# OPERATING CODE NO. 5
**(OC5)**

**GRID CODE MODIFICATION GC0156**
**DATED 195 JUNE~~APRIL~~ 2023**

## TESTING AND MONITORING

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## OC5.1 INTRODUCTION

**Operating Code No. 5** ("**OC5**") specifies the procedures to be followed by **The Company** in carrying out:

(a) monitoring

(i) of **BM Units** against their expected input or output;

(ii) of compliance by **Users** with the **CC** or **ECC** as applicable and in the case of response to **Frequency**, **BC3**; and

(iii) of the provision by **Users** of **Ancillary Services** which they are required or have agreed to provide; and

(b) the following tests (which are subject to **System** conditions prevailing on the day):

(i) tests on **Gensets**, **CCGT Modules**, **Power Generating Modules**, **Power Park Modules**, **DC Converters, HVDC Equipment**, **OTSUA** (prior to the **OTSUA Transfer Time**) and **Generating Units** (excluding **Power Park Units**) to test that they have the capability to comply with the **CC** and **ECC**, and in the case of response to **Frequency**, **BC3** and to provide the **Ancillary Services** that they are either required or have agreed to provide;

(ii) tests on **BM Units**, to ensure that the **BM Units** are available in accordance with their submitted **Export and Import Limits** and **Dynamic Parameters**.

The ~~**OC5**~~ tests specified in OC5.7 include the ~~**Black Start Test** procedure~~procedures relating to **System Restoration Tests**.

**OC5** also specifies in OC5.8 the procedures which apply to the monitoring and testing of **Embedded Medium Power Stations** not subject to a **Bilateral Agreement** and **Embedded DC Converter Stations** (or **Embedded HVDC Equipment**) not subject to a **Bilateral Agreement**.

In respect of a **Cascade Hydro Scheme** the provisions of **OC5** shall be applied as follows:

(a) in respect of the **BM Unit** for the **Cascade Hydro Scheme** the parameters referred to at OC5.4.1 (a) and (c) in respect of **Commercial Ancillary Services** will be monitored and tested;

(b) in respect of each **Genset** forming part of the **Cascade Hydro Scheme** the parameters referred to at OC5.4.1 (a), (b) and (c) will be tested and monitored. In respect of OC5.4.1 (a) the performance of the **Gensets** will be tested and monitored against their expected input or output derived from the data submitted under BC1.4.2(a)(2). Where necessary to give effect to the requirements for **Cascade Hydro Schemes** in the following provisions of **OC5**, the term **Genset** will be read and construed in the place of **BM Unit**.

In respect of **Embedded Exemptable Large Power Stations** the provisions of **OC5** shall be applied as follows:

(a) where there is a **BM Unit** registered in the **BSC** in respect of **Generating Units** the provisions of **OC5** shall apply as written;

(b) in all other cases, in respect of each **Power Generating Module**, and/or **Generating Unit** and **HVDC Equipment** the parameters referred to at OC5.4.1(a), (b) and (c) will be tested and monitored. In respect of OC5.4.1(a) the performance of the **Power Generating Module** and/or **Generating Unit** and **HVDC Equipment** will be tested and monitored against their expected input or output derived from the data submitted under BC1.4.2(a)(2). Where necessary to give effect to the requirements for such **Embedded Exemptable Large Power Stations** in the provisions of **OC5**, the term **Generating Unit** will be read and construed in place of **BM Unit**.

OC5.2 OBJECTIVE

The objectives of **OC5** are to establish:

(a) that **Users** comply with the **CC** or **ECC** as applicable (including in the case of **OTSUA** prior to the **OTSUA Transfer Time**);

(b) whether **BM Units** operate in accordance with their expected input or output derived from their **Final Physical Notification Data** and agreed **Bid-Offer Acceptances** issued under **BC2**;

(c) whether each **BM Unit** is available as declared in accordance with its submitted **Export and Import Limits** and **Dynamic Parameters**; and

(d) whether **Generators**, **DC Converter Station** owners, **HVDC Equipment Owners** and **Suppliers** can provide those **Ancillary Services** which they are either required or have agreed to provide.

In certain limited circumstances as specified in this **OC5**, the output of **CCGT Units** may be verified, namely the monitoring of the provision of **Ancillary Services** and the testing of **Reactive Power** and automatic **Frequency Sensitive Operation**.

OC5.3 SCOPE

**OC5** applies to **The Company** and to **Users**, which in **OC5** means:

(a) **Generators** (including those undertaking **OTSDUW**);

(b) **Network Operators**;

(c) **Non-Embedded Customers**;

(d) **Suppliers**; and

(e) **DC Converter Station** owners or **HVDC Equipment Owners**.

OC5.4 MONITORING

OC5.4.1 Parameters ~~To Be~~to be monitored

**The Company** will monitor the performance of:

(a) **BM Units** against their expected input or output derived from their **Final Physical Notification Data** and agreed **Bid-Offer Acceptances** issued under **BC2**;

(b) compliance by **Users** with the **CC** or **ECC** as applicable; and

(c) the provision by **Users** of **Ancillary Services** which they are required or have agreed to provide.

OC5.4.2 Procedure ~~For~~for Monitoring

OC5.4.2.1 In the event that a **BM Unit** fails persistently, in **The Company's** reasonable view, to follow, in any material respect, its expected input or output or a **User** fails persistently to comply with the **CC** or **ECC** as applicable, or fails to comply in the case of CC.6.3.15 or ECC 6.3.15 as applicable, and in the case of response to **Frequency**, **BC3** or to provide the **Ancillary Services** it is required, or has agreed, to provide, **The Company** shall notify the relevant **User** giving details of the failure and of the monitoring that **The Company** has carried out.

OC5.4.2.2 The relevant **User** will, as soon as possible, and in the case of a failure to comply with the requirements of CC.6.3.15 or ECC.6.3.15 as applicable, within 2 hours in respect of a notification to this effect under OC10 or a longer time period only where agreed by **The Company**, provide **The Company** with an explanation of the reasons for the failure and details of the action that it proposes to take to:

(a) enable the **BM Unit** to meet its expected input or output or to provide the **Ancillary Services** it is required or has agreed to provide, within a reasonable period, or

(b) in the case of a **Power Generating Module**, **Generating Unit** (excluding a **Power Park Unit**), **CCGT Module**, **Power Park Module**, **OTSUA** (prior to the **OTSUA Transfer Time**), **HVDC Equipment** or **DC Converter** to comply with the **CC** or **ECC** as applicable and in the case of response to **Frequency**, **BC3** or to provide the **Ancillary Services** it is required or has agreed to provide, within a reasonable period.

(c) in the case of a **Power Generating Module**, **Generating Unit** (excluding a **Power Park Unit**), **CCGT Module**, **Power Park Module**, **OTSUA** (prior to the **OTSUA Transfer Time**), **HVDC Equipment** or **DC Converter** which has tripped off or de-loaded coincident with a fault as described in CC.6.3.15 or ECC.6.3.15, resolve any non-compliance, within a reasonable period.

For the avoidance of doubt in the case of CC.6.3.15 or ECC.6.3.15 as applicable, the explanation may indicate that the **User** has complied with CC.6.3.15 or ECC.6.3.15 on the basis that:

(i) the **User** had complied with CC.6.3.15 or ECC.6.3.15 as applicable on the basis that the **User** has provided recordings to show the voltage waveform during the fault was beyond the conditions specified in CC.6.3.15 or ECC.6.3.15 as applicable; or

(ii) the **User**'s **Connection Point** had been de-energised by receipt of an intertrip signal from the **National Electricity Transmission System;** or

(iii) that other information has been shared between the **User** and **The Company** enabling agreement between them that compliance with CC.6.3.15 or ECC.6.3.15 as applicable has been confirmed.

Data relating to a fault on the **Transmission System** that **The Company** believes has led to **Users** to co-incidentally trip or de-load is to be provided by **The Company**, where available, in a file structure as agreed with the **User**. Where waveform data is available, this will be obtained from the recorder electrically closest to the **User**'s **Connection Point**.

OC5.4.2.3 In the event of a **User** being notified under OC5.4.2.1 by **The Company** of a potential failure to comply with CC6.3.15 or ECC6.3.15 as applicable and where the **User** is required to provide an explanation as described in OC5.4.2.2(c), the **User** shall take action to restrict the output of their **Power Generating Module, Generating Unit** (excluding a **Power Park Unit**), **CCGT Module, Power Park Module, OTSUA** (prior to the **OTSUA Transfer Time**), **HVDC Equipment** or **DC Converter** to a level and for a period as agreed with **The Company** or until an explanation has been provided by the **User** and agreed between the **User** and **The Company** as set out under OC5.4.2.2(c).

OC5.4.2.4 **The Company** and the **User** will discuss any action the **User** proposes to take and will endeavour to reach agreement as to:

(a) any short term operational measures necessary to protect other **Users**; and

(b) the parameters which are to be submitted for the **BM Unit** and the effective time(s) and date(s) for the application of the agreed parameters. For the avoidance of doubt in the case of a failure to comply with CC.6.3.15 or ECC.6.3.15 as applicable which requires the **User** to provide an explanation as described in OC5.4.2.2(c), this may be to zero MW or another value if agreed between the **User** and **The Company**.

OC5.4.2.5 In the event that agreement cannot be reached within 10 days of notification of the failure by **The Company** to the **User**, **The Company** or the **User** shall be entitled to require a test, as set out in OC5.5 and OC5.6, to be carried out, except in respect of CC.6.3.15 or ECC.6.3.15, as applicable, where testing is impractical and OC.5.4.2.6 shall apply instead.

OC5.4.2.6 In the case of a **Power Generating Module**, **Generating Unit** (excluding a **Power Park Unit**), **CCGT Module**, **Power Park Module**, **OTSUA** (prior to the **OTSUA Transfer Time**), **HVDC Equipment** or **DC Converter** identifying their non-compliance with CC.6.3.15 or ECC.6.3.15 as applicable by completion of their report into this as set out in **OC10, The Company** will as soon as reasonably practicable, issue a **Limited Operational Notification** or amend any **Interim Operational Notification**.

OC5.4.2.7 The requirements of OC5.4.2.1 – OC5.4.2.6 shall not apply during **System Restoration**, unless **The Company** expressly notifies the **User**.

OC5.5 PROCEDURE FOR TESTING

OC5.5.1 The Company's Instruction ~~For~~for Testing

OC5.5.1.1 **The Company** may at any time (although not normally more than twice in any calendar year in respect of any particular **BM Unit**) issue an instruction requiring a **User** to carry out a test, provided **The Company** has reasonable grounds of justification based upon:

(a) a failure to agree arising from the process in CP.8.1 or ECP.8.1; or

(b) monitoring carried out in accordance with OC5.4.2.

OC5.5.1.2 The test, referred to in OC5.5.1.1 and carried out at a time no sooner than 48 hours from the time that the instruction was issued, on any one or more of the **User's BM Units** should only be to demonstrate that the relevant **BM Unit**:

(a) if active in the **Balancing Mechanism**, meets the ability to operate in accordance with its submitted **Export and Import Limits** and **Dynamic Parameters** and achieve its expected input or output which has been monitored under OC5.4; and

(b) meets the requirements of the paragraphs in the **CC** and **ECC** which are applicable to such **BM Units**; and

in the case of a **BM Unit** comprising a **Generating Unit**, a **CCGT Module**, a **Power Park Module**, a **Power Generating Module**, **HVDC System** or a **DC Converter** meets,

(c) the requirements for operation in **Frequency Sensitive Mode** and compliance with the requirements for operation in **Limited Frequency Sensitive Mode** in accordance with CC.6.3.3, ECC.6.3.3, CC.6.3.7, ECC.6.3.7, BC3.5.2, BC.3.7.1 and BC3.7.2; or

(d) the terms of the applicable **Bilateral Agreement** agreed with the **Generator** to have a **Fast Start Capability**; or

(e) the **Reactive Power** capability registered with **The Company** under **OC2** which shall meet the requirements set out in CC.6.3.2 or ECC.6.3.2 as applicable. In the case of a test on a **Generating Unit** within a **CCGT Module** the instruction need not identify the particular **CCGT Unit** within the **CCGT Module** which is to be tested, but instead may specify that a test is to be carried out on one of the **CCGT Units** within the **CCGT Module**.

OC5.5.1.3 (a) The instruction referred to in OC5.5.1.1 may only be issued if the relevant **User** has submitted **Export and Import Limits** which notify that the relevant **BM Unit** is available in respect of the **Operational Day** current at the time at which the instruction is issued. The relevant **User** shall then be obliged to submit **Export and Import Limits** with a magnitude greater than zero for that **BM Unit** in respect of the time and the duration that the test is instructed to be carried out, unless that **BM Unit** would not then be available by reason of forced outage or **Planned Outage** expected prior to this instruction.

(b) In the case of a **CCGT Module** the **Export and Import Limits** data must relate to the same **CCGT Units** which were included in respect of the **Operational Day** current at the time at which the instruction referred to in OC5.5.1.1 is issued and must include, in relation to each of the **CCGT Units** within the **CCGT Module**, details of the various data set out in BC1.A.1.3 and BC1.A.1.5, which parameters **The Company** will utilise in instructing in accordance with this **OC5** in issuing **Bid-Offer Acceptances**. The parameters shall reasonably reflect the true operating characteristics of each **CCGT Unit**.

