant TSO should provide the following signals as are required by NGET.

Detailed specifications of the Active Power Frequency response requirements including the communication requirements will be provided by NGET on request and they are listed as Electrical Standards in the Annex to the General Conditions.

ECC.6.6.2.2 NGET in co-ordination with the Relevant Transmission Licensee shall specify additional signals to be provided by the Generator by monitoring and recording devices in order to verify the performance of the Active Power Frequency response provision of participating Power Generating Modules.

ECC.6.6.3 Compliance Monitoring

ECC.6.6.3.1 For all on site monitoring by NGET of witnessed tests pursuant to the CP or OCS the User shall provide suitable test signals as outlined in OCS.A.1.
The signals which shall be provided by the User to NGET for onsite monitoring shall be of the following resolution, unless otherwise agreed by NGET:

(i) 1 Hz for reactive range tests
(ii) 10 Hz for frequency control tests
(iii) 100 Hz for voltage control tests

The User will provide all relevant signals for this purpose in the form of d.c. voltages within the range -10V to +10V. In exceptional circumstances some signals may be accepted as d.c. voltages within the range -60V to +60V with prior agreement between the User and NGET. All signals shall:

(i) in the case of an Onshore Power Generating Module Power Park Module or Onshore HVDC Convertor Station or Synchronous Generating Unit, be suitably terminated in a single accessible location at the Generator or HVDC Convertor Station owner’s site.

(ii) in the case of an Offshore Power Generating Park Module and OTSDUW Plant and Apparatus, be transmitted onshore without attenuation, delay or filtering which would result in the inability to fully demonstrate the objectives of the test, or identify any potential safety or plant instability issues, and be suitably terminated in a single robust location normally located at or near the onshore Interface Point of the Offshore Transmission System to which it is connected.

All signals shall be suitably scaled across the range. The following scaling would (unless NGET notify the User otherwise) be acceptable to NGET:

(a) 0MW to Registered Capacity or Interface Point Capacity 0-8V dc
(b) Maximum leading Reactive Power to maximum lagging Reactive Power -8 to 8V dc
(c) 48 – 52Hz as -8 to 8V dc
(d) Nominal terminal or connection point voltage -10% to +10% as -8 to 8V dc

The User shall provide to NGET a 230V power supply adjacent to the signal terminal location.

In England and Wales, any User entering and working on its Plant and/or Apparatus (including, until the OTSUA Transfer Time, any OTSUA) on a Transmission Site will work to the Safety Rules of NGET.

In Scotland or Offshore, any User entering and working on its Plant and/or Apparatus (including, until the OTSUA Transfer Time, any OTSUA) on a Transmission Site will work to the Safety Rules of the Relevant Transmission Licensee, as advised by NGET.

NGET entering and working on Transmission Plant and/or Apparatus on a User Site will work to the User’s Safety Rules. For User Sites in Scotland or Offshore, NGET shall procure that the Relevant Transmission Licensee entering and working on Transmission Plant and/or Apparatus on a User Site will work to the User’s Safety Rules.
A User may, with a minimum of six weeks notice, apply to NGET for permission to work according to that User's own Safety Rules when working on its Plant and/or Apparatus on a Transmission Site rather than those set out in ECC.7.2.1. If NGET is of the opinion that the User's Safety Rules provide for a level of safety commensurate with those set out in ECC.7.2.1, NGET will notify the User, in writing, that, with effect from the date requested by the User, the User may use its own Safety Rules when working on its Plant and/or Apparatus on the Transmission Site. For a Transmission Site in Scotland or Offshore, in forming its opinion, NGET will seek the opinion of the Relevant Transmission Licensee. Until receipt of such written approval from NGET, the User will continue to use the Safety Rules as set out in ECC.7.2.1.

In the case of a User Site in England and Wales, NGET may, with a minimum of six weeks notice, apply to a User for permission to work according to NGET's Safety Rules when working on Transmission Plant and/or Apparatus on that User Site, rather than the User's Safety Rules. If the User is of the opinion that NGET's Safety Rules provide for a level of safety commensurate with that of that User's Safety Rules, it will notify NGET, in writing, that, with the effect from the date requested by NGET, NGET may use its own Safety Rules when working on its Transmission Plant and/or Apparatus on that User Site. Until receipt of such written approval from the User, NGET shall continue to use the User's Safety Rules.

In the case of a User Site in Scotland or Offshore, NGET may, with a minimum of six weeks notice, apply to a User for permission for the Relevant Transmission Licensee to work according to the Relevant Transmission Licensee's Safety Rules when working on Transmission Plant and/or Apparatus on that User Site, rather than the User's Safety Rules. If the User is of the opinion that the Relevant Transmission Licensee's Safety Rules, provide for a level of safety commensurate with that of that User's Safety Rules, it will notify NGET, in writing, that, with effect from the date requested by NGET, that the Relevant Transmission Licensee may use its own Safety Rules when working on its Transmission Plant and/or Apparatus on that User Site. Until receipt of such written approval from the User, NGET shall procure that the Relevant Transmission Licensee shall continue to use the User's Safety Rules.

For a Transmission Site in England and Wales, if NGET gives its approval for the User's Safety Rules to apply to the User when working on its Plant and/or Apparatus, that does not imply that the User's Safety Rules will apply to entering the Transmission Site and access to the User's Plant and/or Apparatus on that Transmission Site. Bearing in mind NGET's responsibility for the whole Transmission Site, entry and access will always be in accordance with NGET's site access procedures. For a User Site in England and Wales, if the User gives its approval for NGET's Safety Rules to apply to NGET when working on its Plant and Apparatus, that does not imply that NGET's Safety Rules will apply to entering the User Site, and access to the Transmission Plant and Apparatus on that User Site. Bearing in mind the User's responsibility for the whole User Site, entry and access will always be in accordance with the User's site access procedures.
For a Transmission Site in Scotland or Offshore, if NGET gives its approval for the User’s Safety Rules to apply to the User when working on its Plant and/or Apparatus, that does not imply that the User’s Safety Rules will apply to entering the Transmission Site and access to the User’s Plant and/or Apparatus on that Transmission Site. Bearing in mind the Relevant Transmission Licensee’s responsibility for the whole Transmission Site, entry and access will always be in accordance with the Relevant Transmission Licensee’s site access procedures. For a User Site in Scotland or Offshore, if the User gives its approval for Relevant Transmission Licensee Safety Rules to apply to the User when working on its Plant and/or Apparatus, that does not imply that the User’s Safety Rules will apply to entering the Transmission Site and access to the User’s Plant and/or Apparatus on that Transmission Site. Bearing in mind the User’s responsibility for the whole Transmission Site, entry and access will always be in accordance with the User’s site access procedures.

ECC.7.2.6
For User Sites in England and Wales, Users shall notify NGET of any Safety Rules that apply to NGET’s staff working on User Sites. For Transmission Sites in England and Wales, NGET shall notify Users of any Safety Rules that apply to the User’s staff working on the Transmission Site.

For User Sites in Scotland or Offshore, Users shall notify NGET of any Safety Rules that apply to the Relevant Transmission Licensee’s Staff working on User Sites. For Transmission Sites in Scotland or Offshore NGET shall procure that the Relevant Transmission Licensee shall notify Users of any Safety Rules that apply to the User’s staff working on the User Site.

ECC.7.2.7
Each Site Responsibility Schedule must have recorded on it the Safety Rules which apply to each item of Plant and/or Apparatus.

ECC.7.2.8
In the case of OTSUA a User Site or Transmission Site shall, for the purposes of this ECC.7.2, include a site at which there is an Interface Point until the OTSUA Transfer Time when it becomes part of the National Electricity Transmission System.

ECC.7.3
Site Responsibility Schedules

ECC.7.3.1
In order to inform site operational staff and NGET Control Engineers of agreed responsibilities for Plant and/or Apparatus at the operational interface, a Site Responsibility Schedule shall be produced for Connection Sites (and in the case of OTSUA, until the OTSUA Transfer Time, Interface Sites) in England and Wales for NGET and Users with whom they interface, and for Connection Sites (and in the case of OTSUA, until the OTSUA Transfer Time, Interface Sites) in Scotland or Offshore for NGET, the Relevant Transmission Licensee and Users with whom they interface.

ECC.7.3.2
The format, principles and basic procedure to be used in the preparation of Site Responsibility Schedules are set down in Appendix 1.

ECC.7.4
Operation And Gas Zone Diagrams

ECC.7.4.1
An Operation Diagram shall be prepared for each Connection Site at which a Connection Point exists (and in the case of OTSDUW Plant and Apparatus, by User’s for each Interface Point) using, where appropriate, the graphical symbols shown in Part 1A of Appendix 2. Users should also note that the provisions of OC11 apply in certain circumstances.
The Operation Diagram shall include all HV Apparatus and the connections to all external circuits and incorporate numbering, nomenclature and labelling, as set out in OC11. At those Connection Sites (or in the case of OTSDUW Plant and Apparatus, Interface Points) where gas-insulated metal enclosed switchgear and/or other gas-insulated HV Apparatus is installed, those items must be depicted within an area delineated by a chain dotted line which intersects gas-zone boundaries. The nomenclature used shall conform with that used on the relevant Connection Site and circuit (and in the case of OTSDUW Plant and Apparatus, Interface Point and circuit). The Operation Diagram (and the list of technical details) is intended to provide an accurate record of the layout and circuit interconnections, ratings and numbering and nomenclature of HV Apparatus and related Plant.

A non-exhaustive guide to the types of HV Apparatus to be shown in the Operation Diagram is shown in Part 2 of Appendix 2, together with certain basic principles to be followed unless equivalent principles are approved by NGET.

A Gas Zone Diagram shall be prepared for each Connection Site at which a Connection Point (and in the case of OTSDUW Plant and Apparatus, by User’s for an Interface Point) exists where gas-insulated switchgear and/or other gas-insulated HV Apparatus is utilised. They shall use, where appropriate, the graphical symbols shown in Part 1B of Appendix 2.

The nomenclature used shall conform with that used in the relevant Connection Site and circuit (and in the case of OTSDUW Plant and Apparatus, relevant Interface Point and circuit).

The basic principles set out in Part 2 of Appendix 2 shall be followed in the preparation of Gas Zone Diagrams unless equivalent principles are approved by NGET.

In the case of a User Site, the User shall prepare and submit to NGET, an Operation Diagram for all HV Apparatus on the User side of the Connection Point (and in the case of OTSDUW Plant and Apparatus, on what will be the Offshore Transmission side of the Connection Point and the Interface Point) and NGET shall provide the User with an Operation Diagram for all HV Apparatus on the Transmission side of the Connection Point (and in the case of OTSDUW Plant and Apparatus on what will be the Onshore Transmission side of the Interface Point, in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement prior to the Completion Date under the Bilateral Agreement and/or Construction Agreement.

The User will then prepare, produce and distribute, using the information submitted on the User’s Operation Diagram and NGET Operation Diagram, a composite Operation Diagram for the complete Connection Site (and in the case of OTSDUW Plant and Apparatus, Interface Point), also in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement.

The provisions of ECC.7.4.7 and ECC.7.4.8 shall apply in relation to Gas Zone Diagrams where gas-insulated switchgear and/or other gas-insulated HV Apparatus is utilised.

Preparation of Operation and Gas Zone Diagrams for Transmission Sites
In the case of an **Transmission Site**, the **User** shall prepare and submit to NGET an **Operation Diagram** for all **HV Apparatus** on the **User** side of the **Connection Point**, in accordance with the timing requirements of the **Bilateral Agreement** and/or **Construction Agreement**.

NGET will then prepare, produce and distribute, using the information submitted on the **User’s Operation Diagram**, a composite **Operation Diagram** for the complete **Connection Site**, also in accordance with the timing requirements of the **Bilateral Agreement** and/or **Construction Agreement**.

The provisions of **ECC.7.4.10** and **ECC.7.4.11** shall apply in relation to **Gas Zone Diagrams** where gas-insulated switchgear and/or other gas-insulated **HV Apparatus** is utilised.

**Changes to Operation and Gas Zone Diagrams**

When NGET has decided that it wishes to install new **HV Apparatus** or it wishes to change the existing numbering or nomenclature of **Transmission HV Apparatus** at a **Transmission Site**, NGET will (unless it gives rise to a **Modification** under the **CUSC**, in which case the provisions of the **CUSC** as to the timing apply) one month prior to the installation or change, send to each such **User** a revised **Operation Diagram** of that **Transmission Site**, incorporating the new **Transmission HV Apparatus** to be installed and its numbering and nomenclature or the changes, as the case may be. **OC11** is also relevant to certain **Apparatus**.