(c) The test referred to in OC5.5.1.1 will be initiated by the issue of instructions, which may be accompanied by a **Bid-Offer Acceptance**, under **BC2** (in accordance with the **Export and Import Limits** and **Dynamic Parameters** which have been submitted for the day on which the test was called, or in the case of a **CCGT Unit**, in accordance with the parameters submitted under OC5.5.1.3(b)). The instructions in respect of a **CCGT Unit** within a **CCGT Module** will be in respect of the **CCGT Unit**, as provided in BC2.

OC5.5.2 User Request ~~For~~for Testing

OC5.5.2.1 Where a **GB Code User** undertakes a test to demonstrate compliance with the **Grid Code** and **Bilateral Agreement** in accordance with CP.6 or CP.7 or CP.8 (other than a failure between **The Company** and a **GB Code User** to agree in CP.8.1 where OC5.5.1.1 applies) the **GB Code User** shall request permission to test using the process laid out in OC7.5.

OC5.5.2.2 Where an **EU Code User** undertakes a test to demonstrate compliance with the **Grid Code** and **Bilateral Agreement** in accordance with ECP.6.1, ECP.6.2, ECP.6.3 or ECP.7 or ECP.8 (other than a failure between **The Company** and a **EU Code User** to agree in ECP.8.1 where OC5.5.1.1 applies) the **EU Code User** shall request permission to test using the process laid out in OC7.5.

OC5.5.3 Conduct ~~Of~~of Test

OC5.5.3.1 The performance of the **BM Unit** will be recorded at **Transmission Control Centres** notified by **The Company** with monitoring at site when necessary, from voltage and current signals provided by the **User** for each **BM Unit** under CC.6.6.1 or ECC.6.6.1 as applicable.

OC5.5.3.2 If monitoring at site is undertaken, the performance of the **BM Unit** will be recorded on a suitable recorder (with measurements, in the case of a **Synchronous Generating Unit** (which could be part of a **Synchronous Power Generating Module**), taken on the **Generating Unit** stator terminals / on the **LV** side of the generator transformer) or in the case of a **Non-Synchronous Generating Unit** (excluding **Power Park Units**), **Power Generating Module**, **Power Park Module** or **HVDC Equipment** or **DC Converter** at the point of connection (including where the **OTSUA** is operational prior to the **OTSUA Transfer Time**, the **Transmission Interface Point**) in the relevant **User's Control Room**, in the presence of a reasonable number of representatives appointed and authorised by **The Company**. If **The Company** or the **User** requests, monitoring at site will include measurement of the parameters set out in OC5.A.1.2 or OC5.A.1.3 or ECP.A4.2 or ECP.A.4.3 as appropriate.

OC5.5.3.3 The **User** is responsible for carrying out the test on their **Plant** and retains the responsibility for the safety of personnel and ~~plant~~their **Plant** during the test.

OC5.5.4 Test ~~And~~and Monitoring Assessment

The criteria must be read in conjunction with the full text under the Grid Code reference. The **BM Unit**, **Power Generating Module**, **CCGT Module**, **Power Park Module** or **Generating Unit** (excluding **Power Park Units**), **HVDC Equipment** and **DC Converters** and **OTSUA** will pass the test the criteria below are met:

| ~~Parameter~~Capability to be Tested | | Criteria against which the test results will be assessed by The Company. |
|---|---|---|
| Voltage Quality | Harmonic Content | CC.6.1.5(a) or ECC.6.1.5(a) Measured harmonic emissions do not exceed the limits specified in the **Bilateral Agreement** or where no such limits are specified, the relevant planning level specified in **Engineering Recommendation G5**. |
| | Phase Unbalance | CC.6.1.5(b) or ECC.6.1.5(b), The measured maximum **Phase (Voltage) Unbalance** on the **National Electricity Transmission System** should remain, in England and Wales, below 1% and, in Scotland, below 2% and **Offshore** will be defined in relevant **Bilateral Agreement**.<br><br>CC.6.1.6 or ECC.6.1.6 In England and Wales, measured infrequent short duration peaks in **Phase (Voltage) Unbalance** should not exceed the maximum value stated in the **Bilateral Agreement**. |
| | Rapid Voltage Change | CC.6.1.7(a) or ECC.6.1.7(a) The measured Rapid Voltage Change at the **Point of Common Coupling** shall not exceed the Planning Levels specified in CC.6.1.7(a) or ECC 6.1.7.(i) |
| | Flicker Severity | CC.6.1.7(j) or ECC.6.1.7(j) The measured Flicker Severity at the **Point of Common Coupling** shall not exceed the limits specified in the table of CC.6.1.7(j) or ECC 6.1.7(j). |
| | Voltage Fluctuation | CC.6.1.8 or ECC.6.1.8 **Offshore**, measured voltage fluctuations at the **Point of Common Coupling** shall not exceed the limits set out in the **Bilateral Agreement**. |
| Fault Clearance | Fault Clearance Times | CC.6.2.2.2.2(a), CC.6.2.3.1.1(a), ECC.6.2.2.2.2(a), ECC.6.2.3.1.1(a), **Bilateral Agreement** |
| | **Back Up Protection** | CC.6.2.2.2.2(b), CC.6.2.3.1.1(b), ECC.6.2.2.2.2(a), ECC.6.2.3.1.1(a), **Bilateral Agreement** |
| | Circuit Breaker Fail **Protection** | CC.6.2.2.2.2(c), CC.6.2.3.1.1(c), ECC.6.2.2.2.2(c), ECC.6.2.3.1.1(c) |

| ~~Parameter~~Capability to be Tested | | Criteria against which the test results will be assessed by The Company. |
|---|---|---|
| | Reactive Capability | CC.6.3.2 or ECC.6.3.2 (and in the case of CC.6.3.2(e)(iii) and ECC.6.3.2.5 and ECC.6.3.2.6, the **Bilateral Agreement**), CC.6.3.4, **Ancillary Services Agreement**.<br><br>For a test initiated under OC.5.5.1.1 the **Power Generating Module**, **Generating Unit**, **HVDC Equipment**, **DC Converter** or **Power Park Module** or (prior to the **OTSUA Transfer Time**) **OTSUA** will pass the test if it is within ±5% of the reactive capability registered with **The Company** under **OC2**. The duration of the test will be for a period of up to 60 minutes during which period the **System** voltage at the **Grid Entry Point** for the relevant **Power Generating Module**, **Generating Unit**, **HVDC Equipment**, **DC Converter** or **Power Park Module** or **Interface Point** in the case of **OTSUA** will be maintained by the **Generator** or **HVDC System Owner**, **DC Converter Station** owner at the voltage specified pursuant to BC2.8 by adjustment of **Reactive Power** on the remaining **Power Generating Module**, **Generating Unit**, **HVDC Equipment**, **DC Converter** or **Power Park Modules** or **OTSUA**, if necessary. Any test performed in respect of an **Embedded Medium Power Station** not subject to a **Bilateral Agreement** or, an **Embedded DC Converter Station** or **Embedded HVDC System** not subject to a **Bilateral Agreement** shall be as confirmed pursuant to OC5.8.3.<br><br>Measurements of the **Reactive Power** output under steady state conditions should be consistent with Grid Code requirements i.e. fully available within the voltage range ±5% at all voltages. |
| Governor / Frequency Control | Primary Secondary and High **Frequency** Response | **Ancillary Services Agreement**, CC.6.3.7 and where applicable CC.A.3 or ECC.6.3.7 and where applicable ECC.A.3.<br><br>For a test initiated under OC.5.5.1.1 the measured response in MW/Hz is within ±5% of the level of response specified in the **Ancillary Services Agreement** for that **Genset**. |
| | Stability with Voltage | CC.6.3.4 or ECC.6.3.4 |
| | Governor / Load / **Frequency** Controller **System** Compliance | CC.6.3.6(a), CC.6.3.7, CC.6.3.9, CC8.1, where applicable CC.A.3, BC3.5, BC3.6, BC3.7 or ECC.6.3.6, ECC.6.3.7, ECC.6.3.9, ECC8.1, where applicable ECC.A.3, BC3.5, BC3.6, BC3.7 |
| | Output at Reduced **System Frequency** | CC.6.3.3 or ECC.6.3.3 - For variations in **System Frequency** exceeding 0.1Hz within a period of less than 10 seconds, the **Active Power** output is within ±0.2% of the requirements of CC.6.3.3 or ECC.6.3.3 when monitored at prevailing external air temperatures of up to 25ºC., BC3.5.1 |

| ~~Parameter~~Capability to be Tested | | Criteria against which the test results will be assessed by The Company. |
|---|---|---|
| | **Fast Start** | **Ancillary Services Agreement** requirements |
| | **~~Black Start~~System Restoration** | OC5.7 |
| | Excitation/Voltage **Control System** | CC.6.3.6(b), CC.6.3.8, CC.A.6 or CC.A.7 as applicable, BC2.11.2, and the **Bilateral Agreement** or ECC.6.3.6, ECC.6.3.8, ECC.A.6 or ECC.A.7 or ECC.A.8 and the **Bilateral Agreement** as applicable |
| | Fault Ride Through and Fast Fault Current Injection | CC.6.3.15, CC.A.4.A or CC.A.4.B as applicable or ECC.6.3.15, ECC.6.3.16, ECC.A.4 as applicable |
| Dynamic Parameters | **Export and Import Limits** and **Dynamic Parameters** | BC2<br>The **Export and Import Limits** and **Dynamic Parameters** under test are within 2½% of the declared value being tested. |
| | Synchronisation time | BC2.5.2.3<br>**Synchronisation** takes place within ±5 minutes of the time it should have achieved **Synchronisation**. |
| | Run-up rates | BC2<br>Achieves the instructed output and, where applicable, the first and/or second intermediate breakpoints, each within ±3 minutes of the time it should have reached such output and breakpoints from **Synchronisation** (or break point, as the case may be), calculated from the run-up rates in its **Dynamic Parameters**. |
| | Run-down rates | BC2<br>Achieves the instructed output and, where applicable, the first and/or second intermediate breakpoints, each within ±5 minutes of the time it should have reached such output and breakpoints from **Synchronisation** (or break point, as the case may be), calculated from the run-up rates in its **Dynamic Parameters**. |
| | Demand Response | DRSC.11.7<br>**Non-Embedded Customers** and **BM Participants** who are also **Demand Response Providers** shall execute a demand modification test when requested as per DRSC.11.7 to ensure the requirements of the **Ancillary Services** agreement and **Demand Response Services Code** are satisfied. |

OC5.5.4.1 The duration of the **Dynamic Parameter** tests in the above table will be consistent with and sufficient to measure the relevant expected input or output derived from the **Final Physical Notification Data** and **Bid-Offer Acceptances** issued under **BC2** which are still in dispute following the procedure in OC5.4.2.

OC5.5.4.2 Due account will be taken of any conditions on the **System** which may affect the results of the test. The relevant **User** must, if requested, demonstrate, to **The Company's** reasonable satisfaction, the reliability of the suitable recorders, disclosing calibration records to the extent appropriate.

OC5.5.5 Test Failure / Re-test

OC5.5.5.1 If the **BM Unit**, **Power Generating Module**, **CCGT Module**, **Power Park Module**, **OTSUA**, or **Generating Unit** (excluding **Power Park Units**), **HVDC Equipment** or **DC Converter Station** concerned fails to pass the test instructed by **The Company** under OC5.5.1.1, the **User** must provide **The Company** with a written report specifying in reasonable detail the reasons for any failure of the test so far as they are then known to the **User** after due and careful enquiry. This must be provided within five **Business Days** of the test.

OC5.5.5.2 If in **The Company's** reasonable opinion, the failure to pass the test relates to compliance with the **CC** or **ECC** as applicable, then **The Company** may invoke the process detailed in CP.8.2 to CP.9, or ECP.8.2 to ECP.9

OC5.5.5.3 If a dispute arises relating to the failure, **The Company** and the relevant **User** shall seek to resolve the dispute by discussion, and, if they fail to reach agreement, the **User** may by notice require **The Company** to carry out a re-test on 48 hours' notice which shall be carried out following the procedure set out in OC5.5.3 and OC5.5.4 and subject as provided in OC5.5.1.3, as if **The Company** had issued an instruction at the time of notice from the **User**.

OC5.5.6 Dispute Following Re-Test

If the **BM Unit**, **Power Generating Module**, **CCGT Module**, **Power Park Module**, **OTSUA**, or **Generating Unit** (excluding **Power Park Units**), **HVDC Equipment** or **DC Converter** in **The Company's** view fails to pass the re-test and a dispute arises on that re-test, either party may use the **Disputes Resolution Procedure** for a ruling in relation to the dispute, which ruling shall be binding.

OC5.6 DISPUTE RESOLUTION

OC5.6.1 If following the procedure set out in OC5.5 it is accepted that the **BM Unit**, **Power Generating Module, CCGT Module**, **Power Park Module**, **OTSUA** (prior to the **OTSUA Transfer Time**) or **Generating Unit** (excluding **Power Park Units**) ), **HVDC Equipment** or **DC Converter** has failed the test or re-test (as applicable), the **User** shall within 14 days, or such longer period as **The Company** may reasonably agree, following such failure, submit in writing to **The Company** for approval the date and time by which the **User** shall have brought the **BM Unit** concerned to a condition where it complies with the relevant requirement. **The Company** will not unreasonably withhold or delay its approval of the **User's** proposed date and time submitted. Should **The Company** not approve the **User's** proposed date or time (or any revised proposal), the **User** should amend such proposal having regard to any comments **The Company** may have made and re-submit it for approval.

OC5.6.2 If a **BM Unit** fails the test, the **User** shall submit revised **Export and Import Limits** and/or **Dynamic Parameters**, or in the case of a **BM Unit** comprising a **Generating Unit**, **Power Generating Module, CCGT Module**, **HVDC Equipment**, **DC Converter**, **OTSUA** (prior to the **OTSUA Transfer Time**) or **Power Park Module**, the **User** may amend, with **The Company's** approval, the relevant registered parameters of that **Generating Unit**, **Power Generating Module**, **CCGT Module**, **HVDC Equipment**, **DC Converter**, **OTSUA** (prior to the **OTSUA Transfer Time**) or **Power Park Module**, as the case may be, relating to the criteria, for the period of time until the **BM Unit** can achieve the parameters previously registered, as demonstrated in a re-test.

OC5.6.3 Once the **User** has indicated to **The Company** the date and time that the **BM Unit**, **Power Generating Module**, **CCGT Module**, **Power Park Module**, **Generating Unit** (excluding **Power Park Units**) or **OTSUA** (prior to the **OTSUA Transfer Time**), **HVDC Equipment** or **DC Converter Station** can achieve the parameters previously registered or submitted, **The Company** shall either accept this information or require the **User** to demonstrate the restoration of the capability by means of a repetition of the test referred to in OC5.5.3 by an instruction requiring the **User** on 48 hours notice to carry out such a test. The provisions of this OC5.6 will apply to such further test.

OC5.7 ~~BLACK START~~SYSTEM RESTORATION TESTING

OC5.7.1 General

As provided for in OC9.1.1 there are two ways in which the **Total System** (or disconnected part of the **Total System** in the case of a **Partial Shutdown**) can be re-established. These being a top-down approach using **Local Joint Restoration Plans** or a bottom-up approach using **Distribution Restoration Zone Plans** which are necessary in order to satisfy the requirements of the **Electricity System Restoration Standard**.

To help achieve this objective, it is essential that **Restoration Contractors** test their **Plant** and **Apparatus** at regular intervals to demonstrate that there is a high level of confidence that they will be able to satisfy the requirements of the Grid Code and their **Anchor Restoration Contracts** or **Top Up Restoration Contracts**.

(a) **The Company** and/or relevant **Network Operator** shall require a ~~**Black Start Service Provider**~~**Restoration Contractor** to carry out ~~a **Black Start Test**~~testing in order to demonstrate that ~~a **Black Start Station** or **Black Start HVDC System**~~its **Plant** and **Apparatus** has ~~a **Black Start Capability**~~the appropriate capability.

(i) In the case of ~~a **Generator**~~an **Anchor Generating Unit**, **The Company** and/or relevant **Network Operator** shall require ~~a **Generator** with a **Black Start Station**~~the **Restoration Contractor** to carry out a test (either a ~~"**Black Start**~~**Anchor Generating Unit Test**~~"~~ or a ~~**Black Start**~~**Anchor Power Station Test**~~"))~~ in order to demonstrate that ~~a **Black Start Station**~~an **Anchor Plant** has ~~a **Black Start**~~**Anchor Plant Capability**.

(ii) In the case of either an **Anchor HVDC System** ~~**Owner**~~ or **Anchor DC Converter** ~~**Station Owner**~~, **The Company** or relevant **Network Operator** shall require the **Restoration Contractor** to carry out a test (an **Anchor HVDC System** ~~**Owner**~~**Test** or **Anchor DC Converter** ~~**Station Owner** with a **Black Start HVDC System** to carry out a test (a "**Black Start HVDC Test**") on a **HVDC System** or **DC Converter**,~~), in order to demonstrate that ~~a **Black Start**~~an **Anchor HVDC System** or **Anchor DC Converter** has ~~a **Black Start**~~**Anchor Plant Capability**.

(iii) In the case of an **EU Generator** with an **Anchor Plant Capability** who is also a **Restoration Contractor**, **The Company** and/or relevant **Network Operator** may also require ~~a **Generator** with a **Black Start Station**~~the **Restoration Contractor** to carry out a test (a **Quick Resynchronisation Unit Test**) in order to demonstrate that ~~a **Black Start**~~its **Anchor Power Station** has ~~a~~ **Quick Re-Synchronisation Capability**.

(iv) In the case of a **Top Up Restoration Plant**, **The Company** and/or relevant **Network Operator** shall require the **Top Up Restoration Contractor** to demonstrate that the requirements of their **Top Up Restoration Contract** can be fulfilled.

(b) Where **The Company** and/or relevant **Network Operator** requires a ~~**Black Start Service Provider**~~**Restoration Contractor** to undertake testing, the following requirements shall apply:-

(i) ~~Where **The Company** requires a **Generator** with a **Black Start Station** to carry out a **Black Start**~~Each **Anchor Generating Unit** within an **Anchor Power Station** shall be required to undertake an **Anchor Generating Unit Test**~~, on each **Genset,** which has **Black Start Capability**, within such a **Black Start Station**, the **Generator** shall~~

~~execute such a test~~ at least once every three years. **The Company** and/or relevant **Network Operator** shall not require the ~~**Black Start**~~**Anchor Generating Unit Test** ~~**Unit**~~ to be carried out on more than one ~~**Genset**~~**Generating Unit** at that ~~**Black Start**~~**Anchor Power Station** at the same time, and would not, in the absence of exceptional circumstances, expect any of the other ~~**Gensets**~~**Generating Units** at the ~~**Black Start**~~**Anchor Power Station** to be directly affected by the ~~**Black Start**~~**Anchor Generating Unit Test**.

(ii) **The Company** and/or relevant **Network Operator** may occasionally require the **Anchor Generator** to carry out ~~a **Black Start Station Test**~~an **Anchor Power StationTest** at any time (but will not require a ~~**Black Start**~~**Anchor Power Station Test** to be carried out more than once in every three calendar years in respect of any particular ~~**Genset**~~**Generating Unit** unless it can justify on reasonable grounds the necessity for further tests or unless the further test is a re-test). If successful, this ~~**Black Start**~~ **Anchor Power Station Test** shall count as a successful ~~**Black Start**~~**Anchor Generating Unit Test** for the ~~**Genset**~~ **Generating Unit** used in the test.

(iii) **The Company** ~~may~~and/or relevant **Network Operator** shall require the **Anchor HVDC System Owner** or **Anchor DC Converter** ~~**Station**~~ **Owner** to carry out ~~a **Black Start**~~an **Anchor HVDC System Test** at least once every three years which could be at any time (but ~~will not require~~ such a test will not be required to be carried out more than once in every three calendar years unless it can justify on reasonable grounds the necessity for further tests or unless the further test is a re-test).

(iv) The **Company** and/or relevant **Network Operator** may ~~occasionally~~ require the **EU Generator** to carry out a **Quick Re-Synchronisation Test** at any time, but this will generally only be required where the **EU Generator** has made a change to its **Plant** and **Apparatus** which has an impact on its **Houseload Operation** or after two unsuccessful tripping **Events** in the operational environment. The timing of the test shall be agreed by the relevant parties.

~~The above tests will be deemed a success where starting from **Shutdown** is achieved within a time frame specified by **The Company** and which may be agreed in the **Black Start Contract**.~~

~~(iv)~~(v) ~~c) **The Company** may~~ **The Company** and/or relevant **Network Operator** shall require ~~a **Generator**~~the **Restoration Contractor** to carry out ~~a **Black Start Unit Test**~~ testing on its **Top Up Restoration Plant** at least once every three years which could be at any time (but such a test will not ~~require a **Black Start Unit Test**~~be required to be carried out more than once in ~~each~~every three calendar ~~year in respect of any particular **Genset**~~years unless it can justify on reasonable grounds the necessity for further tests or unless the further test is a ~~re-test).~~ retest).

~~(d)~~ The above tests will be deemed a success where starting from **Shutdown** is achieved within a time frame specified by **The Company** and/or relevant **Network Operator** and which will be agreed in the **Restoration Contract**.

(c) When **The Company** and/or relevant **Network Operator** wishes a ~~**Black Start Service Provider**~~**Restoration Contractor** to carry out ~~a **Black Start**~~either an **Anchor Generating Unit Test**, an **Anchor Power Station Test**, an **Anchor System HVDC Test**, **Quick Re-Synchronisation Test** or **Top Up Restoration Test**, it shall notify the relevant ~~**Black Start Service Provider**~~**Restoration Contractor** at least 7 days prior to the time of the ~~**Black Start Test**~~ test with details of the proposed ~~**Black Start Test**.~~ test.

OC5.7.2 ~~Procedure~~Procedures for ~~a Black Start Test~~Restoration Service Tests

~~The following procedure will, so far as practicable, be carried out in the following sequence for **Black Start Tests**:~~

OC5.7.2.1 ~~Black Start Unit Tests~~Anchor Generating Unit Tests

(a) The relevant **Generating Unit** shall be **Synchronised** and **Loaded**~~;~~.

(b) All the **Auxiliary** ~~**Gas Turbines** and/or **Auxiliary Diesel Engines**~~**Energy Supplies** in the ~~**Black Start**~~**Anchor Power Station** in which that **Generating Unit** is situated, shall be **Shutdown**.

(c) The **Generating Unit** shall be **De-Loaded** and **De-Synchronised** and all alternating current electrical supplies to its **Auxiliaries** shall be disconnected.

(d) The **Auxiliary** ~~**Gas Turbine(s)** or **Auxiliary Diesel Engine(s)**~~**Energy Supplies** to the relevant **Generating Unit** shall be started, and shall re-energise the **Unit Board** of the relevant **Generating Unit**.

(e) The **Auxiliaries** of the relevant **Generating Unit** shall be fed by the **Auxiliary** ~~**Gas Turbine(s)** or **Auxiliary Diesel Engine(s)**,~~**Energy Supplies**, via the **Unit Board**, to enable the relevant **Generating Unit** to return to **Synchronous Speed**.

(f) The relevant **Generating Unit** shall be **Synchronised** to the **System** but not **Loaded**, unless ~~the appropriate~~a subsequent instruction ~~has been given~~is issued by **The Company** or relevant **Network Operator** under **BC2** ~~which would also be in accordance with the requirements of the **Black Start Contract**~~.

~~(g~~(g)Where required by **The Company** and/or relevant **Network Operator** and technically feasible, the test may be arranged such that the relevant **Generating Unit** shall energise the dead sections of the **System** as required in the relevant **Restoration Plan**. As part of these tests, **The Company** (in the case of an **Local Joint Restoration Plan**) or **Network Operator** (in the case of a **Distribution Restoration Zone Plan**) may require the **Anchor Generator** to undertake a:

a) A dead line charge test only; or
b) A dead line charge and a remote synchronisation test.

A dead line charge test would require the steps detailed in (i) and (ii) below to be undertaken. A remote synchronisation test would require the steps detailed in (i) – (iii) below to be undertaken.

i) **Start-Up** of one or more of the **Generating Units** at the **Anchor Power Station** under normal operational conditions;

ii) Re-energisation of a dead test section of the **Total System** as defined in the **Local Joint Restoration Plan** or **Distribution Restoration Zone Plan** as appropriate; and

iii) Demonstration of the ability to synchronise to a section of the **Total System** at a location remote from the **Anchor Power Station's Grid Entry Point** or **User System Entry Point** (as the case may be).

A dead line charge test is to demonstrate the **Anchor Generating Unit's** ability to charge a pre-defined dead part of the **Total System** and its ability to control the voltage on that part of the **Total System**.

A remote synchronisation test is used to demonstrate the successful operation of a **Transmission Licensee's** or **Network Operator's** system synchronising facilities across individual circuit breakers which are either i) a necessary part of a **Local Joint Restoration Plan** or ii) defined in a **Distribution Restoration Zone Plan**.

When planning a dead line charge test, consideration shall be given to the effect the test will have on **Customers** supplied from the part of the **Total System** that needs to be de-energised, including whether their supplies would need to be interrupted to undertake the test. Where possible, tests should be conducted to avoid interruption to **Customer** supplies however where this is not possible, alternative tests or computer simulation exercises can be agreed between **The Company**, **Relevant Transmission Licensee** (as applicable), the **Network Operator** (as applicable) and the **Restoration Contractor**. Where it is identified that routine testing cannot be undertaken which is critical to restoration of the **Total System**, from a strategic perspective, as a result of interruption to **Customer** supplies, consideration should be given to **System** reconfiguration where such a change is technically and economically viable which would be agreed between **The Company**, **Relevant Transmission Licnesee** and **Network Operator** (as appropriate).

(h) In respect of **EU Generators**, the above tests defined in OC5.7.2.1(a) – (~~e~~g) shall be ~~in accordance with~~assessed against the requirements of ECC.6.3.5.3.

(i) **The Company** and/or **Network Operator** shall agree with **Anchor Restoration Contractor** when the above tests have been completed.