When a **User** has decided that it wishes to install new **HV Apparatus**, or it wishes to change the existing numbering or nomenclature of its **HV Apparatus** at its **User Site**, the **User** will (unless it gives rise to a Modification under the **CUSC**, in which case the provisions of the **CUSC** as to the timing apply) one month prior to the installation or change, send to NGET a revised **Operation Diagram** of that **User Site** incorporating the new **User HV Apparatus** to be installed and its numbering and nomenclature or the changes as the case may be. **OC11** is also relevant to certain **Apparatus**.

The provisions of **ECC.7.4.13.1** and **ECC.7.4.13.2** shall apply in relation to **Gas Zone Diagrams** where gas-insulated switchgear and/or other gas-insulated **HV Apparatus** is installed.

**Validity**

(a) The composite **Operation Diagram** prepared by NGET or the **User**, as the case may be, will be the definitive **Operation Diagram** for all operational and planning activities associated with the **Connection Site**. If a dispute arises as to the accuracy of the composite **Operation Diagram**, a meeting shall be held at the **Connection Site**, as soon as reasonably practicable, between NGET and the **User**, to endeavour to resolve the matters in dispute.

(b) The composite **Operation Diagram** prepared by NGET or the **User**, as the case may be, will be the definitive **Operation Diagram** for all operational and planning activities associated with the **Interface Point** until the **OTSUA Transfer Time**. If a dispute arises as to the accuracy of the composite **Operation Diagram** prior to the **OTSUA Transfer Time**, a meeting shall be held at the **Interface Point**, as soon as reasonably practicable, between NGET and the **User**, to endeavour to resolve the matters in dispute.

(c) An equivalent rule shall apply for **Gas Zone Diagrams** where they exist for a **Connection Site**.
ECC.7.4.15 In the case of OTSUA, a User Site and Transmission Site shall, for the purposes of this ECC.7.4, include a site at which there is an Interface Point until the OTSUA Transfer Time when it becomes part of the National Electricity Transmission System and references to HV Apparatus in this ECC.7.4 shall include references to HV OTSUA.

ECC.7.5 Site Common Drawings

ECC.7.5.1 Site Common Drawings will be prepared for each Connection Site (and in the case of OTSDUW, each Interface Point) and will include Connection Site (and in the case of OTSDUW, Interface Point) layout drawings, electrical layout drawings, common Protection/control drawings and common services drawings.

Preparation of Site Common Drawings for a User Site and Transmission Interface Site

ECC.7.5.2 In the case of a User Site, NGET shall prepare and submit to the User, Site Common Drawings for the Transmission side of the Connection Point (and in the case of OTSDUW Plant and Apparatus, on what will be the Onshore Transmission side of the Interface Point,) and the User shall prepare and submit to NGET, Site Common Drawings for the User side of the Connection Point (and in the case of OTSDUW, on what will be the Offshore Transmission side of the Interface Point) in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement.

ECC.7.5.3 The User will then prepare, produce and distribute, using the information submitted on the Transmission Site Common Drawings, Site Common Drawings for the complete Connection Site (and in the case of OTSDUW, Interface Point) in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement.

Preparation of Site Common Drawings for a Transmission Site

ECC.7.5.4 In the case of a Transmission Site, the User will prepare and submit to NGET Site Common Drawings for the User side of the Connection Point in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement.

ECC.7.5.5 NGET will then prepare, produce and distribute, using the information submitted in the User’s Site Common Drawings, Site Common Drawings for the complete Connection Site in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement.

ECC.7.5.6 When a User becomes aware that it is necessary to change any aspect of the Site Common Drawings at a Connection Site (and in the case of OTSDUW, Interface Point) it will:

(a) if it is a User Site, as soon as reasonably practicable, prepare, produce and distribute revised Site Common Drawings for the complete Connection Site (and in the case of OTSDUW, Interface Point); and

(b) if it is a Transmission Site, as soon as reasonably practicable, prepare and submit to NGET revised Site Common Drawings for the User side of the Connection Point (and in the case of OTSDUW, Interface Point) and NGET will then, as soon as reasonably practicable, prepare, produce and distribute, using the information submitted in the User’s Site Common Drawings, revised Site Common Drawings for the complete Connection Site (and in the case of OTSDUW, Interface Point).

In either case, if in the User's reasonable opinion the change can be dealt with by it notifying NGET in writing of the change and for each party to amend its copy of the Site Common Drawings (or where there is only one set, for the party holding that set to amend it), then it shall so notify and each party shall so amend. If the change gives rise to a Modification under the CUSC, the provisions of the CUSC as to timing will apply.
When NGET becomes aware that it is necessary to change any aspect of the Site Common Drawings at a Connection Site (and in the case of OTSDUW, Interface Point) it will:

(a) if it is a Transmission Site, as soon as reasonably practicable, prepare, produce and distribute revised Site Common Drawings for the complete Connection Site (and in the case of OTSDUW, Interface Point); and

(b) if it is a User Site, as soon as reasonably practicable, prepare and submit to the User revised Site Common Drawings for the Transmission side of the Connection Point (in the case of OTSDUW, Interface Point) and the User will then, as soon as reasonably practicable, prepare, produce and distribute, using the information submitted in the Transmission Site Common Drawings, revised Site Common Drawings for the complete Connection Site (and in the case of OTSDUW, Interface Point).

In either case, if in NGET's reasonable opinion the change can be dealt with by it notifying the User in writing of the change and for each party to amend its copy of the Site Common Drawings (or where there is only one set, for the party holding that set to amend it), then it shall so notify and each party shall so amend. If the change gives rise to a Modification under the CUSC, the provisions of the CUSC as to timing will apply.

Validity

(a) The Site Common Drawings for the complete Connection Site prepared by the User or NGET, as the case may be, will be the definitive Site Common Drawings for all operational and planning activities associated with the Connection Site. If a dispute arises as to the accuracy of the Site Common Drawings, a meeting shall be held at the Site, as soon as reasonably practicable, between NGET and the User, to endeavour to resolve the matters in dispute.

(b) The Site Common Drawing prepared by NGET or the User, as the case may be, will be the definitive Site Common Drawing for all operational and planning activities associated with the Interface Point until the OTSUA Transfer Time. If a dispute arises as to the accuracy of the composite Operation Diagram prior to the OTSUA Transfer Time, a meeting shall be held at the Interface Point, as soon as reasonably practicable, between NGET and the User, to endeavour to resolve the matters in dispute.

In the case of OTSUA, a User Site and Transmission Site shall, for the purposes of this ECC.7.5, include a site at which there is an Interface Point until the OTSUA Transfer Time when it becomes part of the National Electricity Transmission System.

Access

The provisions relating to access to Transmission Sites by Users, and to Users’ Sites by Transmission Licensees, are set out in each Interface Agreement (or in the case of Interfaces Sites prior to the OTSUA Transfer Time agreements in similar form) with, for Transmission Sites in England and Wales, NGET and each User, and for Transmission Sites in Scotland and Offshore, the Relevant Transmission Licensee and each User.

In addition to those provisions, where a Transmission Site in England and Wales contains exposed HV conductors, unaccompanied access will only be granted to individuals holding an Authority for Access issued by NGET and where a Transmission Site in Scotland or Offshore contains exposed HV conductors, unaccompanied access will only be granted to individuals holding an Authority for Access issued by the Relevant Transmission Licensee.

The procedure for applying for an Authority for Access is contained in the Interface Agreement.
ECC.7.7 Maintenance Standards

ECC.7.7.1 It is the User’s responsibility to ensure that all its Plant and Apparatus (including, until the OTSUA Transfer Time, any OTSUA) on a Transmission Site is tested and maintained adequately for the purpose for which it is intended, and to ensure that it does not pose a threat to the safety of any Transmission Plant, Apparatus or personnel on the Transmission Site. NGET will have the right to inspect the test results and maintenance records relating to such Plant and Apparatus at any time.

ECC.7.7.2 For User Sites in England and Wales, NGET has a responsibility to ensure that all Transmission Plant and Apparatus on a User Site is tested and maintained adequately for the purposes for which it is intended and to ensure that it does not pose a threat to the safety of any User’s Plant, Apparatus or personnel on the User Site.

For User Sites in Scotland and Offshore, NGET shall procure that the Relevant Transmission Licensee has a responsibility to ensure that all Transmission Plant and Apparatus on a User Site is tested and maintained adequately for the purposes for which it is intended and to ensure that it does not pose a threat to the safety of any User’s Plant, Apparatus or personnel on the User Site.

The User will have the right to inspect the test results and maintenance records relating to such Plant and Apparatus on its User Site at any time.

ECC.7.8 Site Operational Procedures

ECC.7.8.1 NGET and Users with an interface with NGET, must make available staff to take necessary Safety Precautions and carry out operational duties as may be required to enable work/testing to be carried out and for the operation of Plant and Apparatus (including, prior to the OTSUA Transfer Time, any OTSUA) connected to the Total System.

ECC.7.9 Generators and HVDC System owners shall provide a Control Point in respect of each Power Station connected to the National Electricity Transmission System and Embedded Large Power Station or HVDC System to receive and act upon instructions pursuant to OC7 and BC2 at all times that Power Generating Modules at the Power Station are generating or available to generate or HVDC Systems are importing or exporting or available to do so. The Control Point shall be continuously manned except where the Bilateral Agreement in respect of such Embedded Power Station specifies that compliance with BC2 is not required, where the Control Point shall be manned between the hours of 0800 and 1800 each day.

ECC.8 ANCILLARY SERVICES

ECC.8.1 System Ancillary Services

The ECC contain requirements for the capability for certain Ancillary Services, which are needed for System reasons (“System Ancillary Services”). There follows a list of these System Ancillary Services, together with the paragraph number of the ECC (or other part of the Grid Code) in which the minimum capability is required or referred to. The list is divided into two categories: Part 1 lists the System Ancillary Services which:

(a) Generators in respect of Type C and D Power Generating Modules (including DC Connected Power Park Modules) Large Power Stations are obliged to provide (except if Generators in respect of Type C and D Power Generating Modules have a Registered Capacity of less than 50 MW and comprise Power Park Modules)
(b) Generators in respect of Large Power Stations with a Registered Capacity of less than 50MW and comprise Power Park Modules are obliged to provide in respect of Reactive Power only; and,

(c) HVDC System Converter Station Owners are obliged to have the capability to supply; and

(d) Generators in respect of Medium Power Stations (except Embedded Medium Power Stations) are obliged to provide in respect of Reactive Power only:

and Part 2 lists the System Ancillary Services which Generators will provide only if agreement to provide them is reached with NGET:

Part 1

(a) Reactive Power supplied (in accordance with ECC.6.3.2) otherwise than by means of synchronous or static compensators (except in the case of a Power Park Module where synchronous or static compensators within the Power Park Module may be used to provide Reactive Power)

(b) Frequency Control by means of Frequency sensitive generation - ECC.6.3.7 and BC3.5.1

Part 2

(c) Frequency Control by means of Fast Start - ECC.6.3.14

(d) Black Start Capability - ECC.6.3.5

(e) System to Generator Operational Intertripping

Commercial Ancillary Services

Other Ancillary Services are also utilised by NGET in operating the Total System if these have been agreed to be provided by a User (or other person) under an Ancillary Services Agreement or under a Bilateral Agreement, with payment being dealt with under an Ancillary Services Agreement or in the case of Externally Interconnected System Operators or Interconnector Users, under any other agreement (and in the case of Externally Interconnected System Operators and Interconnector Users includes ancillary services equivalent to or similar to System Ancillary Services) ("Commercial Ancillary Services"). The capability for these Commercial Ancillary Services is set out in the relevant Ancillary Services Agreement or Bilateral Agreement (as the case may be).
APPENDIX E1 - SITE RESPONSIBILITY SCHEDULES

FORMAT, PRINCIPLES AND BASIC PROCEDURE TO BE USED IN THE PREPARATION OF SITE RESPONSIBILITY SCHEDULES

**ECC.A.1** Principles

**Types of Schedules**

**ECC.A.1.1** At all Complexes (which in the context of this ECC shall include, Interface Sites until the OTSUA Transfer Time) the following Site Responsibility Schedules shall be drawn up using the relevant proforma attached or with such variations as may be agreed between NGET and Users, but in the absence of agreement the relevant proforma attached will be used. In addition, in the case of OTSUW Plant and Apparatus, and in readiness for the OTSUA Transfer Time, the User shall provide NGET with the necessary information such that Site Responsibility Schedules in this form can be prepared by the Relevant Transmission Licensees for the Transmission Interface Site:

(a) Schedule of HV Apparatus
(b) Schedule of Plant, LV/MV Apparatus, services and supplies;
(c) Schedule of telecommunications and measurements Apparatus.

Other than at Power Generating Module (including DC Connected Power Park Modules) Generating Unit, DC Converter, Power Park Module and Power Station locations, the schedules referred to in (b) and (c) may be combined.