OC5.7.2.2 ~~Black Start~~Anchor Power Station Test

(a) All **Generating Units** at the ~~**Black Start**~~**Anchor Power** **Station**, other than the **Generating Unit** on which the ~~**Black Start**~~**Anchor Plant** **Test** is to be carried out, and all the **Auxiliary** ~~**Gas Turbines** and/or **Auxiliary Diesel Engines** at the **Black Start**~~**Energy Supplies** at the **Anchor Power** **Station**, shall be **Shutdown**.

(b) The relevant **Generating Unit** shall be **Synchronised** and **Loaded**.

(c) The relevant **Generating Unit** shall be **De-Loaded** and **De-Synchronised**.

(d) All external alternating current electrical supplies to the **Unit Board** of the relevant **Generating Unit**, and to the **Station Board** of the relevant ~~**Black Start**~~**Anchor Power** **Station**, shall be disconnected.

(e) ~~An~~ **Auxiliary** ~~**Gas Turbine** or **Auxiliary Diesel Engine**~~**Energy Supplies** at the ~~**Black Start**~~**Anchor Power** **Station** shall be started, and shall re-energise either directly, or via the **Station Board**~~,~~ or the **Unit Board** of the relevant **Generating Unit**.

(f) The provisions of OC5.7.2.1 (e) ~~and (f)~~to (i) in respect of the **Generating Units** in the **Anchor Power Station** shall thereafter be followed.

(g) In respect of **EU Generators**, the above tests defined in OC5.7.2.2(a) – (~~e~~f) shall be ~~in accordance with~~assessed against the requirements of ECC.6.3.5.3.

OC5.7.2.3 ~~Procedure for a **Black Start**~~Anchor HVDC Test or Anchor DC Converter Test

a) The **HVDC System** or **DC Converter** ~~**Station**~~ shall demonstrate its technical capability to energise the busbar of the ~~de-energised~~disconnected AC substation to which it is connected, within the **GB Synchronous Area** within a timeframe specified by **The Company**~~.~~ and/or relevant **Network Operator** in the **Anchor Restoration Contract** or **Top Up Restoration Contract**. In the case of **HVDC Systems** this shall be in accordance with the requirements of ECC.6.3.5.4. As part of this test, all **Auxiliaries** are required to be derived from within the **HVDC System** or **DC Converter Station**~~.~~;

b) The test shall be carried out while the **HVDC System** or **DC Converter Station** starts from **Shutdown**;

c) The test shall be deemed ~~passed, provided that~~to have been successfully completed when the following conditions are cumulatively fulfilled:

i) The **HVDC System Owner** has demonstrated its **HVDC System** or **DC Converter Station** is able to energise the busbar of the isolated AC-substation to which it is connected within the **GB Synchronous Area**.

ii) The **HVDC System** or **DC Converter Station** can achieve a stable operating point at an agreed capacity as agreed with **The Company**~~.~~ and/or relevant **Network Operator**. The relevant **HVDC System** or **DC Converter Station** can be connected to the **Total System** but not **Loaded**, unless appropriate instructions are given by **The Company** under **BC2** which would also be in accordance with the requirements of the ~~**Black Start**~~**Anchor Restoration Contract**.

iii) In respect of **HVDC Systems** and **Remote End HVDC Converter Stations**, the above tests defined in OC5.7.2.3(a) – (c) shall be ~~in accordance with~~assessed against the requirements of~~,~~ ECC.6.1.2, ECC.6.1.4, ECC.6.2.2.9.4 and ECC.6.3.5.4.

iv) In respect of **DC Converter Stations**, the above tests defined in OC5.7.2.3(a) – (c) shall be ~~in accordance with~~assessed against the requirements of, CC.6.1.2, CC.6.1.3 and CC.6.1.4.

(d) As part of these tests, **The Company** (in the case of an **Local Joint Restoration Plan**) or **Network Operator** (in the case of a **Distribution Restoration Zone Plan**) may require the **Anchor HVDC System Owner** or **Anchor DC Converter Owner** to undertake a:

a) A dead line charge test only; or
b) A dead line charge and a remote synchronisation test.

A dead line charge test would require the steps detailed in OC5.7.2.3(d) (i) and (ii) to be undertaken. A remote synchronisation test would require the steps detailed in OC5.7.2.3(d) (i) – (iii) to be undertaken.

i) **Start-Up** of the **HVDC System** or **DC Converter Station** under normal operational conditions.

ii) Re-energisation of a dead test section of the **Total System** as defined in the **Local Joint Restoration Plan** or **Distribution Restoraion Zone Plan** as appropriate.

iii) Demonstration of the ability to synchronise to a section of the **Total System** at a location remote from the **HVDC System** or **DC Converter Station Grid Entry Point** or **User System Entry Point** (as the case may be).

A dead line charge test is to demonstrate the **HVDC System** or **DC Converter Stations** ability to charge a pre-defined dead part of the **Total System** and its ability to control the voltage on that part.

A remote synchronisation test is used to demonstrate the successful operation of a **Transmission Licensee's** or **Network Operator's** system synchronising facilities across individual circuit breakers which are either necessary part of a **Local Joint Restoration Plan** or defined in a **Distribution Restoration Zone Plan**.

When planning a dead line charge test, consideration shall be given to the effect the test will have on **Customers** supplied from the part of the **Total System** that needs to be de-energised, including whether their supplies would need to be interrupted to undertake the test. Where possible, tests should be conducted to avoid interruption to **Customer** supplies however where this is not possible, alternative tests or computer simulation exercises can be agreed between **The Company**, **Relevant Transmission Licensee** (as applicable), **Network Operator** (as applicable) and **Restoration Contractor**. Where it is identified that routine testing cannot be undertaken which is critical to restoration of the **Total System**, from a strategic perspective, as a result of interruption to **Customer** supplies, consideration should be given to **System** reconfiguration where such a change is technically and economically viable which would be agreed between the **The Company**, **Relevant Transmission Licnesee** and **Network Operator** (as appropriate).

OC5.7.2.4 ~~All **Black Start**~~ Top Up Restoration Plant Tests

**Top Up Restoration Contractors** have contracts with **The Company** and where appropriate **Network Operators**, to provide a service in respect of their **Top Up Plant** to contribute to a **Local Joint Restoration Plan** or **Distribution Restoration Zone Plan**. As provided for in OC9.4.7.7.4 and OC9.4.7.8.4, **Top Up Restoration Contractors** will be generally be instructed to prepare their **Top Up Restoration Plant** immediately after instructions are issued to **Restoration Contractors** in respect of their **Anchor Plant** such that a **Top Up Restoration Contractor** can deliver the service they have agreed to provide, without delay, upon restoration of external site supplies. The purpose of these tests is to demonstrate that **Top Up Restoration Plant** has the capability in accordance with the requirements of the **Top Up Restoration Contract**.

(a) Prior to the test, the relevant **Transmission Licensee** and/or **Network Operator** shall reconfigure its **System** as necessary to enable the test of the relevant **Plant** and **Apparatus** to be completed whilst having due regard for the safety of **Plant** and **Apparatus** and personnel on or adjacent to its **System**, and for the public.

(b) The relevant **Plant** and/or **Apparatus** shall be operating normally, i.e. in the operational state it is anticipated to be in if a **Shutdown** were to occur.

(c) All the **Auxiliary Energy Supplies** which relate to the relevant **Plant** and/or **Apparatus** shall be **Shutdown**.

(d) The **Plant** and/or **Apparatus** shall be de-loaded, **De-Synchronised** and **Shutdown** as appropriate and all alternating current electrical supplies to its **Auxiliaries** shall be disconnected.

(e) **Auxiliary Energy Supplies** at the **Top Up Plant** shall be started, and shall re-energise either directly, or via the **Station Board** or the **Unit Board** of the relevant **Plant**.

(f) With the **Auxiliaries** available the relevant **Plant** and/or **Apparatus** should be in a position to return to a condition when it is ready to be reconnected and/or **Synchronised** to the **System**.

(g) Relevant **Top Up Restoration Plant** shall be **Synchronised** to the **System** and shall be **Loaded** with **Active Power** and/or **Reactive Power** as agreed with **The Company** and/or the **Network Operator**, unless an overriding instruction has been given directly by **The Company** or from **The Company** to the **Network Operator** under **BC2**.

(h) **The Company** and/or **Network Operator** shall agree with the **Top Up Restoration Contractor** when the test has been completed.

OC5.7.2.5 Quick Re-synchronisation Unit Test

(a) The relevant **Generating Unit** shall be **Synchronised** and **Loaded**;

(b) All the **Auxiliary Energy Supplies** in the **Anchor Power Station** in which that **Generating Unit** is situated, shall be **Shutdown**;

(c) The **Generating Unit** shall tripped to house load;

(d) The relevant **Generating Unit** shall be **Synchronised** to the **System** but not **Loaded**, unless the appropriate instruction has been given by **The Company** and/or **relevant Network Operator** under **BC2** which would also be in accordance with the requirements of the **Anchor Restoration Contract**;

In respect of **EU Generators**, the above tests defined in OC5.7.2.5(a) – (c) shall be assessed against the requirements of ECC.6.3.5.6.

OC5.7.2.6 Distribution Restoration Zone Control System Tests

Where a **Network Operator** uses a **Distribution Restoration Zone Control System** as part of the implementation of a **Distribution Restoration Zone Plan**, the **Network Operator** shall undertake tests or otherwise demonstrate the correct functioning of the **Distribution Restoration Zone Control System**. The tests shall be in accordance with the requirements of the **Distribution Restoration Zone Control System** standard as specified in the **Electrical Standard** listed in the annex to the **General Conditions**

OC5.7.2.7 General Testing Arrangments

All the above tests listed in OC5.7.2.1 to OC5.7.2.6, shall be carried out at the time ~~specified~~agreed by **The Company** and/or relevant **Network Operator** in the notice given under OC5.7.1 and shall be undertaken in the presence of a reasonable number of representatives appointed and authorised by **The Company** and/or relevant **Network Operator**, who shall be given access to all information relevant to the ~~**Black Start Test**~~**Test**. In the case of a **Restoration Contractor** who wishes to undertake their own tests independently of a test requested by **The Company** and/or **Relevant Network Operator**, then they shall be undertaken in accordance with OC7.5.

OC5.7.~~2.5~~3. Failure of ~~a Black Start Test~~Restoration Service Tests

~~A **Black Start Station** or **Black Start HVDC System**~~ OC5.7.3.1 An **Anchor Restotion Contractor** shall fail ~~a **Black Start**~~an **Anchor Plant** **Test** if ~~the **Black Start Test** shows~~it fails to enerigse parts of the **System** and to provide the **Active Power** or **Reactive Power** output in accordance with that ~~it does not have a **Black Start Capability** (ie. if the relevant **Generating Unit** or **HVDC System** or **DC Converter**~~specified in the **Anchor Restoration Contract**.

OC5.7.3.2 A **Top Up Restoration Contractor** shall fail a **Top Up Restoration Plant Test** if it fails to be **Synchronised** to the **System** ~~within two hours of the **Auxiliary Gas Turbine(s)** or **Auxiliary Diesel Engine(s)** being required to start unless this is part of a **Local Joint Restoration Plan** where~~and to provide the ~~times will be adjusted accordingly).~~**Active Power** or **Reactive Power** output in accordance with that specified in the **Top Up Restoration Contract**.

OC5.7.~~2.6~~3.4 If a ~~**Black Start Station** or **Black Start HVDC System**~~**Restoration Contractor's Plant** fails to pass a ~~**Black Start**~~ **Restoration Service** **Test** the ~~**Black Start Service Provider**~~**Restoration Contractor** must provide **The Company** and/or relevant **Network Operator** with a written report specifying in reasonable detail the reasons for any failure of the test so far as they are then known to the ~~**Black Start Service Provider**~~**Restoration Contractor** after due and careful enquiry. This must be provided within five **Business Days** of the test. If a dispute arises relating to the failure, **The Company** and~~-~~/or relevant **Network Operator** and the relevant ~~**Black Start Service Provider**~~**Restoration Contractor** shall seek to resolve the dispute by discussion~~, and if they fail to reach agreement,~~. To aid resolution of the ~~**Black Start Service Provider**~~dispute the **Restoration Contractor** may ~~require~~request **The Company** ~~to carry out~~and/or relevant **Network Operator** to help facilitate a further ~~**Black Start**~~ **Restoration Service** **Test** ~~on~~with 48 hours notice which shall be carried out following the applicable procedure set out in OC5.7.2.1 ~~or~~to OC5.7.2.~~2 or OC5.~~7~~.2.3~~ as the case may be~~, as if **The Company** had issued an instruction at the time of notice from the **Black Start Service Provider**.~~.

OC5.7.~~2.7~~ 3.5 If the ~~**Black Start Station** or **Black Start HVDC System**~~**Restoration Contractor's Plant** and **Apparatus** concerned fails to pass the re-test and a dispute arises on that re-test, ~~either party~~the parties may use the **Disputes Resolution Procedure** for a ruling in relation to the dispute, which ~~ruling~~ shall be binding.