**New Connection Sites**

**ECC.A.1.2** In the case of a new Connection Site each Site Responsibility Schedule for a Connection Site shall be prepared by NGET in consultation with relevant Users at least 2 weeks prior to the Completion Date (or, where the OTSUA is to become Operational prior to the OTSUA Transfer Time, an alternative date) under the Bilateral Agreement and/or Construction Agreement for that Connection Site (which may form part of a Complex). In the case of a new Interface Site where the OTSUA is to become Operational prior to the OTSUA Transfer Time each Site Responsibility Schedule for an Interface Site shall be prepared by NGET in consultation with relevant Users at least 2 weeks prior to the Completion Date under the Bilateral Agreement and/or Construction Agreement for that Interface Site (which may form part of a Complex) (and references to and requirements placed on “Connection Site” in this CC shall also be read as “Interface Site” where the context requires and until the OTSUA Transfer Time). Each User shall, in accordance with the timing requirements of the Bilateral Agreement and/or Construction Agreement, provide information to NGET to enable it to prepare the Site Responsibility Schedule.

**Sub-division**

**ECC.A.1.3** Each Site Responsibility Schedule will be subdivided to take account of any separate Connection Sites on that Complex.

**Scope**

**ECC.A.1.4** Each Site Responsibility Schedule shall detail for each item of Plant and Apparatus:

(a) Plant/Apparatus ownership;
(b) Site Manager (Controller) (except in the case of Plant/Apparatus located in SPT’s Transmission Area);
(c) Safety issues comprising applicable Safety Rules and Control Person or other responsible person (Safety Co-ordinator), or such other person who is responsible for safety;
(d) Operations issues comprising applicable Operational Procedures and control engineer;
(e) Responsibility to undertake statutory inspections, fault investigation and maintenance.

Each Connection Point shall be precisely shown.

Detail

ECC A.1.1.5
(a) In the case of Site Responsibility Schedules referred to in ECC A.1.1.1(b) and (c), with the exception of Protection Apparatus and Intertrip Apparatus operation, it will be sufficient to indicate the responsible User or Transmission Licensee, as the case may be.
(b) In the case of the Site Responsibility Schedule referred to in ECC A.1.1.1(a) and for Protection Apparatus and Intertrip Apparatus, the responsible management unit must be shown in addition to the User or Transmission Licensee, as the case may be.

ECC A.1.1.6
The HV Apparatus Site Responsibility Schedule for each Connection Site must include lines and cables emanating from or traversing the Connection Site.

Issue Details

ECC A.1.1.7
Every page of each Site Responsibility Schedule shall bear the date of issue and the issue number.

Accuracy Confirmation

ECC A.1.1.8
When a Site Responsibility Schedule is prepared it shall be sent by NGET to the Users involved for confirmation of its accuracy.

ECC A.1.1.9
The Site Responsibility Schedule shall then be signed on behalf of NGET by its Responsible Manager (see ECC A.1.1.16) and on behalf of each User involved by its Responsible Manager (see ECC A.1.1.16), by way of written confirmation of its accuracy. For Connection Sites in Scotland or Offshore, the Site Responsibility Schedule will also be signed on behalf of the Relevant Transmission Licensee by its Responsible Manager.

Distribution and Availability

ECC A.1.1.10
Once signed, two copies will be distributed by NGET, not less than two weeks prior to its implementation date, to each User which is a party on the Site Responsibility Schedule, accompanied by a note indicating the issue number and the date of implementation.

ECC A.1.1.11
NGET and Users must make the Site Responsibility Schedules readily available to operational staff at the Complex and at the other relevant control points.

Alterations to Existing Site Responsibility Schedules

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1 Details of circuits traversing the Connection Site are only needed from the date which is the earlier of the date when the Site Responsibility Schedule is first updated and 15th October 2004. In Scotland or Offshore, from a date to be agreed between NGET and the Relevant Transmission Licensee.
Without prejudice to the provisions of ECC.A 1.1.15 which deals with urgent changes, when a User identified on a Site Responsibility Schedule becomes aware that an alteration is necessary, it must inform NGET immediately and in any event 8 weeks prior to any change taking effect (or as soon as possible after becoming aware of it, if less than 8 weeks remain when the User becomes aware of the change). This will cover the commissioning of new Plant and/or Apparatus at the Connection Site, whether requiring a revised Bilateral Agreement or not, de-commissioning of Plant and/or Apparatus, and other changes which affect the accuracy of the Site Responsibility Schedule.

Where NGET has been informed of a change by a User, or itself proposes a change, it will prepare a revised Site Responsibility Schedule by not less than six weeks prior to the change taking effect (subject to it having been informed or knowing of the change eight weeks prior to that time) and the procedure set out in ECC.A 1.1.8 shall be followed with regard to the revised Site Responsibility Schedule.

The revised Site Responsibility Schedule shall then be signed in accordance with the procedure set out in ECC.A 1.1.9 and distributed in accordance with the procedure set out in ECC.A 1.1.10, accompanied by a note indicating where the alteration(s) has/have been made, the new issue number and the date of implementation.
Urgent Changes

**ECC.A.1.1.15** When a User identified on a Site Responsibility Schedule, or NGET, as the case may be, becomes aware that an alteration to the Site Responsibility Schedule is necessary urgently to reflect, for example, an emergency situation which has arisen outside its control, the User shall notify NGET, or NGET shall notify the User, as the case may be, immediately and will discuss:

(a) what change is necessary to the Site Responsibility Schedule;

(b) whether the Site Responsibility Schedule is to be modified temporarily or permanently;

(c) the distribution of the revised Site Responsibility Schedule.

NGET will prepare a revised Site Responsibility Schedule as soon as possible, and in any event within seven days of it being informed of or knowing the necessary alteration. The Site Responsibility Schedule will be confirmed by Users and signed on behalf of NGET and Users (by the persons referred to in ECC.A.1.1.9) as soon as possible after it has been prepared and sent to Users for confirmation.

Responsible Managers

**ECC.A.1.1.16** Each User shall, prior to the Completion Date under each Bilateral Agreement and/or Construction Agreement, supply to NGET a list of Managers who have been duly authorised to sign Site Responsibility Schedules on behalf of the User and NGET shall, prior to the Completion Date under each Bilateral Agreement and/or Construction Agreement, supply to that User the name of its Responsible Manager and for Connection Sites in Scotland or Offshore, the name of the Relevant Transmission Licensee’s Responsible Manager and each shall supply to the other any changes to such list six weeks before the change takes effect where the change is anticipated, and as soon as possible after the change, where the change was not anticipated.

De-commissioning of Connection Sites

**ECC.A.1.1.17** Where a Connection Site is to be de-commissioned, whichever of NGET or the User who is initiating the de-commissioning must contact the other to arrange for the Site Responsibility Schedule to be amended at the relevant time.
## PROFORMA FOR SITE RESPONSIBILITY SCHEDULE

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<th>CONTROL OR OTHER RESPONSIBLE PERSON (SAFETY COORDINATOR)</th>
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<th>PARTY RESPONSIBLE FOR UNDERTAKING STATUTORY INSPECTIONS, FAULT INVESTIGATION &amp; MAINTENANCE</th>
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**Issue 5 Revision 21**

21 March 2017
# PROFORMA FOR SITE RESPONSIBILITY SCHEDULE

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21 March 2017
## SP TRANSMISSION Ltd
## SITE RESPONSIBILITY SCHEDULE
## OWNERSHIP, MAINTENANCE AND OPERATIONS OF EQUIPMENT
## IN JOINT USER SITUATIONS

### Network Area:
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### SECTION 'D' CONFIGURATION AND CONTROL

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### SECTION 'E' ADDITIONAL INFORMATION

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## Scottish Hydro-Electric Transmission Limited

### Site Responsibility Schedule

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APPENDIX E2 - OPERATION DIAGRAMS

PART 1A - PROCEDURES RELATING TO OPERATION DIAGRAMS
PART E2 - NON-EXHAUSTIVE LIST OF APPARATUS
TO BE INCLUDED ON OPERATION DIAGRAMS

Basic Principles

(1) Where practicable, all the HV Apparatus on any Connection Site shall be shown on one Operation Diagram. Provided the clarity of the diagram is not impaired, the layout shall represent as closely as possible the geographical arrangement on the Connection Site.

(2) Where more than one Operation Diagram is unavoidable, duplication of identical information on more than one Operation Diagram must be avoided.

(3) The Operation Diagram must show accurately the current status of the Apparatus e.g. whether commissioned or decommissioned. Where decommissioned, the associated switchbay will be labelled "spare bay".

(4) Provision will be made on the Operation Diagram for signifying approvals, together with provision for details of revisions and dates.

(5) Operation Diagrams will be prepared in A4 format or such other format as may be agreed with NGET.

(6) The Operation Diagram should normally be drawn single line. However, where appropriate, detail which applies to individual phases shall be shown. For example, some HV Apparatus is numbered individually per phase.

Apparatus To Be Shown On Operation Diagram

(1) Busbars
(2) Circuit Breakers
(3) Disconnector (Isolator) and Switch Disconnecters (Switching Isolators)
(4) Disconnectors (Isolators) - Automatic Facilities
(5) Bypass Facilities
(6) Earthing Switches
(7) Maintenance Earths
(8) Overhead Line Entries
(9) Overhead Line Traps
(10) Cable and Cable Sealing Ends
(11) Generating Unit
(12) Generator Transformers
(13) Generating Unit Transformers, Station Transformers, including the lower voltage circuit-breakers.
(14) Synchronous Compensators
(15) Static Variable Compensators
(16) Capacitors (including Harmonic Filters)
(17) Series or Shunt Reactors (Referred to as "Inductors" at nuclear power station sites)
(18) Supergrid and Grid Transformers
(19) Tertiary Windings
(20) Earthing and Auxiliary Transformers
(21) Three Phase VT’s
(22) Single Phase VT & Phase Identity
(23) High Accuracy VT and Phase Identity
(24) Surge Arrestors/Diversers
(25) Neutral Earthing Arrangements on HV Plant
(26) Fault Throwing Devices
(27) Quadrature Boosters
(28) Arc Suppression Coils
(29) Single Phase Transformers (BR) Neutral and Phase Connections
(30) Current Transformers (where separate plant items)
(31) Wall Bushings
(32) Combined VT/CT Units
(33) Shorting and Discharge Switches
(34) Thyristor
(35) Resistor with Inherent Non-Linear Variability, Voltage Dependent
(36) Gas Zone
APPENDIX E3 - MINIMUM FREQUENCY RESPONSE CAPABILITY REQUIREMENT PROFILE AND OPERATING RANGE FOR POWER GENERATING MODULES AND HVDC EQUIPMENT

The current text has been taken from Issue 5 Revision 16 of the Grid Code and will require checking to ensure consistency with latest version of the GB Grid Code.

ECC.A.3.1  Scope

The frequency response capability is defined in terms of Primary Response, Secondary Response and High Frequency Response. In addition to the requirements defined in ECC.6.3.7 this appendix defines the minimum frequency response requirements for:

(a) each Type C and Type D Power Generating Module
(b) each DC Connected Power Park Module
(c) each HVDC Converter at a HVDC Converter Station
(d) each HVDC Converter at a HVDC Converter Station including Remote End HVDC Converters

Frequency response capability is defined in terms of the response to a step change in frequency and the ability to respond with an Active Power change satisfying the minimum requirements set out in ECC.6.3.7.3.3.

(i) Frequency response service is defined in terms of Primary, Secondary and High frequency response profiles. The definitions of these services are illustrated diagrammatically in Figures ECC.A.3.2 and ECC.A.3.3.

For the avoidance of doubt, this appendix does not apply to Type A and Type B Power Generating Modules.

OTSDUW Plant and Apparatus should facilitate the delivery of frequency response services provided by Offshore Generating Units and Offshore Power Park Units.

The functional definition provides appropriate performance criteria relating to the provision of Frequency control by means of Frequency sensitive generation in addition to the other requirements identified in ECC.6.3.7.

In this Appendix 3 to the ECC, for a Power Generating Module including a CCGT Module or a Power Park Module or DC Connected Power Park Module, the phrase Minimum Regulating Level applies to the entire CCGT Module or Power Park Module or DC Connected Power Park Module operating with all Generating Units Synchronised to the System.

The minimum Frequency response requirement profile is shown diagrammatically in Figure ECC.A.3.1. The capability profile specifies the minimum required level of Frequency Response Capability throughout the normal plant operating range.