OC5.7.~~2.8~~3.6 If, following the procedure in OC5.7.~~2.6~~3.4 and OC5.7.~~2.7~~3.5, it is accepted that the ~~**Black Start Station** or **Black Start HVDC System**~~ **Restoration Contractor** has failed the ~~**Black Start**~~ **Restoration Service** **Test** (or a re-test carried out under OC5.7.2.~~5~~7), within 14 days, or such longer period as **The Company** and/or relevant **Network Operator** may reasonably agree, following such failure, the relevant ~~**Black Start Service Provider**~~**Restoration Contractor** shall submit to **The Company** and/or relevant **Network Operator** in writing for approval, the date and time by which that ~~**Black Start Service Provider**~~**Restoration Contractor** shall have brought ~~that **Black Start Station**~~ the relevant **Plant** and/or ~~**Black Start HVDC System**~~ **Apparatus** back to a ~~condition where~~ suitable state that it ~~has a **Black Start Capability** and~~ would pass ~~the **Black Start**~~ a **Restoration Service** **Test**, and **The Company** and/or relevant **Network Operator** will not unreasonably withhold or delay its approval of the ~~**Black Start Service Provider's**~~**Restoration Contractor's** proposed date and time submitted. Should **The Company** and/or relevant **Network Operator** not approve the ~~**Black Start Service Provider's**~~**Restoration Contractor's** proposed date and time (or any revised proposal) the ~~**Black Start Service Provider**~~**Restoration Contractor** shall revise such proposal, having regard to any comments **The Company** and/or relevant **Network Operators** may have made, and resubmit it for approval.

OC5.7.3.7.~~2.9~~ Once the ~~**Black Start Service Provider**~~**Restoration Contractor** has indicated to **The Company** and/or relevant **Network Operator** that the ~~**Power Station** or **HVDC System** or **DC Converter Station** has~~ **Restoration Contractor's Plant** and/or **Apparatus** has been restored to a ~~**Black Start Capability**~~suitlable state, **The Company** and/or relevant **Network Operator** shall either accept this information or require the ~~**Black Start Service Provider**~~**Restoration Contractor** to demonstrate that the relevant ~~**Black Start Station** or **Black Start HVDC System**~~ **Plant** and/or **Apparatus** has its ~~**Black Start Capability**~~capability restored, by means of a repetition of the ~~**Black Start**~~ **Restoration Service** **Test** referred to in OC5.7.1~~(d)~~ following the same procedure as for the initial ~~**Black Start**~~ **Restoration Service** **Test**. The provisions of this OC5.7.2 will apply to such test.

OC5.7.~~3 Quick Re-synchronisation UnitTest~~

~~The relevant **Generating Unit** shall be **Synchronised**~~4 System Restoration Assurance, Awareness and ~~**Loaded**;~~Training

~~(a) All the **Auxiliary Gas Turbines** and/or **Auxiliary Diesel Engines** in the **Black Start Station** in which that **Generating Unit** is situated, shall be **Shutdown**.~~

~~(b) The **Generating Unit** shall tripped to house load.~~

~~The relevant **Generating Unit** shall~~ OC5.7.4.1 **The Company** will coordinate with **Users** and **Restoration Contractors** for undertaking regular exercises with **Users** and **Restoration Contractors** to ensure **System Restoration** plans are capable of meeting the **Electricity System Restoration Standard**.

OC5.7.4.2 **The Company** in coordination with **Users** and **Restoration Contractors** will undertake desk top and computer exercises and tests at the specified frequencies defined in Part III of **DRC** Schedule 16 to confirm:-

i) That **The Company's** plans for **System Restoration** are robust and sufficiently able to satisfy the requirements of the **Electricity System Restoration Standard**.

ii) There is a high level of confidence that **Restoration Contractors** will be able to deliver the service they have contracted to provide.

iii) There is a high level of confidence that **User's Critical Tools and Facilites** will be able to satisfy the requirements of CC7.10 and/or ECC.7.10 in addition to the requirements of CC7.11 and/or ECC.7.11.

iv) There is a high level of assurance that **Local Joint Restoration Plans** and **Distribution Restoration Zone Plans** will be ~~**Synchronised** to~~ capable of contributing to the restoration of those sections of the **System** ~~but not **Loaded**, unless the appropriate instruction has been given~~they have been designed to re-establish.

v) That **Restoration Contractors** and **Users** have arrangements in place in order for them to receive and act upon instructions issued by **The Company** ~~under **BC2** which would also be~~ or relevant **Transmission Licensee** in Scotland or relevant **Network Operator** for a period of upto 72 hours following the loss of site supplies.

vi) All communications systems used satisfy the minimum requirements of CC6.5.1 – CC.6.5.5 and/or ECC.6.5.1 – ECC.6.5.5.

vii) **Network Operators** can satisfy the requirements of CC.6.4.5 and/or ECC.6.4.6.

viii) **The Company** in coordination with **Network Operators** involved in planning the wider **System Restoration** process shall work collaboratively to ensure the balance of generation and demand, and minimise the risk of actions which could have a destabilising effect on the **Total System**.

ix) Demonstrate their control systems will remain functional and can handle incidents when the **Total System** is in a de-energised state including client applications and server architecture.

~~i)~~x) Demonstrate the cyber-security of their voice and control systems in accordance with ~~the requirements of the **Black Start Contract**.~~CC.7.10.6 or ECC.7.10.6.

xi) ~~In respect~~Report the service level agreement compliance of ~~**EU Generators**,~~their telephony systems including infrastructure and service provision as provided for CC.6.5.4 or ECC.6.5.4.

xii) The resilience of voice systems including power supplies by its ability to withstand a minimum of 72 hours during **System Restoration**.

As part of these exercises, **Restoration Contractors** and **Users** are required to inform **The Company** of any assumptions they make and any reasons why they would be unable to fufil their obligations.

OC.5.7.4.3 In addition to the above ~~tests defined in~~ requirements, from 31 December 2026 onwards, **Users** and **Restoration Contractors** are also required to provide an annual statement confirming that their **Plant** and **Apparatus** has the capability to satisfy the requirements of OC.5.7 through their Week 24 data submission.

OC5.7.5 In addition to the requirements of OC5.7.4.2~~.3(a) – (e)~~ the following assurance tests shall be ~~in~~ undertaken at least once every three years.

i) **Users**, **BM Participants** and **Restoration Contractors** shall undertake tests or otherwise demonstrate their **Critical Tools and Facilities** satisfy the requirements of CC.6.5.4.4, CC.6.5.5.1, CC.7.10 and CC.7.11 or ECC.6.5.4.4, ECC.6.5.5.1, ECC.7.10 and ECC.7.11 as applicable.

~~i)~~ii) **User's**, **BM Participants** and **Restoration Contractors** shall undertake tests or otherwise demonstrate that their **Critical Tools and Faciliaties** are sufficiently robust and reliable enough to manage the high volumes of data and alarms that are expected to be generated during **System Restoration** in accordance with the requirements of CC.7.10.7 and/or ECC.~~6.3.5.6~~7.10.7.

OC5.7.6 **The Company**, as part of its regular **System Restoration** assurance activities, will ensure **Users** and **Restoration Contractors** are capable of satisfying the applicable requirements of OC5.7.

OC5.8 PROCEDURES APPLYING TO EMBEDDED MEDIUM POWER STATIONS NOT SUBJECT TO A BILATERAL AGREEMENT AND EMBEDDED DC CONVERTER STATIONS NOT SUBJECT TO A BILATERAL AGREEMENT

OC5.8.1 Compliance Statement

Each **Network Operator** shall ensure that each **Embedded Person** provides to the **Network Operator** upon **The Company's** request:

(a) written confirmation that each such **Power Generating Module**, **Generating Unit**, **Power Park Module**, **HVDC Equipment**, or **DC Converter** complies with the requirements of the **CC** and **ECC**; and

(b) evidence, where requested, reasonably satisfactory to **The Company**, of such compliance. Such a request shall not normally be made by **The Company** more than twice in any calendar year in respect of any **Generator's Power Generating Module**, **Generating Unit** or **Power Park Module** or **HVDC System Owner's HVDC System**, or **DC Converter** owner's **DC Converter**.

The **Network Operator** shall provide the evidence or written confirmation required under OC5.8.1 (a) and (b) forthwith upon receipt to **The Company**.

OC5.8.2 Network Operator's Obligations To Facilitate Tests

If:

(a) the **Network Operator** fails to procure the confirmation referred to at OC5.8.1(a); or

(b) the evidence of compliance is not to **The Company's** reasonable satisfaction,

then, **The Company** shall be entitled to require the **Network Operator** to procure access upon terms reasonably satisfactory to **The Company** to enable **The Company** to witness the **Embedded Person** carrying out the tests referred to in OC5.8.3 in respect of the relevant **Embedded Medium Power Station** or **Embedded DC Converter Station** or **Embedded HVDC System**.

OC5.8.3 Testing Of Embedded Medium Power Stations Not Subject To A Bilateral Agreement Or Embedded DC Converter Stations Not Subject To A Bilateral Agreement or Embedded HVDC Equipment Not Subject To A Bilateral Agreement

**The Company** may, in accordance with the provisions of OC5.8.2, at any time (although not normally more than twice in any calendar year in respect of any particular **Embedded Medium Power Station** not subject to a **Bilateral Agreement** or **Embedded DC Converter Station** or **Embedded HVDC Equipment** not subject to a **Bilateral Agreement**) issue an instruction requiring the **Network Operator** within whose **System** the relevant **Medium Power Station** not subject to a **Bilateral Agreement** or **DC Converter Station** or **HVDC Equipment** not subject to a **Bilateral Agreement** is **Embedded**, to require the **Embedded Person** to carry out a test.

Such test shall be carried out at a time no sooner than 48 hours from the time that the instruction was issued, on any one or more of the **Generating Units**, **Power Generating Modules, Power Park Modules** or **DC Converters** or **HVDC Equipment** comprising part of the relevant **Embedded Medium Power Station** or **Embedded DC Converter Station** or **HVDC System** and should only be to demonstrate that:

(a) the relevant **Generating Unit**, **Power Generating Module, Power Park Module** or **DC Converter** or **HVDC Equipment** meets the requirements of the paragraphs in the **CC** or **ECC** which are applicable to such **Generating Units**, **Power Generating Modules**, **Power Park Module** or **DC Converter** or **HVDC Equipment**;

(b) the **Reactive Power** capability registered with **The Company** under **OC2** meets the requirements set out in CC.6.3.2 or ECC.6.3.2 as applicable.

The instruction may only be issued where, following consultation with the relevant **Network Operator**, **The Company** has:

(c) confirmed to the relevant **Network Operator** the manner in which the test will be conducted, which shall be consistent with the principles established in OC5.5.3; and

(d) received confirmation from the relevant **Network Operator** that the relevant **Generating Unit**, **Power Generating Module**, **Power Park Module** or **DC Converter** or **HVDC Equipment** would not then be unavailable by reason of forced outage or **Planned Outage** expected prior to the instruction.

The relevant **Network Operator** is responsible for ensuring the performance of any test so required by **The Company** and the **Network Operator** shall ensure that the **Embedded Person** retains the responsibility for ensuring the safety of personnel and plant during the test.

OC5.8.4 Test Failures/Re-Tests ~~And~~and Disputes

The relevant **Network Operator** shall:

(a) ensure that provisions equivalent to OC5.5.5, OC5.5.6 and OC5.6 apply to **Embedded Medium Power Stations** not the subject of a **Bilateral Agreement, Embedded DC Converter Stations** not the subject of a **Bilateral Agreement** or **Embedded HVDC Equipment** not the subject of a **Bilateral Agreement** within its **System** in respect of test failures, re-tests and disputes as to test failures and re-tests;

(b) ensure that the provisions equivalent to OC5.5.5, OC5.5.6 and OC5.6 referred to in OC5.8.4(a) are effective so that **The Company** may require, if it so wishes, the provision to it of any reports or other information equivalent to those or that to which **The Company** would be entitled in relation to test failures, re-tests and disputes as to test failures and re-tests under the provisions of OC5.5.5, OC5.5.6 and OC5.6; and

(c) the provisions equivalent to OC5.5.5, OC5.5.6 and OC5.6 referred to in OC5.8.4(a) are effective to permit **The Company** to conduct itself and take decisions in such a manner in relation to test failures, re-tests and disputes as to test failures and re-tests in respect of **Embedded Medium Power Stations** not the subject of a **Bilateral Agreement**, **Embedded DC Converter Stations** not the subject of a **Bilateral Agreement** or **Embedded HVDC Equipment** not the subject of a **Bilateral Agreement** as it is able to conduct itself and take decisions in relation to test failures, re-tests and disputes as to test failures and re-tests under OC5.5.5, OC5.5.6 and OC5.6.