ECC.A.3.2  Plant Operating Range

The upper limit of the operating range is the Maximum Capacity of the Power Generating Module or Generating Unit or CCGT Module or HVDC Equipment.
The **Minimum Regulating Level** level may be less than, but must not be more than, 65% of the **Maximum Capacity**. Each **Power Generating Module** and/or **Generating Unit** and/or **CCGT Module** and/or **Power Park Module** or **HVDC Equipment** must be capable of operating satisfactorily down to the **Minimum Regulating Level** as dictated by **System operating conditions**, although it will not be instructed to below its **Minimum Stable Operating Level** level. If a **Power Generating Module** or **Generating Unit** or **CCGT Module** or **Power Park Module**, or **HVDC Equipment** is operating below **Minimum Stable Operating Level** because of high **System Frequency**, it should recover adequately to its **Minimum Stable Operating Level** as the **System Frequency** returns to **Target Frequency** so that it can provide **Primary** and **Secondary Response** from its **Minimum Stable Operating Level** if the **System Frequency** continues to fall. For the avoidance of doubt, under normal operating conditions steady state operation below the **Minimum Stable Operating Level** is not expected. The **Minimum Regulating Level** must not be more than 55% of **Maximum Capacity**.

In the event of a **Power Generating Module** or **Generating Unit** or **CCGT Module** or **Power Park Module** or **HVDC Equipment** load rejecting down to no less than its **Minimum Regulating Level** it should not trip as a result of automatic action as detailed in BC3.7. If the load rejection is to a level less than the **Minimum Regulating Level** then it is accepted that the condition might be so severe as to cause it to be disconnected from the **System**.

**ECC.A.3.3 Minimum Frequency Response Requirement Profile**

Figure **ECC.A.3.1** shows the minimum ***Frequency*** response capability requirement profile diagrammatically for a 0.5 Hz change in ***Frequency***. The percentage response capabilities and loading levels are defined on the basis of the **Maximum Capacity** of the **Power Generating Module** or **CCGT Module** or **Power Park Module** or **HVDC Equipment**. Each **Power Generating Module** or and/or **CCGT Module** or **Power Park Module** (including a **DC** Connected **Power Park Module**) and/or **HVDC Equipment** must be capable of operating in a manner to provide ***Frequency*** response at least to the solid boundaries shown in the figure. If the ***Frequency*** response capability falls within the solid boundaries, the **Power Generating Module** or **CCGT Module** or **Power Park Module** or **HVDC Equipment** is providing response below the minimum requirement which is not acceptable. Nothing in this appendix is intended to prevent a **Power Generating Module** or **CCGT Module** or **Power Park Module** or **HVDC Equipment** from being designed to deliver a ***Frequency*** response in excess of the identified minimum requirement.

The ***Frequency*** response delivered for ***Frequency*** deviations of less than 0.5 Hz should be no less than a figure which is directly proportional to the minimum ***Frequency*** response requirement for a ***Frequency*** deviation of 0.5 Hz. For example, if the ***Frequency*** deviation is 0.2 Hz, the corresponding minimum ***Frequency*** response requirement is 40% of the level shown in Figure **ECC.A.3.1**. The ***Frequency*** response delivered for ***Frequency*** deviations of more than 0.5 Hz should be no less than the response delivered for a ***Frequency*** deviation of 0.5 Hz.

Each **Power Generating Module** and/or **CCGT Module** and/or **Power Park Module** or **HVDC Equipment** must be capable of providing some response, in keeping with its specific operational characteristics, when operating between 95% to 100% of **Maximum Capacity** as illustrated by the dotted lines in Figure **ECC.A.3.1**.

At the **Minimum Stable Operating level**, each **Power Generating Module** and/or **CCGT Module** and/or **Power Park Module** and/or **HVDC Equipment** is required to provide high and low frequency response depending on the **System Frequency** conditions. Where the **Frequency** is high, the **Active Power** output is therefore expected to fall below the **Minimum Stable Operating level**.
The Minimum Regulating Level is the output at which a Power Generating Module and/or CCGT Module and/or Power Park Module and/or HVDC Equipment has no High Frequency Response capability. It may be less than, but must not be more than, 55% of the Maximum Capacity. This implies that a Power Generating Module or CCGT Module or Power Park Module or HVDC Equipment is not obliged to reduce its output to below this level unless the Frequency is at or above 50.5 Hz (cf BC3.7).

### ECC.A.3.4 Testing of Frequency Response Capability

The frequency response capabilities shown diagrammatically in Figure ECC.A.3.1 are measured by taking the responses as obtained from some of the dynamic step response tests specified by NGET and carried out by Generators and HVDC System owners for compliance purposes. The injected signal is a step of 0.5Hz (an additional diagram may be required here) from zero to 0.5 Hz Frequency change over a ten second period, and is sustained at 0.5 Hz Frequency change thereafter, the latter as illustrated diagrammatically in figures ECC.A.3.2 and ECC.A.3.3 ECC.A.3.4 and ECC.A.3.5.

In addition to provide and/or to validate the content of Ancillary Services Agreements a progressive injection of a Frequency change to the plant control system (i.e. governor and load controller) is used. The injected signal is a ramp of 0.5Hz from zero to 0.5 Hz Frequency change over a ten second period, and is sustained at 0.5 Hz Frequency change thereafter, the latter as illustrated diagrammatically in figures ECC.A.3.2 and ECC.A.3.3. For the avoidance of doubt, these tests will be conducted with ramp signals for the purposes of determining Primary, Secondary and High Frequency Responses.

The Primary Response capability (P) of a Power Generating Module or a CCGT Module or Power Park Module or HVDC Equipment is the minimum increase in Active Power output between 10 and 30 seconds after the start of the ramp injection as illustrated diagrammatically in Figure ECC.A.3.2. This increase in Active Power output should be released increasingly with time over the period 0 to 10 seconds from the time of the start of the Frequency fall as illustrated by the response from Figure ECC.A.3.2.

The Secondary Response capability (S) of a Power Generating Module or a CCGT Module or Power Park Module or HVDC Equipment is the minimum increase in Active Power output between 30 seconds and 30 minutes after the start of the ramp injection as illustrated diagrammatically in Figure ECC.A.3.2.

The High Frequency Response capability (H) of a Power Generating Module or a CCGT Module or Power Park Module or HVDC Equipment is the decrease in Active Power output provided 10 seconds after the start of the ramp injection and sustained thereafter as illustrated diagrammatically in Figure ECC.A.3.3. This reduction in Active Power output should be released increasingly with time over the period 0 to 10 seconds from the time of the start of the Frequency rise as illustrated by the response in Figure ECC.A.3.2.

### ECC.A.3.5 Repeatability Of Response

When a Power Generating Module or CCGT Module or Power Park Module or HVDC Equipment has responded to a significant Frequency disturbance, its response capability must be fully restored as soon as technically possible. Full response capability should be restored no later than 20 minutes after the initial change of System Frequency arising from the Frequency disturbance.

Comment [A116]: Removed - relates to LEEMPS
Figure ECC.A.3.1 - Minimum Frequency Response requirement profile for a 0.5 Hz frequency change from Target Frequency
Figure ECC.A.3.2 - Interpretation of Primary and Secondary Response values

Figure ECC.A.3.3 - Interpretation of High Frequency Response values
ECC.4 - APPENDIX 4 - FAULT RIDE THROUGH REQUIREMENTS

FAULT RIDE THROUGH REQUIREMENTS FOR TYPE B, TYPE C AND TYPE D POWER GENERATING MODULES
(INCLUDING OFFSHORE POWER PARK MODULES WHICH ARE EITHER AC CONNECTED POWER PARK MODULES OR DC CONNECTED POWER PARK MODULES), HVDC SYSTEMS AND OTSDUW PLANT AND APPARATUS

ECC.A.4A.1 Scope

The Fault Ride Through requirements are defined in ECC.6.3.15.1 – ECC.6.3.15.8(a), (b) and CC.6.3.15.3. This Appendix provides illustrations by way of examples only of ECC.6.3.15.1 – ECC.6.3.15.10 and further background and illustrations to ECC.6.3.15.1 – ECC.6.3.15.10 and CC.6.3.15.1 (2b) (i) and is not intended to show all possible permutations.

ECC.A.4A.2 Short Circuit Faults At Supergrid Voltage On The Onshore Transmission System Up To 140ms In Duration

For short circuit faults at Supergrid Voltage on the Onshore Transmission System (which could be at an Interface Point) up to 140ms in duration, the Fault Ride Through requirement is defined in ECC.6.3.15. In summary any Power Generating Module (including a DC Connected Power Park Module) or HVDC System is required to remain connected and stable whilst connected to a healthy circuit. Figure ECC.A.4.A.2 illustrates this principle.

In Figure ECC.A.4.A.2 a solid three phase short circuit fault is applied adjacent to substation A resulting in zero voltage at the point of fault. All circuit breakers on the faulty circuit (Lines ABC) will open within 140ms. The effect of this fault, due to the low impedance of the network, will be the observation of a low voltage at each substation node until the fault has been cleared.

Under this example, Generator X in Figure ECC.A.4.A.2, will trip as it is disconnected and isolated from the Transmission System by the opening of circuit breakers on circuit ABC. Generator Y and Generator Z (an Embedded Generator) would need to remain connected and stable as both are still connected to the Total System and remain connected to healthy circuits.

Comment [A117]: Need to check this adequately covers the Offshore requirements.
The criteria for assessment is based on a voltage against time curve at each Grid Entry Point or User System Entry Point. The voltage against time curve at the Grid Entry Point or User System Entry Point varies for each different type and size of Power Generating Module as detailed in ECC.6.3.15.X – ECC.6.3.15.Y.

The voltage against time curve represents the voltage profile at a Grid Entry Point or User System Entry Point that would be obtained by plotting the voltage at that Grid Entry Point or User System Entry Point before during and after the fault. This is not to be confused with a voltage duration curve (as defined under ECC.6.3.15.X) which represents a voltage level and associated time duration.

The post fault voltage at a Grid Entry Point or User System Entry Point is largely influenced by the topology of the network rather than the behaviour of the Power Generating Module itself. The Generator therefore needs to ensure each Power Generating Module remains connected and stable for a close up solid three phase short circuit fault for 140ms at the Grid Entry Point or User System Entry Point.

Two examples are shown in Figure ECC.A.4.A.2.X and ECC.A.4.A.2.Y. In Figure ECC.A.4.A.2.X, the post fault profile is above the heavy black line. In this case the Power Generating Module must remain connected and stable. In Figure ECC.A.4.A.2.Y the post fault voltage dips below the heavy black line in which case the Power Generating Module is permitted to trip.
The process for demonstrating **Fault Ride Through** compliance against the requirements of ECC.6.3.15 are detailed in ECP.A.3.5.

**ECC.A.4A.3**

**Supergrid Voltage Dips On The Onshore Transmission System Greater Than 140ms In Duration**

**ECC.A.4A.3.1**

Requirements applicable to **Synchronous Power Generating Modules Generating Units** subject to **Supergrid Voltage** dips on the **Onshore Transmission System** greater than 140ms in duration.

For balanced **Supergrid Voltage** dips on the **Onshore Transmission System** having durations greater than 140ms and up to 3 minutes, the **Fault Ride Through** requirement is defined in ECC.6.3.15.1 (1b) and Figure 5a which is reproduced in this Appendix as Figure ECC.A.4A3.1 and termed the voltage–duration profile.

This profile is not a voltage-time response curve that would be obtained by plotting the transient voltage response at a point on the **Onshore Transmission System** (or **User System** if located **Onshore**) to a disturbance. Rather, each point on the profile (i.e., the heavy black line) represents a voltage level and an associated time duration which connected **Synchronous Power Generating Modules Units** must withstand or ride through.

Figures ECC.A.4A3.2 (a), (b) and (c) illustrate the meaning of the voltage-duration profile for voltage dips having durations greater than 140ms.

![Figure ECC.A.4A3.1](image-url)
Figure ECC.A.4A3.2 (a)

Figure ECC.A.4A3.2 (b)
Requirements applicable to Power Park Modules or OTSDUW Plant and Apparatus subject to Supergrid Voltage dips on the Onshore Transmission System greater than 140ms in duration.

For balanced Supergrid Voltage dips on the Onshore Transmission System (which could be at an Interface Point) having durations greater than 140ms and up to 3 minutes the Fault Ride Through requirement is defined in ECC.6.3.15.1 (2b) and Figure 5b which is reproduced in this Appendix as Figure ECC.A.4A3.3 and termed the voltage-duration profile.

This profile is not a voltage-time response curve that would be obtained by plotting the transient voltage response at a point on the Onshore Transmission System (or User System if located Onshore) to a disturbance. Rather, each point on the profile (ie the heavy black line) represents a voltage level and an associated time duration which connected Power Park Modules or OTSDUW Plant and Apparatus must withstand or ride through.