# APPENDIX 1 - ONSITE SIGNAL PROVISION FOR WITNESSING TESTS

OC5.A.1.1 During tests witnessed on-site by **The Company**, the following signals shall be provided to **The Company** by the **GB Generator**, **GB Generator** undertaking **OTSDUW** or **DC Converter Station** owner in accordance with CC.6.6.2:

OC5.A.1.2 Synchronous Generating Units

(a) All Tests

- MW - **Active Power** at **Generating Unit** terminals

(b) Reactive & Excitation System

- MVAr - **Reactive Power** at **Generating Unit** terminals
- Vt - **Generating Unit** terminal voltage
- Efd- **Generating Unit** field voltage and/or main exciter field voltage
- Ifd – **Generating Unit** field current (where possible)
- **Power System Stabiliser** output, where applicable.
- Noise – Injected noise signal (where applicable and possible)

(c) Governor System & **Frequency** Response

- Fsys - **System Frequency**
- Finj - Injected Speed Reference
- Logic - Stop / Start Logic Signal

For Gas Turbines:

- GT Fuel Demand
- GT Fuel Valve Position
- GT Inlet Guide Vane Position
- GT Exhaust Gas Temperature

For Steam Turbines at >= 1Hz:

- Pressure before Turbine Governor Valves
- Turbine Governor Valve Positions
- Governor Oil Pressure*
- Boiler Pressure Set Point *
- Superheater Outlet Pressure *
- Pressure after Turbine Governor Valves*
- Boiler Firing Demand*

*Where applicable (typically not in **CCGT Module**)

For Hydro Plant:

- Speed Governor Demand Signal
- Actuator Output Signal
- Guide Vane / Needle Valve Position

| | |
|---|---|
| (d) Compliance with CC.6.3.3 | • Fsys - **System Frequency**<br>• Finj - Injected Speed Reference<br>• Appropriate control system parameters as agreed with **The Company** (See OC5.A.2.9) |

OC5.A.1.3 Power Park Modules, OTSUA and DC Converters

| | |
|---|---|
| | Each **Power Park Module** and **DC Converter** at a **Grid Entry Point** or **User System Entry Point** |
| (a) Real Time on site. | • Total **Active Power** (MW)<br>• Total **Reactive Power** (MVAr)<br>• Line-line Voltage (kV)<br>• **System Frequency** (Hz) |
| (b) Real Time on site or Downloadable | • Injected frequency signal (Hz) or test logic signal (Boolean) when appropriate<br>• Injected voltage signal (per unit voltage) or test logic signal (Boolean) when appropriate<br>• In the case of an **Onshore Power Park Module** the **Onshore Power Park Module** site voltage (MV) (kV)<br>• **Power System Stabiliser** output, where appropriate<br>• In the case of a **Power Park Module** or **DC Converter** where the **Reactive Power** is provided from more than one **Reactive Power** source, the individual **Reactive Power** contributions from each source, as agreed with **The Company**.<br>• In the case of **DC Converters** appropriate control system parameters as agreed with **The Company** (See OC5.A.4)<br>• In the case of an **Offshore Power Park Module** the total **Active Power** (MW) and the total **Reactive Power** (MVAr) at the **Offshore Grid Entry Point** |
| (c) Real Time on site or Downloadable | • Available power for **Power Park Module** (MW)<br>• Power source speed for **Power Park Module** (e.g. wind speed) (m/s) when appropriate<br>• Power source direction for **Power Park Module** (degrees) when appropriate<br>See OC5.A.1.3.1 |

OC5.A.1.3.1 **The Company** accept that the signals specified in OC5.A.1.3(c) may have lower effective sample rates than those required in CC.6.6.2 although any signals supplied for connection to **The Company's** recording equipment which do not meet at least the sample rates detailed in CC.6.6.2 should have the actual sample rates indicated to **The Company** before testing commences.

OC5.A.1.3.2 For all **The Company** witnessed testing either;

(i) the **Generator** or **DC Converter Station** owner shall provide to **The Company** all signals outlined in OC5.A.1.3 direct from the **Power Park Module** control system without any 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 with a signal update rate corresponding to CC.6.6.2.1; or

(ii) in the case of **Onshore Power Park Modules**, the **Generator** or **DC Converter Station** owner shall provide signals OC5.A.1.3(a) direct from one or more transducer(s) connected to current and voltage transformers for monitoring in real time on site; or,

(iii) In the case of **Offshore Power Park Modules** and **OTSUA** signals OC5.A.1.3(a) will be provided at the **Interface Point** by the **Offshore Transmission Licensee** pursuant to the **STC** or by the **Generator** when **OTSDUW Arrangements** apply.

OC5.A.1.3.3 Options OC5.A.1.3.2 (ii) and (iii) will only be available on condition that;

(a) all signals outlined in OC5.A.1.3 are recorded and made available to **The Company** by the **Generator** or **DC Converter Station** owner from the **Power Park Module** or **OTSUA** or **DC Converter** control systems as a download once the testing has been completed; and

(b) the full test results are provided by the **Generator** or **DC Converter Station** owner within 2 working days of the test date to **The Company** unless **The Company** agrees otherwise; and

(c) all data is provided with a sample rate in accordance with CC.6.6.2.2 or ECC.6.6.3.3 unless **The Company** agrees otherwise; and

(d) in **The Company's** reasonable opinion the solution does not unreasonably add a significant delay between tests or impede the volume of testing which can take place on the day.

OC5.A.1.3.4 In the case of where transducers connected to current and voltage transformers are installed (OC5.A.1.3.3 (ii) and (iii)), the transducers shall meet the following specification

(a) The transducer(s) shall be permanently installed to easily allow safe testing at any point in the future, and to avoid a requirement for recalibration of the current transformers and voltage transformers.

(b) The transducer(s) should be directly connected to the metering quality current transformers and voltage transformers or similar.

(c) The transducers shall either have a response time no greater than 50ms to reach 90% of output, or no greater than 300ms to reach 99.5%.

OC5.A.1.4 Testing not witnessed by **The Company** on-site

OC5.A.1.4.1.1 Where **The Company** has decided not to witness testing on-site, the results shall be submitted to **The Company** in spreadsheet format with the signal data in columns arranged as follows. Signal data denoted by "#" is not essential but if not provided the column should remain in place but without values entered. Where two signal names are given in a column these are alternatives related to the type of plant under test.

OC5.A.1.4.1.2. Where **The Company** has requested addition signals to be recorded prior to the testing these signals shall be placed in columns to the right of the spreadsheet.

OC5.A.1.4.2.1 Onshore Synchronous Generating Unit Excitation System and Reactive Capability

| | Col 1 | Col 2 | Col 3 | Col 4 | Col 5 | Col 6 | Col 7 | Col 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | Time | Active Power | Reactive Power | Terminal Voltage | Speed /Frequency # | Freq Injection # | Logic / Test Start # | Field Voltage |
| | Col 9 | Col 10 | Col 11 | Col 12 | Col 13 | Col 14 | Col 15 | Col 16 |
| 1 | Field Current | PSS Output # | Noise Injection # | | | | | |
| # Columns may be left blank but the column must still be included in the files | | | | | | | | |

OC5.A.1.4.2.2 Onshore Synchronous Generating Unit Frequency Response and CC.6.3.3

| | Col 1 | Col 2 | Col 3 | Col 4 | Col 5 | Col 6 | Col 7 | Col 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | Time | Active Power | Reactive Power # | Terminal Voltage # | Speed /Frequency | Freq Injection | Logic / Test Start | Fuel Demand |
| 2 | | | | | | | | Guide Vane Setpoint |
| | Col 9 | Col 10 | Col 11 | Col 12 | Col 13 | Col 14 | Col 15 | Col 16 |
| 1 | Inlet Guide Vane | Exhaust Gas Temp | ST Valve Pos | Fuel Valve Pos | HP Steam Valve Pos | IP Steam Valve Pos | LP Steam Valve Pos | |
| 2 | Guide Vane Position | Head | | | | | | |
| # Columns may be left blank but must still be included in the files | | | | | | | | |

OC5.A.1.4.3.1 Onshore Power Park Modules Voltage Control & Reactive Capability

| | Col 1 | Col 2 | Col 3 | Col 4 | Col 5 | Col 6 | Col 7 | Col 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | Time | Active Power | Reactive Power | Connection Point Voltage | Speed /Frequency # | Freq Injection # | Logic / Test Start # | Statcom or Windfarm Reactive Power # |
| | Col 9 | Col 10 | Col 11 | Col 12 | Col 13 | Col 14 | Col 15 | Col 16 |
| 1 | Power Available | Wind Speed | Wind Direction | Voltage Setpoint | | | | |
| 2 | State of Charge | | | | | | | |
| # Columns may be left blank but the column must still be included in the files | | | | | | | | |

OC5.A.1.4.3.2 Offshore Power Park Modules Voltage Control & Reactive Capability

| | Col 1 | Col 2 | Col 3 | Col 4 | Col 5 | Col 6 | Col 7 | Col 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | Time | Onshore Interface Point Active Power | Onshore Interface Point Reactive Power | Onshore Interface Point Voltage | Speed /Frequency # | Freq Injection # | Logic / Test Start # | Statcom or Windfarm Reactive Power # |
| | Col 9 | Col 10 | Col 11 | Col 12 | Col 13 | Col 14 | Col 15 | Col 16 |
| 1 | Power Available | Wind Speed m/s | Wind Direction | Voltage Setpoint | | | | |
| 2 | State of Charge | | | | | | | |
| # Columns may be left blank but the column must still be included in the files | | | | | | | | |

OC5.A.1.4.3.3 Power Park Modules Frequency Control

| | Col 1 | Col 2 | Col 3 | Col 4 | Col 5 | Col 6 | Col 7 | Col 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | Time | GEP Active Power | GEP Reactive Power # | GEP Connection Voltage # | Speed /Frequency | Freq Injection | Logic / Test Start | Statcom or Windfarm Output # |
| | Col 9 | Col 10 | Col 11 | Col 12 | Col 13 | Col 14 | Col 15 | Col 16 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Power Available | Wind Speed m/s | Wind Direction | | | | | |
| 2 | State of Charge | | | | | | | |
| # Columns may be left blank but must still be included in the files | | | | | | | | |

OC5.A.1.5.1 Where test results are completed without any prescence of **The Company** but are relied upon as evidence of the compliance they should be accompanied by a logsheet. This sheet should be legible, in English and detail the items as indicated below:

- Time and date of test;
- Name of **Power Station** and module if applicable;
- Name of test engineer(s) and company name;
- Name of **User** representative(s) and company name;
- Type of testing being undertake eg voltage control;
- Ambient conditions eg. temperature, pressure, wind speed, wind direction; and
- Controller settings, eg voltage slope, frequency droop, voltage setpoint, UEL & OEL settings.

OC5.A.1.5.2 For each test the following items should be recorded as relevant to the type of test being undertaken. Where there is uncertainty on the information to be recorded this should be discussed with **The Company** in advance of the test.

OC5.A.1.5.2 .1 Voltage Control Tests

- Start time of each test step;
- **Active Power**;
- **Reactive Power**;
- Connection voltage;
- Voltage vontrol setpoint, if applicable or changed;
- Voltage control slope, if applicable or changed;
- Terminal voltage if applicable;
- **Generating Unit** transformer tap position or grid transformer tap position, as applicable;
- Number of **Power Park Units** in service in each **Power Park Module**, if applicable; and
- For Offshore Connections, **Offshore Grid Entry Point** voltage.

OC5.A.1.5.2.2 Reactive Power Capability Tests

- Start time of test;
- **Active Power**;
- **Reactive Power**;
- Connection voltage;
- Terminal voltage if applicable;
- **Generating Unit** transformer tap position or grid transformer tap position as applicable;

- Number of **Power Park Units** in service in each **Power Park Module**, if applicable and
- For Offshore Connections, **Offshore Grid Entry Point** voltage.

OC5.A.1.5.2.3 Frequency Response Capability Tests

- Start time of test;
- **Active Power**;
- **System Frequency**;
- For **CCGT Modules, Active Power** for the individual units (GT &ST);
- For boiler plant, HP steam pressure;
- Droop setting of controller if applicable;
- Number of **Power Park Units** in service in each **Power Park Module**, if applicable.; and
- For Offshore Connections, **Offshore Grid Entry Point Active Power** for each Power Park Module.

OC5.A.1.5.3 Material changes during the test period should be recorded e.g. **Generating Unit**s tripping / starting, changes to tapchange positions.

# APPENDIX 2 - COMPLIANCE TESTING OF SYNCHRONOUS PLANT

OC5.A.2.1 Scope

OC5.A.2.1.1 This Appendix sets out the tests contained therein to demonstrate compliance with the relevant clauses of the **Connection Conditions** of the Grid Code and apply only to **GB Generators**. This Appendix shall be read in conjunction with the **CP** with regard to the submission of the reports to **The Company**. The testing requirements applicable to **EU Generators** are specified in ECP.A.5.

OC5.A.2.1.2 The tests specified in this Appendix will normally be sufficient to demonstrate compliance however **The Company** may:

(i) agree an alternative set of tests provided **The Company** deem the alternative set of tests sufficient to demonstrate compliance with the **Grid Code** and **Bilateral Agreement**; and/or

(ii) require additional or alternative tests if information supplied to **The Company** during the compliance process suggests that the tests in this Appendix will not fully demonstrate compliance with the relevant section of the **Grid Code** or **Bilateral Agreement**.

(iii) Agree a reduced set of tests for subsequent **Generating Units** following successful completion of the first **Generating Unit** tests in the case of a **Power Station** comprised of two or more **Generating Units** which **The Company** reasonably considers to be identical.

If:

(a) the tests performed pursuant to OC5.A.2.1.2(iii) in respect of subsequent **Generating Units** do not replicate the full tests for the first **Generating Unit**, or

(b) any of the tests performed pursuant to OC5.A.2.1.2(iii) do not fully demonstrate compliance with the relevant aspects of the **Grid Code**, **Ancillary Services Agreement** and / or **Bilateral Agreement**,

then notwithstanding the provisions above, the full testing requirements set out in this Appendix will be applied.