Figures ECC.A.4A.4 (a), (b) and (c) illustrate the meaning of the voltage-duration profile for voltage dips having durations greater than 140ms.
30% retained voltage, 364ms duration

Figure ECC.A.4A3.4 (a)

50% retained voltage, 710ms duration

Figure ECC.A.4A3.4 (b)

85% retained voltage, 3 minutes duration
APPENDIX EADX – FAST FAULT CURRENT INJECTION REQUIREMENTS FOR POWER PARK MODULES, DC CONVERTERS AT A DC CONVERTER STATION, DC CONNECTED POWER PARK MODULES AND REMOTE END DC CONVERTERS

ECC.AX4 Fast Fault Current Injection requirements (ECC.6.3.16.4) – Option 3

ECC.AX4.1 Fast Fault Current Injection behaviour during a solid three phase close up short circuit fault lasting up to 140ms

ECC.AX4.1.1 For a voltage depression at a Grid Entry Point or User System Connection Point, the Fast Fault Current Injection requirements are detailed in ECC.6.3.16.4. Figure ECCAX4.1.1 shows an example of a 500MW Power Park Module subject to a close up solid three phase short circuit fault connected directly connected to the Transmission System operating at 400kV.

![Diagram showing a Power Park Module subject to a close up solid three phase short circuit fault.]

**Figure ECCAX4.1**

ECC.AX4.1.2 Assuming negligible impedance between the fault and substation C, the voltage at Substation C will be close to zero until circuit breakers at Substation C open, typically within 80 – 100ms, subsequentially followed by the opening of circuit breakers at substations A and B, typically 140ms after fault inception. The operation of circuit breakers at Substations A, B and C will also result in the tripping of the 1800MW Generator which is permitted under the SQSS. The Power Park Module is required to satisfy the requirements of ECC.6.3.16.4.1, and an example of the expected reactive current injected by the Power Park Module before, during and after the fault is shown in Figure ECC.AX4.2.
Figure ECC.AX4.2 = Reactive Current Injected from the Power Park Module connected to Substation C

It is important to note that blocking is permitted upon fault clearance in order to limit the impact of transient overvoltages. This effect is shown in Figure ECC.AX4.1.2(a) and Figure ECC.AX4.1.2(b).

Modify Figure – Superimpose Reactive Current on top of curve – Figure ECC.AX4.1.2(a)
Modify Figure – Superimpose Reactive Current on top of curve – Figure ECC.AX4.1.2(b)

ECC.AX4.1.3 So long as the reactive current injected is above the shaded area as illustrated in Figure ECC.AX4.1.2(a) or ECC.AX4.1.2, the Power Park Module would be considered to be compliant with the requirements of ECC.6.3.16.4.1. Taking the example outlined in ECC.AX4.1.1 where the fault is cleared in 140ms, the following diagram in Figure ECC.AX4.1.3 results:

ECC.AX4.2 Fast Fault Current Injection behaviour during a voltage dip at the Connection Point lasting in excess of 140ms
ECC.AX4.2.1 Under the fault ride through requirements specified in ECC.6.3.15 (Voltage dips cleared in excess of 140ms), Type B, Type C and Type D Power Park Modules are also required to remain connected and stable for voltage dips on the Transmission System in excess of 140ms. Figure ECCAX4.2.1(a) shows an example of a 500MW Power Park Module connected to the Transmission System and Figure ECCAX4.2.1(b) shows the corresponding voltage dip seen at the Grid Entry Point or User System Connection Point which has resulted from a remote fault on the Transmission System cleared in a backup operating time of 710ms.

![Figure ECCAX4.2.1(a)](image1)

![Figure ECCAX4.2.1(b)](image2)
In this example, the voltage dips to 0.5pu for 710ms. Under ECC.6.3.16.4.1(ii) each Type B, Type C and Type D Power Park Module is required to inject reactive current into the System and shall respond in proportion to the change in System voltage at the Connection Point up to a maximum value of 1.0pu of rated current. An example of the expected injected reactive current at the Connection Point is shown in Figure ECC.AX4.2.2.
ECC.A.5.1 Low Frequency Relays

The Low Frequency Relays to be used shall have a setting range of 47.0 to 50Hz and be suitable for operation from a nominal AC input of 63.5, 110 or 240V. The following general parameters specify the requirements of approved Low Frequency Relays for automatic installations installed and commissioned after 1st April 2007 and provide an indication, without prejudice to the provisions that may be included in a Bilateral Agreement, for those installed and commissioned before 1st April 2007:

(a) Frequency settings: 47-50Hz in steps of 0.05Hz or better, preferably 0.01Hz;
(b) Operating time: Relay operating time shall not be more than 150 ms;
(c) Voltage lock-out: Selectable within a range of 55 to 90% of nominal voltage;
(d) Facility stages: One or two stages of Frequency operation;
(e) Output contacts: Two output contacts per stage to be capable of repetitively making and breaking for 1000 operations;
(f) Accuracy: 0.01 Hz maximum error under reference environmental and system voltage conditions. 0.05 Hz maximum error at 8% of total harmonic distortion Electromagnetic Compatibility Level.
(h) Indications: Provide the direction of Active Power flow at the point of de-energisation.

ECC.A.5.2 Low Frequency Relay Voltage Supplies

ECC.A.5.2.1 It is essential that the voltage supply to the Low Frequency Relays shall be derived from the primary System at the supply point concerned so that the Frequency of the Low Frequency Relays input voltage is the same as that of the primary System. This requires either:

(a) the use of a secure supply obtained from voltage transformers directly associated with the grid transformer(s) concerned, the supply being obtained where necessary via a suitable automatic voltage selection scheme; or

(b) the use of the substation 240V phase-to-neutral selected auxiliary supply, provided that this supply is always derived at the supply point concerned and is never derived from a standby supply Power Generating Module Generating Unit or from another part of the User System.

ECC.A.5.3 Scheme Requirements

ECC.A.5.3.1 The tripping facility should be engineered in accordance with the following reliability considerations:

(a) Dependability
Failure to trip at any one particular Demand shedding point would not harm the overall operation of the scheme. However, many failures would have the effect of reducing the amount of Demand under low Frequency control. An overall reasonable minimum requirement for the dependability of the Demand shedding scheme is 96%, i.e. the average probability of failure of each Demand shedding point should be less than 4%. Thus the Demand under low Frequency control will not be reduced by more than 4% due to relay failure.

(b) Outages

Low Frequency Demand shedding schemes will be engineered such that the amount of Demand under control is as specified in Table ECC.A.5.5.1a and is not reduced unacceptably during equipment outage or maintenance conditions.

ECC.A.5.3.2 The total operating time of the scheme, including circuit breakers operating time, shall where reasonably practicable, be less than 200 ms. For the avoidance of doubt, the replacement of plant installed prior to October 2009 will not be required in order to achieve lower total scheme operating times.

ECC.A.5.4 Low Frequency Relay Testing

ECC.A.5.4.1 Low Frequency Relays installed and commissioned after 1st January 2007 shall be type tested in accordance with and comply with the functional test requirements for Frequency Protection contained in Energy Networks Association Technical Specification 48-6-5 Issue 1 dated 2005 “ENA Protection Assessment Functional Test Requirements – Voltage and Frequency Protection”.

For the avoidance of doubt, Low Frequency Relays installed and commissioned before 1st January 2007 shall comply with the version of ECC.A.5.1.1 applicable at the time such Low Frequency Relays were commissioned.

ECC.A.5.5 Scheme Settings

ECC.A.5.5.1 Table CC.A.5.5.1a shows, for each Transmission Area, the percentage of Demand (based on Annual ACS Conditions) at the time of forecast National Electricity Transmission System peak Demand that each Network Operator whose System is connected to the Onshore Transmission System within such Transmission Area shall disconnection by Low Frequency Relays at a range of frequencies. Where a Network Operator’s System is connected to the National Electricity Transmission System in more than one Transmission Area, the settings for the Transmission Area in which the majority of the Demand is connected shall apply.

<table>
<thead>
<tr>
<th>Frequency Hz</th>
<th>% Demand disconnection for each Network Operator in Transmission Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NGET</td>
</tr>
<tr>
<td>48.8</td>
<td>5</td>
</tr>
<tr>
<td>48.75</td>
<td>5</td>
</tr>
<tr>
<td>48.7</td>
<td>10</td>
</tr>
<tr>
<td>48.6</td>
<td>7.5</td>
</tr>
<tr>
<td>48.5</td>
<td>7.5</td>
</tr>
<tr>
<td>48.4</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Note – the percentages in table ECC.A.5.5.1a are cumulative such that, for example, should the frequency fall to 48.6 Hz in the NGET Transmission Area, 27.5% of the total Demand connected to the National Electricity Transmission System in the NGET Transmission Area shall be disconnected by the action of Low Frequency Relays.

The percentage Demand at each stage shall be allocated as far as reasonably practicable. The cumulative total percentage Demand is a minimum.

### ECC.A.5.6 Connection and Reconnection

#### ECC.A.5.6.1

As defined under OC.6.6 once automatic low Frequency Demand Disconnection has taken place, the Network Operator on whose User System it has occurred, will not reconnect until NGET instructs that Network Operator to do so in accordance with OC6. The same requirement equally applies to Non-Embedded Customers.

#### ECC.A.5.6.2

Once NGET instructs the Network Operator or Non Embedded Customer to reconnect to the National Electricity Transmission System following operation of the Low Frequency Demand Disconnection scheme it shall do so in accordance with the requirements of ECC.6.2.3.10 and OC6.6.

Network Operator or Non Embedded Customers shall be capable of being remotely disconnected from the National Electricity Transmission System when instructed by NGET. If required, Any requirement for the automated disconnection equipment for reconfiguration of the National Electricity Transmission System in preparation for block loading and the time required for remote disconnection shall be specified by NGET in accordance with the terms of the Bilateral Agreement.
APPENDIX E6 - PERFORMANCE REQUIREMENTS FOR CONTINUOUSLY ACTING AUTOMATIC EXCITATION CONTROL SYSTEMS FOR ONSHORE SYNCHRONOUS POWER GENERATING MODULES

ECC.A.6.1 Scope

ECC.A.6.1.1 This Appendix sets out the performance requirements of continuously acting automatic excitation control systems for Type C and Type D Onshore Synchronous Power Generating Modules that must be complied with by the User. This Appendix does not limit any site specific requirements where in NGET’s reasonable opinion these facilities are necessary for system reasons.

ECC.A.6.1.2 Where the requirements may vary the likely range of variation is given in this Appendix. It may be necessary to specify values outside this range where NGET identifies a system need, and notwithstanding anything to the contrary NGET may specify values outside of the ranges provided in this Appendix 6. The most common variations are in the on-load excitation ceiling voltage requirements and the response time required of the Exciter. Actual values will be included in the Bilateral Agreement.

ECC.A.6.1.3 Should a Generator anticipate making a change to the excitation control system it shall notify NGET under the Planning Code (PC.A.1.2(b) and (c)) as soon as the Generator anticipates making the change. The change may require a revision to the Bilateral Agreement.

ECC.A.6.2 Requirements

ECC.A.6.2.1 The Excitation System of a Type C or Type D Onshore Synchronous Power Generating Module shall include an excitation source (Exciter), a Power System Stabiliser and a continuously acting Automatic Voltage Regulator (AVR) and shall meet the following functional specification. Type D Synchronous Power Generating Modules are also required to be fitted with a Power System Stabiliser as a means of supplementary control. The functional specification of the Power System Stabiliser is included in ECA.A.6.2.5.

ECC.A.6.2.2 In respect of Onshore Synchronous Generating Units with a Completion Date on or after 1 January 2009, and Onshore Synchronous Generating Units with a Completion Date before 1 January 2009 subject to a Modification to the excitation control facilities where the Bilateral Agreement does not specify otherwise, the continuously acting automatic excitation control system shall include a Power System Stabiliser (PSS) as a means of supplementary control. The functional specification of the Power System Stabiliser is included in ECA.A.6.2.5.

ECC.A.6.2.3 Steady State Voltage Control

ECC.A.6.2.3.1 An accurate steady state control of the Onshore Synchronous Power Generating Module pre-set Synchronous Generating Unit terminal voltage is required. As a measure of the accuracy of the steady-state voltage control, the Automatic Voltage Regulator shall have static zero frequency gain, sufficient to limit the change in terminal voltage to a drop not exceeding 0.5% of rated terminal voltage, when the output of a Synchronous Generating Unit within an Onshore Synchronous Power Generating Module is gradually changed from zero to rated MVA output at rated voltage, Active Power and Frequency.

ECC.A.6.2.4 Transient Voltage Control
ECC.A.6.2.4.1 For a step change from 90% to 100% of the nominal Onshore Synchronous Generating Unit terminal voltage, with the Onshore Synchronous Generating Unit on open circuit, the Excitation System response shall have a damped oscillatory characteristic. For this characteristic, the time for the Onshore Synchronous Generating Unit terminal voltage to first reach 100% shall be less than 0.6 seconds. Also, the time to settle within 5% of the voltage change shall be less than 3 seconds.

ECC.A.6.2.4.2 To ensure that adequate synchronising power is maintained, when the Onshore Power Generating Module is subjected to a large voltage disturbance, the Exciter whose output is varied by the Automatic Voltage Regulator shall be capable of providing its achievable upper and lower limit ceiling voltages to the Onshore Synchronous Generating Unit field in a time not exceeding that specified in the Bilateral Agreement. This will normally be not less than 50 ms and not greater than 300 ms. The achievable upper and lower limit ceiling voltages may be dependent on the voltage disturbance.

ECC.A.6.2.4.3 The Exciter shall be capable of attaining an Excitation System On Load Positive Ceiling Voltage of not less than a value specified in the Bilateral Agreement that will be:

- not less than 2 per unit (pu)
- normally not greater than 3 pu
- exceptionally up to 4 pu

of Rated Field Voltage when responding to a sudden drop in voltage of 10 percent or more at the Onshore Synchronous Generating Unit terminals. NGET may specify a value outside the above limits where NGET identifies a system need.

ECC.A.6.2.4.4 If a static type Exciter is employed:

(i) the field voltage should be capable of attaining a negative ceiling level specified in the Bilateral Agreement after the removal of the step disturbance of ECC.A.6.2.4.3. The specified value will be 80% of the value specified in ECC.A.6.2.4.3. NGET may specify a value outside the above limits where NGET identifies a system need.

(ii) the Exciter must be capable of maintaining free firing when the Onshore Synchronous Generating Unit terminal voltage is depressed to a level which may be between 20% to 30% of rated terminal voltage

(iii) the Exciter shall be capable of attaining a positive ceiling voltage not less than 80% of the Excitation System On Load Positive Ceiling Voltage upon recovery of the Onshore Synchronous Generating Unit terminal voltage to 80% of rated terminal voltage following fault clearance. NGET may specify a value outside the above limits where NGET identifies a system need.

(iv) the requirement to provide a separate power source for the Exciter will be specified if NGET identifies a Transmission System need.

ECC.A.6.2.5 Power Oscillations Damping Control

ECC.A.6.2.5.1 To allow Type D Onshore Power Generating Modules to maintain second and subsequent swing stability and also to ensure an adequate level of low frequency electrical damping power, the Automatic Voltage Regulator of each Onshore Synchronous Generating Unit within each Type D Onshore Synchronous Power Generating Module shall include a Power System Stabiliser as a means of supplementary control.
Whatever supplementary control signal is employed, it shall be of the type which operates into the Automatic Voltage Regulator to cause the field voltage to act in a manner which results in the damping power being improved while maintaining adequate synchronising power.

The arrangements for the supplementary control signal shall ensure that the Power System Stabiliser output signal relates only to changes in the supplementary control signal and not the steady state level of the signal. For example, if generator electrical power output is chosen as a supplementary control signal then the Power System Stabiliser output should relate only to changes in the Synchronous Generating Unit electrical power output and not the steady state level of power output. Additionally the Power System Stabiliser should not react to mechanical power changes in isolation for example during rapid changes in steady state load or when providing frequency response.

The output signal from the Power System Stabiliser shall be limited to not more than ±10% of the Onshore Synchronous Generating Unit terminal voltage signal at the Automatic Voltage Regulator input. The gain of the Power System Stabiliser shall be such that an increase in the gain by a factor of 3 shall not cause instability.

The Power System Stabiliser shall include elements that limit the bandwidth of the output signal. The bandwidth limiting must ensure that the highest frequency of response cannot excite torsional oscillations on other plant connected to the network. A bandwidth of 0-5 Hz would be judged to be acceptable for this application.

The Generator in respect of its Type D Synchronous Power Generating Modules will agree Power System Stabiliser settings with NGET prior to the on-load commissioning detailed in BC2.11.2(d). To allow assessment of the performance before on-load commissioning the Generator will provide to NGET a report covering the areas specified in CP.A.3.2.1.

The Power System Stabiliser must be active within the Excitation System at all times when Synchronised including when the Under Excitation Limiter or Over Excitation Limiter are active. When operating at low load when Synchronising or De-Synchronising an Onshore Synchronous Generating Unit, within a Type D Synchronous Power Generating Module, the Power System Stabiliser may be out of service.

Where a Power System Stabiliser is fitted to a Pumped Storage Unit within a Type D Synchronous Power Generating Module it must function when the Pumped Storage Unit is in both generating and pumping modes.

Overall Excitation System Control Characteristics

The overall Excitation System shall include elements that limit the bandwidth of the output signal. The bandwidth limiting must be consistent with the speed of response requirements and ensure that the highest frequency of response cannot excite torsional oscillations on other plant connected to the network. A bandwidth of 0-5 Hz will be judged to be acceptable for this application.

The response of the Automatic Voltage Regulator combined with the Power System Stabiliser shall be demonstrated by injecting similar step signal disturbances into the Automatic Voltage Regulator reference as detailed in OCS.A.2.2 and OCS.A.2.4. The Automatic Voltage Regulator shall include a facility to allow step injections into the Automatic Voltage Regulator voltage reference, with the Onshore Type D Power Generating Module operating at points specified by NGET (up to rated MVA output). The damping shall be judged to be adequate if the corresponding Active Power response to the disturbances decays within two cycles of oscillation.
ECC.A.6.2.6.3 A facility to inject a band limited random noise signal into the Automatic Voltage Regulator voltage reference shall be provided for demonstrating the frequency domain response of the Power System Stabiliser. The tuning of the Power System Stabiliser shall be judged to be adequate if the corresponding Active Power response shows improved damping with the Power System Stabiliser in combination with the Automatic Voltage Regulator compared with the Automatic Voltage Regulator alone over the frequency range 0.3Hz – 2Hz.

ECC.A.6.2.7 Under-Excitation Limiters

ECC.A.6.2.7.1 The security of the power system shall also be safeguarded by means of MVAr Under Excitation Limiters fitted to the Synchronous Power Generating Module Excitation System. The Under Excitation Limiter shall prevent the Automatic Voltage Regulator reducing the Synchronous Generating Unit excitation to a level which would endanger synchronous stability. The Under Excitation Limiter shall operate when the excitation system is providing automatic control. The Under Excitation Limiter shall respond to changes in the Active Power (MW) the Reactive Power (MVAr) and to the square of the Synchronous Generating Unit voltage in such a direction that an increase in voltage will permit an increase in leading MVAr. The characteristic of the Under Excitation Limiter shall be substantially linear from no-load to the maximum Active Power output of the Onshore Power Generating Module at any setting and shall be readily adjustable.

ECC.A.6.2.7.2 The performance of the Under Excitation Limiter shall be independent of the rate of change of the Onshore Synchronous Power Generating Module load and shall be demonstrated by testing as detailed in OC5.A.2.5. The resulting maximum overshoot in response to a step injection which operates the Under Excitation Limiter shall not exceed 4% of the Onshore Synchronous Generating Unit rated MVA. The operating point of the Onshore Synchronous Generating Unit shall be returned to a steady state value at the limit line and the final settling time shall not be greater than 5 seconds. When the step change in Automatic Voltage Regulator reference voltage is reversed, the field voltage should begin to respond without any delay and should not be held down by the Under Excitation Limiter. Operation into or out of the preset limit levels shall ensure that any resultant oscillations are damped so that the disturbance is within 0.5% of the Onshore Synchronous Generating Unit MVA rating within a period of 5 seconds.

ECC.A.6.2.7.3 The Generator shall also make provision to prevent the reduction of the Onshore Synchronous Power Generating Module excitation to a level which would endanger synchronous stability when the Excitation System is under manual control.

ECC.A.6.2.8 Over-Excitation and Stator Current Limiters

ECC.A.6.2.8.1 The settings of the Over-Excitation Limiter and stator current limiter, where it exists, shall ensure that the Onshore Synchronous Generating Unit excitation is not limited to less than the maximum value that can be achieved whilst ensuring the Onshore Synchronous Generating Unit is operating within its design limits. If the Onshore Synchronous Generating Unit excitation is reduced following a period of operation at a high level, the rate of reduction shall not exceed that required to remain within any time dependent operating characteristics of the Onshore Synchronous Power Generating Module.

ECC.A.6.2.8.2 The performance of the Over-Excitation Limiter, where it exists, shall be demonstrated by testing as described in OC5.A.2.6. Any operation beyond the Over-Excitation Limit shall be controlled by the Over-Excitation Limiter or stator current limiter without the operation of any Protection that could trip the Onshore Synchronous Power Generating Module.
CC.A.6.2.8.3 The Generator shall also make provision to prevent any over-excitation restriction of the Onshore Synchronous Generating Unit when the Excitation System is under manual control, other than that necessary to ensure the Onshore Power Generating Module is operating within its design limits.
APPENDIX E7 - PERFORMANCE REQUIREMENTS FOR CONTINUOUSLY ACTING AUTOMATIC VOLTAGE CONTROL SYSTEMS FOR AC CONNECTED ONSHORE NON-SYNCHRONOUS GENERATING UNITS, ONSHORE DC CONVERTERS, POWER PARK MODULES AND OTSDUW PLANT AND APPARATUS AT THE INTERFACE POINT, HVDC SYSTEMS AND REMOTE END HVDC CONVERTER STATIONS

ECC.A.7.1 Scope

ECC.A.7.1.1 This Appendix sets out the performance requirements of continuously acting automatic voltage control systems for Onshore Non-Synchronous Generating Units, Power Park Modules, HVDC Systems, Remote End HVDC Converter Stations and OTSDUW Plant and Apparatus at the Interface Point that must be complied with by the User. This Appendix does not limit any site specific requirements where in NGET's reasonable opinion these facilities are necessary for system reasons.

ECC.A.7.1.2 Proposals by Generators or HVDC System Owners to make a change to the voltage control systems are required to be notified to NGET under the Planning Code (PC.A.1.2(b) and (c)) as soon as the Generator or HVDC System Owner anticipates making the change. The change may require a revision to the Bilateral Agreement.

ECC.A.7.2 Requirements

ECC.A.7.2.1 NGET requires that the continuously acting automatic voltage control system for the Onshore Non-Synchronous Generating Unit, Onshore DC Converter or Onshore Power Park Module, HVDC System or Remote End HVDC Converter Station or OTSDUW Plant and Apparatus shall meet the following functional performance specification. If a Network Operator has confirmed to NGET that its network to which an Embedded Onshore Non-Synchronous Generating Unit, Onshore DC Converter, Onshore Power Park Module or HVDC System or Remote End HVDC Converter Station or OTSDUW Plant and Apparatus is connected is restricted such that the full reactive range under the steady state voltage control requirements (ECC.A.7.2.2) cannot be utilised, NGET may specify alternative limits to the steady state voltage control range that reflect these restrictions. Where the Network Operator subsequently notifies NGET that such restriction has been removed, NGET may propose a Modification to the Bilateral Agreement (in accordance with the CUSC contract) to remove the alternative limits such that the continuously acting automatic voltage control system meets the following functional performance specification. All other requirements of the voltage control system will remain as in this Appendix.

ECC.A.7.2.2 Steady State Voltage Control

ECC.A.7.2.2.1 The Onshore Non-Synchronous Generating Unit, Onshore DC Converter, Onshore Power Park Module, HVDC System and/or Remote End HVDC Converter Station or OTSDUW Plant and Apparatus shall provide continuous steady state control of the voltage at the Onshore Grid Entry Point (or Onshore User System Entry Point if Embedded) (or the Interface Point in the case of OTSDUW Plant and Apparatus or HVDC Interface Point in the case of a Remote End HVDC Converter Station) with a Setpoint Voltage and Slope characteristic as illustrated in Figure ECC.A.7.2.2a. It should be noted that where the Reactive Power capability requirement of a directly connected Onshore Non-Synchronous Generating Unit, Onshore DC Converter, Onshore Power Park Module in Scotland, or OTSDUW Plant and Apparatus in Scotland as specified in CC.6.3.2 (c), is not at the Onshore Grid Entry Point or Interface Point, the values of Qmin and Qmax shown in this figure will be as modified by the 33/132kV or 33/275kV or 33/400kV transformer.
ECC.A.7.2.2 The continuously acting automatic control system shall be capable of operating to a **Setpoint Voltage** between 95% and 105% with a resolution of 0.25% of the nominal voltage. For the avoidance of doubt values of 95%, 95.25%, 95.5% ... may be specified, but not intermediate values. The initial **Setpoint Voltage** will be 100%. The tolerance within which this **Setpoint Voltage** shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.25% and a Setpoint Voltage of 100%, the achieved value shall be between 99.75% and 100.25%. **NGET** may request the **Generator** or **HVDC System Owner** to implement an alternative **Setpoint Voltage** within the range of 95% to 105%. For **Embedded Generators** and **Embedded HVDC System Owners** the **Setpoint Voltage** will be discussed between **NGET** and the relevant **Network Operator** and will be specified to ensure consistency with ECC.6.3.4.