OC5.A.2.1.3 The **Generator** is responsible for carrying out the tests set out in and in accordance with this Appendix and the **Generator** retains the responsibility for the safety of personnel and plant during the test. **The Company** will witness all of the tests outlined or agreed in relation to this Appendix unless **The Company** decides and notifies the **Generator** otherwise. Reactive Capability tests may be witnessed by **The Company** remotely from the **The Company** control centre. During **The Company** witnessed tests, the **Generator** should ensure suitable representatives from the **Generator** and manufacturer (if appropriate) are available on site for the entire testing period. In all cases the **Generator** shall provide suitable monitoring equipment to record all relevant test signals as outlined below in OC5.A.3.1.5.

OC5.A.2.1.4 The **Generator** shall submit a schedule of tests to **The Company** in accordance with CP.4.3.1

OC5.A.2.1.5 Prior to the testing of a **Generating Unit**, the **Generator** shall complete the **Integral Equipment Test** procedure in accordance with OC.7.5

OC5.A.2.1.6 Full **Generating Unit** testing as required by CP.7.2 is to be completed as defined in OC5.A.2.2 through to OC5.A.2.9

OC5.A.2.2 Excitation System Open Circuit Step Response Tests

OC5.A.2.2.1 The open circuit step response of the **Excitation System** will be tested by applying a voltage step change from 90% to 100% of the nominal **Generating Unit** terminal voltage, with the **Generating Unit** on open circuit and at rated speed.

OC5.A.2.2.2 The test shall be carried out prior to synchronisation in accordance with CP.6.4. This is not witnessed by **The Company** unless specifically requested by **The Company**. Where **The Company** is not witnessing the tests, the **Generator** shall supply the recordings of the following signals to **The Company** in an electronic spreadsheet format:

Vt - **Generating Unit** terminal voltage

Efd - **Generating Unit** field voltage or main exciter field voltage

Ifd- **Generating Unit** field current (where possible)

Step injection signal

OC5.A.2.2.3 Results shall be legible, identifiable by labelling, and shall have appropriate scaling.

OC5.A.2.3 Open & Short Circuit Saturation Characteristics

OC5.A.2.3.1 The test shall normally be carried out prior to synchronisation in accordance with CP.6.4. Manufacturer factory test results may be used where appropriate or manufacturers factory type test results may be used if agreed by **The Company**.

OC5.A.2.3.2 This is not witnessed by **The Company**. Graphical and tabular representations of the results in an electronic spreadsheet format showing per unit open circuit terminal voltage and short circuit current versus per unit field current shall be submitted to **The Company**.

OC5.A.2.3.3 Results shall be legible, identifiable by labelling, and shall have appropriate scaling.

OC5.A.2.4 Excitation System On-Load Tests

OC5.A.2.4.1 The time domain performance of the **Excitation System** shall be tested by application of voltage step changes corresponding to 1% and 2% of the nominal terminal voltage.

OC5.A.2.4.2 Where a **Power System Stabiliser** is present:

(i) The **PSS** must only be commissioned in accordance with BC2.11.2. When a **PSS** is switched on for the first time as part of on-load commissioning or if parameters have been adjusted, the **Generator** should consider reducing the **PSS** output gain by at least 50% and should consider reducing the limits on the **PSS** output by at least a factor of 5 to prevent unexpected PSS action affecting the stability of the **Generating Unit** or the **National Electricity Transmission System**.

(ii) The time domain performance of the **Excitation System** shall be tested by application of voltage step changes corresponding to 1% and 2% of the nominal terminal voltage, repeating with and without the **PSS** in service.

(iii) The frequency domain tuning of the **PSS** shall also be demonstrated by injecting a 0.2Hz-3Hz band limited random noise signal into the **Automatic Voltage Regulator** reference with the **Generating Unit** operating at points specified by **The Company** (up to rated MVA output).

(iv) The **PSS** gain margin shall be tested by increasing the **PSS** gain gradually to threefold and observing the **Generating Unit** steady state **Active Power** output.

(v) The interaction of the **PSS** with changes in **Active Power** shall be tested by application of a +0.5Hz frequency injection to the governor while the **Generating Unit** is selected to **Frequency Sensitive Mode**.

(vi) If the **Generating Unit** is of the pump storage type, then the step tests shall be carried out, with and without the **PSS**, in the pumping mode in addition to the generating mode.

(vii) Where the **Bilateral Agreement** requires that the **PSS** is in service at a specified loading level, additional testing witnessed by **The Company** will be required during the commissioning process before the **Generating Unit** or **CCGT Module** may exceed this output level.

(viii) Where the **Excitation System** includes a **PSS**, the **Generator** shall provide a suitable noise source to facilitate noise injection testing.

OC5.A.2.4.3 The following typical procedure is provided to assist **Generators** in drawing up their own site specific procedures for the **The Company** witnessed **PSS** Tests.

| Test | Injection | Notes |
|---|---|---|
| | Synchronous Generator running rated MW, unity pf, PSS Switched Off | |
| 1 | • Record steady state for 10 seconds<br>• Inject +1% step to **AVR** Voltage Reference and hold for at least 10 seconds until stabilised<br>• Remove step returning **AVR** Voltage Reference to nominal and hold for at least 10 seconds | |
| 2 | • Record steady state for 10 seconds<br>• Inject +2% step to **AVR** Voltage Reference and hold for at least 10 seconds until stabilised<br>• Remove step returning **AVR** Voltage Reference to nominal and hold for at least 10 seconds | |
| 3 | • Inject band limited (0.2-3Hz) random noise signal into voltage reference and measure frequency spectrum of Real Power.<br>• Remove noise injection. | |
| | Switch On **Power System Stabiliser** | |
| 4 | • Record steady state for 10 seconds<br>• Inject +1% step to **AVR** Voltage Reference and hold for at least 10 seconds until stabilised<br>• Remove step returning **AVR** Voltage Reference to nominal and hold for at least 10 seconds | |
| 5 | • Record steady state for 10 seconds<br>• Inject +2% step to **AVR** Voltage Reference and hold for at least 10 seconds until stabilised<br>• Remove step returning **AVR** Voltage Reference to nominal and hold for at least 10 seconds | |
| 6 | • Increase **PSS** gain at 30 second intervals. i.e. x1 – x1.5 – x2 – x2.5 – x3<br>• Return **PSS** gain to initial setting | |
| 7 | • Inject band limited (0.2-3Hz) random noise signal into voltage reference and measure frequency spectrum of Real Power.<br>• Remove noise injection. | |

| | | |
|---|---|---|
| 8 | • Select the governor to **Frequency Senstive Mode** (FSM)<br>• Inject +0.5 Hz step into governor.<br>• Hold until generator MW output is stabilised<br>• Remove step | |

OC5.A.2.5 Under-excitation Limiter Performance Test

OC5.A.2.5.1 Initially the performance of the **Under-excitation Limiter** should be checked by moving the limit line close to the operating point of the **Generating Unit** when operating close to unity power factor. The operating point of the **Generating Unit** is then stepped into the limit by applying a 2% decrease in **Automatic Voltage Regulator** reference voltage.

OC5.A.2.5.2 The final performance of the **Under-excitation Limiter** shall be demonstrated by testing its response to a step change corresponding to a 2% decrease in **Automatic Voltage Regulator** reference voltage when the **Generating Unit** is operating just off the limit line, at the designed setting as indicated on the **Performance Chart** submitted to **The Company** under OC2.

OC5.A.2.5.3 Where possible, the **Under-excitation Limiter** should also be tested by operating the tap-changer when the **Generating Unit** is operating just off the limit line, as set up.

OC5.A.2.5.4 The **Under-excitation Limiter** will normally be tested at low **Active Power** output and at maximum **Active Power** output (**Registered Capacity**).

OC5.A.2.5.5 The following typical procedure is provided to assist **Generators** in drawing up their own site specific procedures for the **The Company** witnessed **Under-excitation Limiter** Tests.

| Test | Injection | Notes |
|---|---|---|
| | Synchronous generator running rated MW at unity **Power Factor**. Under-excitation limit temporarily moved close to the operating point of the generator. | |
| 1 | • **PSS** on.<br>• Inject -2% voltage step into **AVR** voltage reference and hold at least for 10 seconds until stabilised<br>• Remove step returning **AVR** Voltage Reference to nominal and hold for at least 10 seconds | |
| | Under-excitation limit moved to normal position. Synchronous generator running at rated MW and at leading MVArs close to Under-excitation limit. | |
| 2 | • **PSS** on.<br>• Inject -2% voltage step into **AVR** voltage reference and hold at least for 10 seconds until stabilised<br>• Remove step returning **AVR** Voltage Reference to nominal and hold for at least 10 seconds | |

OC5.A.2.6 Over-excitation Limiter Performance Test

Description & Purpose of Test

OC5.A.2.6.1 The performance of the **Over-excitation Limiter**, where it exists, shall be demonstrated by testing its response to a step increase in the **Automatic Voltage Regulator** reference voltage that results in operation of the **Over-excitation Limiter**. Prior to application of the step the **Generating Unit** shall be generating **Rated Active Power** and operating within its continuous **Reactive Power** capability. The size of the step will be determined by the minimum value necessary to operate the **Over-excitation Limiter** and will be agreed by **The Company** and the **Generator**. The resulting operation beyond the **Over-excitation Limit** shall be controlled by the **Over-excitation Limiter** without the operation of any protection that could trip the **Generating Unit**. The step shall be removed immediately on completion of the test.

OC5.A.2.6.2 If the **Over-excitation Limiter** has multiple levels to account for heating effects, an explanation of this functionality will be necessary and if appropriate, a description of how this can be tested.

OC5.A.2.6.3 The following typical procedure is provided to assist **Generators** in drawing up their own site specific procedures for the **The Company** witnessed **Under-excitation Limiter** Tests.

| Test | Injection | Notes |
|---|---|---|
| | Synchronous Generator running **Rated MW** and maximum lagging MVAr. | |
| | Over-excitation Limit temporarily set close to this operating point. **PSS** on. | |
| 1 | • Inject positive voltage step into **AVR** voltage reference and hold<br>• Wait till **Over-excitation Limiter** operates after sufficient time delay to bring back the excitation back to the limit.<br>• Remove step returning **AVR** Voltage Reference to nominal. | |
| | Over-excitation Limit restored to its normal operating value. **PSS** on. | |

OC5.A.2.7 Reactive Capability

OC5.A.2.7.1 The leading and lagging **Reactive Power** capability on each **Generating Unit** will normally be demonstrated by operation of the **Generating Unit** at 0.85 power factor lagging for 1 hour and 0.95 power factor leading for 1 hour.

OC5.A.2.7.2 In the case of an **Embedded Generating Unit** where distribution network considerations restrict the **Generating Unit Reactive Power** output then the maximum leading and lagging capability will be demonstrated without breaching the host network operators limits.

OC5.A.2.7.3 The test procedure, time and date will be agreed with **The Company** and will be to the instruction of **The Company** control centre and shall be monitored and recorded at both the **The Company** control centre and by the **Generator**.

OC5.A.2.7.4 Where the **Generator** is recording the voltage and **Reactive Power** at the **Generating Unit** terminals, the results shall be supplied in an electronic spreadsheet format.

OC5.A.2.7.5 The ability of the **Generating Unit** to comply with the operational requirements specified in BC2.A.2.6 and CC.6.1.7 will normally be demonstrated by changing the tap position and, where agreed in the **Bilateral Agreement**, the **Generating Unit** terminal voltage.

OC5.A.2.8 Governor and Load Controller Response Performance

OC5.A.2.8.1 The governor and load controller response performance will be tested by injecting simulated frequency deviations into the governor and load controller systems. Such simulated frequency deviation signals must be injected simultaneously at both speed governor and load controller references. For **CCGT modules**, simultaneous injection into all gas turbines, steam turbine governors and module controllers is required.

OC5.A.2.8.2 Prior to witnessing the governor tests set out in OC5.A.2.8.6, **The Company** requires the **Generator** to conduct the preliminary tests detailed in OC5.A.2.8.4 and send the results to **The Company** for assessment unless agreed otherwise by **The Company**. The results should be supplied in an electronic spreadsheet format. These tests shall be completed at least two weeks prior to the witnessed governor response tests.

OC5.A.2.8.3 Where a **CCGT Module** or **Generating Unit** is capable of operating on alternative fuels, tests will be required to demonstrate performance when operating on each fuel. **The Company** may agree a reduction from the tests listed in OC5.A.2.8.6 for demonstrating performance on the alternative fuel. This includes the case where a main fuel is supplemented by bio-fuel.

Preliminary Governor Frequency Response Testing

OC5.A.2.8.4 Prior to conducting the full set of tests as per OC5.A.2.8.6, **Generators** are required to conduct a preliminary set of tests below to confirm the frequency injection method is correct and the plant control performance is within expectation. The test numbers refer to Figure 1 below. With the plant running at 80% of full load, the following frequency injections shall be applied.

| **Test No (Figure 1)** | **Frequency Injection** | **Notes** |
|---|---|---|
| 8 | • Inject - 0.5Hz frequency fall over 10 sec<br>• Hold until conditions stabilise<br>• Remove the injected signal | |
| 14 | • Inject +0.5Hz frequency rise over 10 sec<br>• Hold until conditions stabilise<br>• Remove the injected signal | |
| 13 | • Inject -0.5Hz frequency fall over 10 sec<br>• Hold for a further 20 sec<br>• At 30 sec from the start of the test, Inject a +0.3Hz frequency rise over 30 sec.<br>• Hold until conditions stabilise<br>• Remove the injected signal | |

OC5.A.2.8.5 The recorded results (e.g. Finj, MW and control signals) should be sampled at a minimum rate of 1 Hz to allow **The Company** to assess the plant performance from the initial transients (seconds) to the final steady state conditions (5-15 minutes depending on the plant design). This is not witnessed by **The Company**. The **Generator** shall supply the recordings including data to **The Company** in an electronic spreadsheet format. Results shall be legible, identifiable by labelling, and shall have appropriate scaling.