ECC.A.7.2.3 The **Slope** characteristic of the continuously acting automatic control system shall be adjustable over the range 2% to 7% (with a resolution of 0.5%). For the avoidance of doubt values of 2%, 2.5%, 3% may be specified, but not intermediate values. The initial **Slope** setting will be 4%. The tolerance within which this **Slope** shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.5% and a **Slope** setting of 4%, the achieved value shall be between 3.5% and 4.5%. **NGET** may request the **Generator** or **HVDC System Owner** to implement an alternative slope setting within the range of 2% to 7%. For **Embedded Generators** and **Embedded HVDC Converter Station Owners** the **Slope** setting will be discussed between **NGET** and the relevant **Network Operator** and will be specified to ensure consistency with ECC.6.3.4.
Comment [A125]: This diagram needs updating to include HVDC Interface Point Voltage.

Comment [A126]: This diagram needs updating to include Interface Point and HVDC Interface Point Voltage.
ECCA.7.2.4  Figure ECC.A.7.2.2b shows the required envelope of operation for Onshore Non-Synchronous Generating Units, Onshore DC Converters, OTSDUW Plant and Apparatus, Onshore Power Park Modules, HVDC Systems and Remote End HVDC Converter Stations except for those Embedded at 33kV and below or directly connected to the National Electricity Transmission System at 33kV and below. Figure ECC.A.7.2.2c shows the required envelope of operation for Onshore Non-Synchronous Generating Units, Onshore DC Converters and Onshore Power Park Modules Embedded at 33kV and below, or directly connected to the National Electricity Transmission System at 33kV and below. Where the Reactive Power capability requirement of a directly connected Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module in Scotland, as specified in CC.6.3.2 (c), is not at the Onshore Grid Entry Point or Interface Point in the case of OTSDUW Plant and Apparatus, the values of \( Q_{\text{min}} \) and \( Q_{\text{max}} \) shown in this figure will be as modified by the 33/132kV or 33/275kV or 33/400kV transformer. The enclosed area within points ABCDEFGH is the required capability range within which the Slope and Setpoint Voltage can be changed.

ECCA.7.2.5  Should the operating point of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module, or HVDC System or Remote End HVDC Converter Station deviate so that it is no longer a point on the operating characteristic (figure ECC.A.7.2.2a) defined by the target Setpoint Voltage and Slope, the continuously acting automatic voltage control system shall act progressively to return the value to a point on the required characteristic within 5 seconds.

ECCA.7.2.6  Should the Reactive Power output of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module, or HVDC System or Remote End HVDC Converter Station reach its maximum lagging limit at a Onshore Grid Entry Point voltage (or Onshore User System Entry Point voltage if Embedded (or Interface Point in the case of OTSDUW Plant and Apparatus or HVDC Interface Point voltage in the case of Remote End HVDC Converter Stations) above 95% of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module, or HVDC System or Remote End HVDC Converter Station shall maintain maximum lagging Reactive Power output for voltage reductions down to 95%. This requirement is indicated by the line EF in figures ECC.A.7.2.2b and ECC.A.7.2.2c as applicable. Should the Reactive Power output of the Onshore Non-Synchronous Generating Unit, Onshore DC Converters, OTSDUW Plant and Apparatus or Onshore Power Park Module, or HVDC System or Remote End HVDC Converter Station reach its maximum leading limit at a Onshore Grid Entry Point voltage (or Onshore User System Entry Point voltage if Embedded or Interface Point in the case of OTSDUW Plant and Apparatus, or HVDC Interface Point voltage in the case of Remote End HVDC Converter Stations) below 105%, the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module, or HVDC System or Remote End HVDC Converter Station shall maintain maximum leading Reactive Power output for voltage increases up to 105%. This requirement is indicated by the line AB in figures ECC.A.7.2.2b and ECC.A.7.2.2c as applicable.
**ECC.A.7.2.2.7** For Onshore Grid Entry Point voltages (or Onshore User System Entry Point voltages if Embedded or Interface Point voltages) below 95%, the lagging Reactive Power capability of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module or HVDC Systems (or Remote End HVDC Converter Stations at a HVDC Interface Point) should be that which results from the supply of maximum lagging reactive current whilst ensuring the current remains within design operating limits. An example of the capability is shown by the line DF in figures ECC.A.7.2.2b and ECC.A.7.2.2c. For Onshore Grid Entry Point voltages (or User System Entry Point voltages if Embedded or Interface Point voltages or HVDC Interface Point voltages) above 105%, the leading Reactive Power capability of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module or HVDC System or Remote End DC Converter should be that which results from the supply of maximum leading reactive current whilst ensuring the current remains within design operating limits. An example of the capability is shown by the line DE in figures ECC.A.7.2.2b and ECC.A.7.2.2c as applicable. Should the Reactive Power output of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module or HVDC System or Remote End HVDC Converter Station reach its maximum lagging limit at an Onshore Grid Entry Connection Point voltage (or Onshore User System Entry Point voltage if Embedded or Interface Point in the case of OTSDUW Plant and Apparatus or HVDC Interface Point in the case of a Remote End DC Converter) below 95%, the Onshore Non-Synchronous Generating Unit, Onshore DC Converter or Onshore Power Park Module, HVDC Converter System or Remote End HVDC Converter shall maintain maximum lagging reactive current output for further voltage decreases. Should the Reactive Power output of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module or HVDC System or Remote End HVDC Converter Station reach its maximum leading limit at a Onshore Grid Entry Point voltage (or User System Entry Point voltage if Embedded or Interface Point voltage in the case of an OTSDUW Plant and Apparatus or HVDC Interface Point Voltage in the case of a Remote End HVDC Converter Stations) above 105%, the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module or HVDC System Converter at a DC Converter Station or Remote End DC Converter shall maintain maximum leading reactive current output for further voltage increases.

**ECC.A.7.2.2.8** All OTSDUW Plant and Apparatus must be capable of enabling Users undertaking OTSDUW to comply with an instruction received from NGET relating to a variation of the Setpoint Voltage at the Interface Point within 2 minutes of such instruction being received.

**ECC.A.7.2.2.9** For OTSDUW Plant and Apparatus connected to a Network Operator’s System where the Network Operator has confirmed to NGET that its System is restricted in accordance with ECC.A.7.2.1, clause ECC.A.7.2.2.8 will not apply unless NGET can reasonably demonstrate that the magnitude of the available change in Reactive Power has a significant effect on voltage levels on the Onshore National Electricity Transmission System.

**ECC.A.7.2.3** Transient Voltage Control

**ECC.A.7.2.3.1** For an on-load step change in Onshore Grid Entry Point or Onshore User System Entry Point voltage, or in the case of OTSDUW Plant and Apparatus an on-load step change in Transmission Interface Point voltage, or in the case of Remote End HVDC Converter Stations an on-load step change in HVDC Interface Point voltage, the continuously acting automatic control system shall respond according to the following minimum criteria:
(i) the Reactive Power output response of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Modules or HVDC System or Remote End HVDC Converter Station shall commence within 0.2 seconds of the application of the step. It shall progress linearly although variations from a linear characteristic shall be acceptable provided that the MVAr seconds delivered at any time up to 1 second are at least those that would result from the response shown in figure ECC.A.7.2.3.1a.

(ii) the response shall be such that 90% of the change in the Reactive Power output of the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module, or HVDC System or Remote End HVDC Converter Station will be achieved within

- 2 seconds, where the step is sufficiently large to require a change in the steady state Reactive Power output from its maximum leading value to its maximum lagging value or vice versa and
- 1 second where the step is sufficiently large to require a change in the steady state Reactive Power output from zero to its maximum leading value or maximum lagging value as required by ECC.6.3.2 (or, if appropriate ECC.A.7.2.2.6 or ECC.A.7.2.2.7);

(iii) the magnitude of the Reactive Power output response produced within 1 second shall vary linearly in proportion to the magnitude of the step change.

(iv) within 2.5 seconds from achieving 90% of the response as defined in ECC.A.7.2.3.1 (ii), the peak to peak magnitude of any oscillations shall be less than 5% of the change in steady state maximum Reactive Power.

(v) following the transient response, the conditions of ECC.A.7.2.2 apply.

![Diagram](image)
leading value, or vice versa, then reverting back to the initial level of Reactive Power output once every 15 seconds for at least 5 times within any 5 minute period; and

(b) changing its Reactive Power output from zero to its maximum leading value then reverting back to zero Reactive Power output at least 25 times within any 24 hour period and from zero to its maximum lagging value then reverting back to zero Reactive Power output at least 25 times within any 24 hour period. Any subsequent restriction on reactive capability shall be notified to NGET in accordance with BC2.5.3.2, and BC2.6.1.

In all cases, the response shall be in accordance to ECC.A.7.2.3.1 where the change in Reactive Power output is in response to an on-load step change in Onshore Grid Entry Point or Onshore User System Entry Point voltage, or in the case of OTSDUW Plant and Apparatus an on-load step change in Transmission Interface Point voltage or in the case of Remote End HVDC Converter Stations an on load step change in HVDC Interface Point voltage.

ECC.A.7.2.4 Power Oscillation Damping

ECC.A.7.2.4.1 The requirement for the continuously acting voltage control system to be fitted with a Power System Stabiliser (PSS) shall be specified if, in NGET's view, this is required for system reasons. However if a Power System Stabiliser is included in the voltage control system its settings and performance shall be agreed with NGET and commissioned in accordance with BC2.11.2. To allow assessment of the performance before on-load commissioning the Generator will provide to NGET a report covering the areas specified in CP.A.3.2.2.

ECC.A.7.2.5 Overall Voltage Control System Characteristics

ECC.A.7.2.5.1 The continuously acting automatic voltage control system is required to respond to minor variations, steps, gradual changes or major variations in Onshore Grid Entry Point voltage or Onshore User System Entry Point voltage if Embedded or Interface Point voltage in the case of OTSDUW Plant and Apparatus or HVDC Interface Point voltage in the case of Remote End HVDC Converter Stations).

ECC.A.7.2.5.2 The overall voltage control system shall include elements that limit the bandwidth of the output signal. The bandwidth limiting must be consistent with the speed of response requirements and ensure that the highest frequency of response cannot excite torsional oscillations on other plant connected to the network. A bandwidth of 0-5Hz would be judged to be acceptable for this application. All other control systems employed within the Onshore Non-Synchronous Generating Unit, Onshore DC Converter, OTSDUW Plant and Apparatus or Onshore Power Park Module or HVDC System or Remote End HVDC Converter Station should also meet this requirement.

ECC.A.7.2.5.3 The response of the voltage control system (including the Power System Stabiliser if employed) shall be demonstrated by testing in accordance with OCS.A.3.

ECC.A.7.3 Reactive Power Control

ECC.A.7.3.1 As defined in ECC.6.3.8.3.4, Reactive Power control mode of operation is not required in respect of Onshore Power Park Modules or OTSDUW Plant and Apparatus or HVDC Systems or Remote End HVDC Converter Stations unless otherwise specified by NGET in coordination with the relevant Network Operator. However where there is a requirement
for Reactive Power control mode of operation, the following requirements shall apply.

**ECC.A.7.3.2** The Onshore Power Park Module or OTSDUW Plant and Apparatus or HVDC Systems or Remote End HVDC Converter Stations shall be capable of setting the Reactive Power setpoint anywhere in the Reactive Power range as specified in ECC.6.3.2.6 with setting steps no greater than 5 MVAR or 5% (whichever is smaller) of full Reactive Power controlling the reactive power at the Grid Entry Point or User System Entry Point or Embedded or HVDC Interface Point in the case of a Remote End HVDC Converter Stations to an accuracy within plus or minus 5 MVAR or plus or minus 5% (whichever is smaller) of the full Reactive Power.

**ECC.A.7.3.3** Any additional requirements for Reactive Power control mode of operation shall be specified by NGET in coordination with the relevant Network Operator.

**ECC.A.7.4** Power Factor Control

**ECC.A.7.4.1** As defined in ECC.6.3.8.4.3, Power Factor control mode of operation is not required in respect of Onshore Power Park Modules or OTSDUW Plant and Apparatus or HVDC Systems or Remote End HVDC Converter Stations unless otherwise specified by NGET in coordination with the relevant Network Operator. However where there is a requirement for Power Factor control mode of operation, the following requirements shall apply.

**ECC.A.7.4.2** The Onshore Power Park Module or OTSDUW Plant and Apparatus or HVDC System or Remote End HVDC Converter Station shall be capable of controlling the Power Factor at the Grid Entry Point or User System Entry Point of Embedded or HVDC Interface Point in the case of a Remote End HVDC Converter Stations within the required Reactive Power range as specified in ECC.6.3.2.2.1 and ECC.6.3.2.4 with a specified Target Power Factor in steps no greater than 0.01. NGET shall specify the Target Power Factor value (which shall be achieved within 0.01 of the set Power Factor), its tolerance and the period of time to achieve the Target Power Factor following a sudden change of Active Power output. The tolerance of the Target Power Factor shall be expressed through the tolerance of its corresponding Reactive Power. This Reactive Power tolerance shall be expressed by either an absolute value or by a percentage of the maximum Reactive Power of the Onshore Power Park Module or OTSDUW Plant and Apparatus or HVDC Remote End DC Converter. The details of these requirements being pursuant to the terms of the Bilateral Agreement.

**ECC.A.7.4.3** Any additional requirements for Power Factor control mode of operation shall be specified by NGET in coordination with the relevant Network Operator.
APPENDIX E8 - PERFORMANCE REQUIREMENTS FOR CONTINUOUSLY ACTING AUTOMATIC VOLTAGE CONTROL SYSTEMS FOR CONFIGURATION 2 AC CONNECTED OFFSHORE POWER PARK MODULES AND DC CONNECTED POWER PARK MODULES

ECC.A.8.1 Scope

ECC.A.8.1.1 This Appendix sets out the performance requirements of continuously acting automatic voltage control systems for Configuration 2 AC connected Offshore Power Park Modules that must be complied with by the User. This Appendix does not limit any site specific requirements that may be specified where in NGET’s reasonable opinion these facilities are necessary for system reasons.

ECC.A.8.1.2 These requirements also apply to DC Connected Power Park Modules. In the case of a Configuration 1 DC Connected Power Park Module the technical performance requirements shall be specified by NGET. Where the DC Connected Power Park Module has agreed to a wider reactive capability range as defined under ECC.6.3.2.7.3 then the requirements that apply will be specified by NGET and which shall reflect the performance requirements detailed in ECC.A.8.2 below but with different parameters such as droop and Setpoint Voltage.

ECC.A.8.2 Requirements

ECC.A.8.2.1 NGET requires that the continuously acting automatic voltage control system for the Configuration 2 AC connected Offshore Power Park Module and Configuration 2 DC Connected Power Park Module shall meet the following functional performance specification.

ECC.A.8.2.2 Steady State Voltage Control

ECC.A.8.2.2.1 The Configuration 2 AC connected Offshore Power Park Module and Configuration 2 DC Connected Power Park Module shall provide continuous steady state control of the voltage at the Offshore Connection Point with a Setpoint Voltage and Slope characteristic as illustrated in Figure ECC.A.8.2.2a.
### ECC.A.8.2.2a

**ECC.A.8.2.2.2** The continuously acting automatic control system shall be capable of operating to a **Setpoint Voltage** between 95% and 105% with a resolution of 0.25% of the nominal voltage. For the avoidance of doubt values of 95%, 95.25%, 95.5% ... may be specified, but not intermediate values. The initial **Setpoint Voltage** will be 100%. The tolerance within which this **Setpoint Voltage** shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.25% and a **Setpoint Voltage** of 100%, the achieved value shall be between 99.75% and 100.25%. **NGET** may request the **Generator** to implement an alternative **Setpoint Voltage** within the range of 95% to 105%.

**ECC.A.8.2.2.3** The **Slope** characteristic of the continuously acting automatic control system shall be adjustable over the range 2% to 7% (with a resolution of 0.5%). For the avoidance of doubt values of 2%, 2.5%, 3% may be specified, but not intermediate values. The initial **Slope** setting will be 4%. The tolerance within which this **Slope** shall be achieved is specified in BC2.A.2.6. For the avoidance of doubt, with a tolerance of 0.5% and a **Slope** setting of 4%, the achieved value shall be between 3.5% and 4.5%. **NGET** may request the **Generator** to implement an alternative slope setting within the range of 2% to 7%.

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**Figure ECC.A.8.2.2a**

The diagram illustrates the relationship between Point Voltage (pu) and reactive capability. The continuously acting automatic control system is depicted with a setpoint voltage range between 95% and 105% and a slope characteristic adjustable over the range 2% to 7%. The diagram also shows the reactive capability corresponding to 0.05 leading Power Factor at Rated MW and 0.98 lagging Power Factor at Rated MW.
Figure ECC.A.8.2.2b

ECC.A.8.2.2.4 Figure ECC.A.8.2.2b shows the required envelope of operation for Configuration 2 AC connected Offshore Power Park Module and Configuration 2 DC Connected Power Park Module. The enclosed area within points ABCDEFGH is the required capability range within which the Slope and Setpoint Voltage can be changed.

ECC.A.8.2.2.5 Should the operating point of the Configuration 2 AC connected Offshore Power Park or Configuration 2 DC Connected Power Park Module deviate so that it is no longer a point on the operating characteristic (Figure ECC.A.8.2.2a) defined by the target Setpoint Voltage and Slope, the continuously acting automatic voltage control system shall act progressively to return the value to a point on the required characteristic within 5 seconds.

ECC.A.8.2.2.6 Should the Reactive Power output of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module reach its maximum lagging limit at an Offshore Grid Entry Point or Offshore User System Entry Point or HVDC Interface Point voltage above 95%, the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module shall maintain maximum lagging Reactive Power output for voltage reductions down to 95%. This requirement is indicated by the line EF in figure ECC.A.8.2.2b. Should the Reactive Power output of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module reach its maximum leading limit at the Offshore Grid Entry Point or Offshore User System Entry Point or HVDC Interface Point voltage below 105%, the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module shall maintain maximum leading Reactive Power output for voltage increases up to 105%. This requirement is indicated by the line AB in figures ECC.A.7.2.2b.
For Offshore Grid Entry Point or User System Entry Point or HVDC Interface Point voltages below 95%, the lagging Reactive Power capability of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module should be that which results from the supply of maximum lagging reactive current whilst ensuring the current remains within design operating limits. An example of the capability is shown by the line DE in figures ECC.A.8.2.2b. For Offshore Grid Entry Point or Offshore User System Entry Point voltages or HVDC Interface Point voltages above 105%, the leading Reactive Power capability of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module should be that which results from the supply of maximum leading reactive current whilst ensuring the current remains within design operating limits. An example of the capability is shown by the line AH in figures ECC.A.8.2.2b. Should the Reactive Power output of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module reach its maximum lagging limit at an Offshore Grid Entry Point or Offshore User System Entry voltage or HVDC Interface Point voltage below 95%, the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module shall maintain maximum lagging reactive current output for further voltage decreases. Should the Reactive Power output of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module reach its maximum leading limit at an Offshore Grid Entry Point or Offshore User System Entry voltage or HVDC Interface Point voltage above 105%, the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module shall maintain maximum leading reactive current output for further voltage increases.

ECC.A.8.2.3 Transient Voltage Control

ECC.A.8.2.3.1 For an on-load step change in Offshore Grid Entry Point or Offshore User System Entry Point voltage or HVDC Interface Point voltage, the continuously acting automatic control system shall respond according to the following minimum criteria:

(i) the Reactive Power output response of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module shall commence within 0.2 seconds of the application of the step. It shall progress linearly although variations from a linear characteristic shall be acceptable provided that the MVAr seconds delivered at any time up to 1 second are at least those that would result from the response shown in figure ECC.A.8.2.3.1a.

(ii) the response shall be such that 90% of the change in the Reactive Power output of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module will be achieved within

- 2 seconds, where the step is sufficiently large to require a change in the steady state Reactive Power output from its maximum leading value to its maximum lagging value or vice versa and

- 1 second where the step is sufficiently large to require a change in the steady state Reactive Power output from zero to its maximum leading value or maximum lagging value as required by ECC.6.3.2 (or, if appropriate ECC.A.8.2.2.6 or ECC.A.8.2.2.7);

(iii) the magnitude of the Reactive Power output response produced within 1 second shall vary linearly in proportion to the magnitude of the step change.
(iv) within 5 seconds from achieving 90% of the response as defined in ECC.A.8.2.3.1 (ii), the peak to peak magnitude of any oscillations shall be less than 5% of the change in steady state maximum Reactive Power.

(v) following the transient response, the conditions of ECC.A.8.2.2 apply.

**ECC.A.8.2.3.2** Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module shall be capable of

(a) changing their Reactive Power output from maximum lagging value to maximum leading value, or vice versa, then reverting back to the initial level of Reactive Power output once every 15 seconds for at least 5 times within any 5 minute period; and

(b) changing Reactive Power output from zero to maximum leading value then reverting back to zero Reactive Power output at least 25 times within any 24 hour period and from zero to its maximum lagging value then reverting back to zero Reactive Power output at least 25 times within any 24 hour period. Any subsequent restriction on reactive capability shall be notified to NGET in accordance with BC2.5.3.2, and BC2.6.1.

In all cases, the response shall be in accordance to ECC.A.8.2.3.1 where the change in Reactive Power output is in response to an on-load step change in Offshore Grid Entry Point or Offshore User System Entry Point voltage or HVDC Interface Point voltage.

**ECC.A.8.2.4** Power Oscillation Damping
ECC.A.8.2.4.1 The requirement for the continuously acting voltage control system to be fitted with a Power System Stabiliser (PSS) shall be specified if, in NGET’s view, this is required for system reasons. However if a Power System Stabiliser is included in the voltage control system its settings and performance shall be agreed with NGET and commissioned in accordance with BC2.11.2. To allow assessment of the performance before on-load commissioning the Generator or HVDC System Owner will provide to NGET a report covering the areas specified in CP.A.3.2.2.

ECC.A.8.2.5 Overall Voltage Control System Characteristics

ECC.A.8.2.5.1 The continuously acting automatic voltage control system is required to respond to minor variations, steps, gradual changes or major variations in Offshore Grid Entry Point or Offshore User System Entry Point or HVDC Interface Point voltage.

ECC.A.8.2.5.2 The overall voltage control system shall include elements that limit the bandwidth of the output signal. The bandwidth limiting must be consistent with the speed of response requirements and ensure that the highest frequency of response cannot excite torsional oscillations on other plant connected to the network. A bandwidth of 0.5Hz would be judged to be acceptable for this application. All other control systems employed within the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module should also meet this requirement.

ECC.A.8.2.5.3 The response of the voltage control system (including the Power System Stabiliser if employed) shall be demonstrated by testing in accordance with OC5A.A.3.

ECC.A.8.3 Reactive Power Control

ECC.A.8.3.1 Reactive Power control mode of operation is not required in respect of Configuration 2 AC connected Offshore Power Park Modules or Configuration 2 DC Connected Power Park Modules unless otherwise specified by NGET. However where there is a requirement for Reactive Power control mode of operation, the following requirements shall apply.

ECC.A.8.3.2 Configuration 2 AC connected Offshore Power Park Modules or Configuration 2 DC Connected Power Park Modules shall be capable of setting the Reactive Power setpoint anywhere in the Reactive Power range as specified in ECC.6.3.2.8.2 with setting steps no greater than 5 MVar or 5% (whichever is smaller) of full Reactive Power, controlling the reactive power at the Offshore Grid Entry Point or Offshore User System Entry Point or HVDC Interface Point to an accuracy within plus or minus 5MVar or plus or minus 5% (whichever is smaller) of the full Reactive Power.

ECC.A.8.3.3 Any additional requirements for Reactive Power control mode of operation shall be specified by NGET.

ECC.A.8.4 Power Factor Control

ECC.A.8.4.1 Power Factor control mode of operation is not required in respect of Configuration 2 AC connected Offshore Power Park Modules or Configuration 2 DC Connected Power Park Modules unless otherwise specified by NGET. However where there is a requirement for Power Factor control mode of operation, the following requirements shall apply.

ECC.A.8.4.2 Configuration 2 AC connected Offshore Power Park Modules or Configuration 2 DC Connected Power Park Modules shall be capable of controlling the Power Factor at the Offshore Grid Entry Point or Offshore User System Entry Point or HVDC Interface...
Point within the required Reactive Power range as specified in ECC.6.3.2.8.2 with a target Power Factor. NGET shall specify the target Power Factor (which shall be achieved to within 0.01 of the set Power Factor), its tolerance and the period of time to achieve the target Power Factor following a sudden change of Active Power output. The tolerance of the target Power Factor shall be expressed through the tolerance of its corresponding Reactive Power. This Reactive Power tolerance shall be expressed by either an absolute value or by a percentage of the maximum Reactive Power of the Configuration 2 AC connected Offshore Power Park Module or Configuration 2 DC Connected Power Park Module. The details of these requirements being specified by NGET.

ECC.A.8.4.3 Any additional requirements for Power Factor control mode of operation shall be specified by NGET.

< END OF EUROPEAN CONNECTION CONDITIONS >