Full Frequency Response Testing Schedule Witnessed by The Company

OC5.A.2.8.6 The tests are to be conducted at a number of different Module Load Points (MLP). The load points are conducted as shown below unless agreed otherwise by **The Company**.

| | |
|---|---|
| Module Load Point 6<br>(**Maximum Export Limit**) | 100% MEL |
| Module Load Point 5 | 95% MEL |
| Module Load Point 4<br>(Mid point of Operating Range) | 80% MEL |
| Module Load Point 3 | 70% MEL |
| Module Load Point 2<br>(**Minimum Generation**) | MG |
| Module Load Point 1<br>(**Design Minimum Operating Level**) | DMOL |

OC5.A.2.8.7 The tests are divided into the following two types;

(i) **Frequency** response volume tests as per OC5.A.2.8. Figure 1. These tests consist of **Frequency** profile and ramp tests.

(ii) **System** islanding and step response tests as shown by OC5.A.2.8. Figure 2.

OC5.A.2.8.8 There should be sufficient time allowed between tests for control systems to reach steady state. Where the diagram states 'HOLD' the current injection should be maintained until the **Active Power** (MW) output of the **Generating Unit** or **CCGT Module** has stabilised or 90 seconds, which ever is the longer. The frequency response capability test (see Figure 1) injection signal shall be returned to zero at the same rate at which it was applied. **The Company** may require repeat tests should the tests give unexpected results. When witnessed by **The Company** each test should be carried out as a separate injection; when not witnessed by **The Company** there must be sufficient time allowed between tests for the **Plant** to have reached a stable steady state operating condition or 90 seconds, whichever is the longer.

| Load Point | LF Event Profile 1 | LF Ramp -0.1Hz | HF Ramp +0.1Hz | LF Ramp -0.2Hz | HF Ramp +0.2Hz | LF Ramp -0.5Hz | HF Ramp +0.5Hz | LF Event Profile 2 |
|---|---|---|---|---|---|---|---|---|
| **MLP6** | | | 1 | 2 | 3 | | 4 | |
| **MLP5** | 5 | | | 6 | | | 7 | |
| **MLP4** | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| **MLP3** | 15 | | | | | | 16 | 17 |
| **MLP2** | 18 | | | 19 | 20 | 21 | | 22 |
| **MLP1** | 23 | | | 24 | 25 | | | 26 |

Figure 1: Frequency Response Capability Tests

| Load Point | +2.0* | ±0.02 | -0.2 | +0.2 | -0.5 | +0.5 | +0.6 | -0.5 | -2.0 | ± 0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **MLP6** | BC1 | | | | | | BC2 | | | L |
| **MLP6 LFSM** | BC3 | | | | | | BC4 | | | |
| **MLP5** | | | | | | | | A | | |
| **MLP4** | | D/E | F | G | H | I | | J | | M |
| **MLP4 LFSM** | | | | | | | | | | N |
| **MLP3** | | | | | | | | | | |
| **MLP2** | | | | | | | | | | |
| **MLP1** | | | | | | | | K | | |

| Load Point | +2.0* | ±0.02 | -0.2 | +0.2 | -0.5 | +0.5 | +0.6 | -0.5 | -2.0 | ± 0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **MLP6** | BC1 | | | | | | BC2 | | | L |
| **MLP6 LFSM** | BC3 | | | | | | BC4 | | | |
| **MLP5** | | | | | | | | A | | |
| **MLP4** | | D/E | F | G | H | I | | J | | M |
| **MLP4 LFSM** | | | | | | | | | | N |
| **MLP3** | | | | | | | | | | |
| **MLP2** | | | | | | | | | | |
| **MLP1** | | | | | | | | K | | |

Figure 2: System islanding and step response tests

* This will generally be +2.0Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Designed Minimum Operating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example, 0.9Hz is needed to take an initial output 65% to a final output of 20%. If the initial output was not 65% and the **Designed Minimum Operating Level** is not 20% then the injected step should be adjusted accordingly as shown in the example given below

| | |
|---|---|
| Initial Output | 65% |
| **Designed Minimum Operating Level** | 20% |
| Frequency Controller Droop | 4% |
| Frequency to be injected = | (0.65 - 0.20) x 0.04 x 50 = 0.9Hz |

** Tests L and M in Figure 2 shall be conducted if in this range of tests the **System Frequency** feedback signal is replaced by the injection signal rather than the injection signal being added to the **System Frequency** signal. The tests will consist of monitoring the **Generating Unit** and **CCGT Module** in **Frequency Sensitive Mode** during normal **System Frequency** variations without applying any injection. Test N in figure 2 shall be conducted in all cases. All three tests should be conducted for a period of at least 10 minutes.

OC5.A.2.8.9 The target frequency adjustment facility should be demonstrated from the normal **Control Point** within the range of 49.9Hz to 50.1Hz by step changes to the target frequency setpoint as indicated in OC5.A.2.8 Figure 3.

OC5.A.2.8.10 Figure 3 – Target Frequency setting changes

OC5.A.2.9 Compliance with CC.6.3.3 Functionality Test

OC5.A.2.9.1 Where the plant design includes active control function or functions to deliver CC.6.3.3 compliance, the **Generator** will propose and agree a test procedure with **The Company**, which will demonstrate how the **Generating Unit Active Power** output responds to changes in **System Frequency** and ambient conditions (e.g. by **Frequency** and temperature injection methods).

OC5.A.2.9.2 The **Generator** shall inform **The Company** if any load limiter control is additionally employed.

OC5.A.2.9.3 With reference to the signals specified in OC5.A.1, **The Company** will agree with the **Generator** which additional control system parameters shall be monitored to demonstrate the functionality of CC.6.3.3 compliance systems. Where **The Company** recording equipment is not used, results shall be supplied to **The Company** in an electronic spreadsheet format.

# APPENDIX 3 - COMPLIANCE TESTING OF POWER PARK MODULES (AND OTSUA)

OC5.A.3.1 Scope

OC5.A.3.1.1 This Appendix outlines the general testing requirements for **Power Park Modules** and **OTSUA** to demonstrate compliance with the relevant aspects of the **Grid Code**, **Ancillary Services Agreement** and **Bilateral Agreement** and apply only to **GB Generators**. The testing requirements applicable to **EU Generators** are specified in ECP.A.6. The tests specified in this Appendix will normally be sufficient to demonstrate compliance however **The Company** may:

(i) agree an alternative set of tests provided **The Company** deem the alternative set of tests sufficient to demonstrate compliance with the **Grid Code**, **Ancillary Services Agreement** and **Bilateral Agreement**; and/or

(ii) require additional or alternative tests if information supplied to **The Company** during the compliance process suggests that the tests in this Appendix will not fully demonstrate compliance with the relevant section of the **Grid Code**, **Ancillary Services Agreement** or **Bilateral Agreement**; and/or

(ii) require additional tests if a **Power System Stabiliser** is fitted; and/or

(iv) agree a reduced set of tests if a relevant **Manufacturer's Data & Performance Report** has been submitted to and deemed to be appropriate by **The Company**; and/or

(v) agree a reduced set of tests for subsequent **Power Park Modules** or **OTSUA** following successful completion of the first **Power Park Module** or **OTSUA** tests in the case of a **Power Station** comprised of two or more **Power Park Modules** or **OTSUA** which **The Company** reasonably considers to be identical.

If:

(a) the tests performed pursuant to OC5.A.3.1.1(iv) do not replicate the results contained in the **Manufacturer's Data & Performance Report** or

(b) the tests performed pursuant to OC5.A.3.1.1(v) in respect of subsequent **Power Park Modules** or **OTSUA** do not replicate the full tests for the first **Power Park Module** or **OTSUA**, or

(c) any of the tests performed pursuant to OC5.A.3.1.1(iv) or OC5.A.3.1.1(v) do not fully demonstrate compliance with the relevant aspects of the **Grid Code**, **Ancillary Services Agreement** and / or **Bilateral Agreement**,

then notwithstanding the provisions above, the full testing requirements set out in this Appendix will be applied.

OC5.A.3.1.2 The **Generator** is responsible for carrying out the tests set out in and in accordance with this Appendix and the **Generator** retains the responsibility for the safety of personnel and plant during the test. **The Company** will witness all of the tests outlined or agreed in relation to this Appendix unless **The Company** decides and notifies the **Generator** owner otherwise. Reactive Capability tests may be witnessed by **The Company** remotely from the **The Company** control centre. For all on site during **The Company** witnessed tests, the **Generator** must ensure suitable representatives from the **Generator** and / or **Power Park Module** manufacturer (if appropriate) and/or **OTSUA** manufacturer (if appropriate) are available on site for the entire testing period. In all cases and in addition to any recording of signals conducted by **The Company,** the **Generator** shall record all relevant test signals as outlined in OC5.A.1.

OC5.A.3.1.3 In addition to the dynamic signals supplied in OC5.A.1, the **Generator** shall inform **The Company** of the following information prior to the commencement of the tests and any changes to the following, if any values change during the tests:

(i) All relevant transformer tap numbers; and

(ii) Number of **Power Park Units** in operation

OC5.A.3.1.4 The **Generator** shall submit a detailed schedule of tests to **The Company** in accordance with CP.6.3.1, and this Appendix.

OC5.A.3.1.5 Prior to the testing of a **Power Park Module** or **OTSUA**, the **Generator** shall complete the **Integral Equipment Tests** procedure in accordance with OC.7.5.

OC5.A.3.1.6 Partial **Power Park Module** or **OTSUA** testing as defined in OC5.A.3.2 and OC5.A.3.3 is to be completed at the appropriate stage in accordance with CP.6.

OC5.A.3.1.7 Full **Power Park Module** or **OTSUA** testing as required by CP.7.2 is to be completed as defined in OC5.A.3.4 through to OC5.A.3.7.

OC5.A.3.1.8 Where **OTSDUW Arrangements** apply and prior to the **OTSUA Transfer Time**, any relevant **OTSDUW Plant and Apparatus** shall be considered within the scope of testing described in this Appendix. Performance shall be assessed against the relevant Grid Code requirements for **OTSDUW Plant and Apparatus** at the **Interface Point** and other **Generator Plant** and **Apparatus** at the **Offshore Grid Entry Point**. This Appendix should be read accordingly.

OC5.A.3.2 Pre 20% (or <50MW) **Synchronised Power Park Module** basic Voltage Control Tests

OC5.A.3.2.1 Before 20% of the **Power Park Module** (or 50MW if less) has commissioned, either voltage control test OC5.A.3.5.6(i) or (ii) must be completed in accordance with CP.6.

OC5.A.3.2.2 In the case of an **Offshore Power Park Module** which provides all or a portion of the **Reactive Power** capability as described in CC.6.3.2(e)(iii) and / or voltage control requirements as described in CC.6.3.8(b)(ii) to enable an **Offshore Transmission Licensee** to meet the requirements of **STC** Section K, the **Generator** is required to cooperate with the **Offshore Transmission Licensee** to conduct the 20% voltage control test. The results in relation to the **Offshore Power Park Module** will be assessed against the requirements in the **Bilateral Agreement**. In the case of **OTSUA** prior to the **OTSUA Transfer Time**, the **Generator** shall conduct the testing by reference to the entire control system responding to changes at the **Interface Point.**

OC5.A.3.3 Pre 70% **Power Park Module** Tests

OC5.A.3.3.1 For **Power Park Modules** with **Registered Capacity** ≥100MW only. Before 70% but with at least 50% of the **Power Park Module** commissioned, the following **Limited Frequency Sensitive** tests as detailed in OC5.A.3.6.2 must be completed.

(a) BC3

(b) BC4

OC5.A.3.4 Reactive Capability Test

OC5.A.3.4.1 This section details the procedure for demonstrating the reactive capability of an **Onshore Power Park Module** or an **Offshore Power Park Module** or **OTSUA** which provides all or a portion of the **Reactive Power** capability as described in CC.6.3.2(e)(iii) (for the avoidance of doubt, an **Offshore Power Park Module** which does not provide part of the **Offshore Transmission Licensee Reactive Power** capability as described in CC6.3.2(e)(i) and CC6.3.2(e)(ii) should complete the reactive power transfer / voltage control tests as per section OC5.A.3.8). These tests should be scheduled at a time where there are at least 95% of the **Power Park Units** within the **Power Park Module** in service. There should be sufficient MW resource forecasted in order to generate at least 85% of **Registered Capacity** of the **Power Park Module**.

OC5.A.3.4.2 The tests shall be performed by modifying the voltage set-point of the voltage control scheme of the **Power Park Module** or **OTSUA** by the amount necessary to demonstrate the required reactive range. This is to be conducted for the operating points and durations specified in OC5.A.3.4.5.

OC5.A.3.4.3 **Embedded Generators** should liaise with the relevant **Network Operator** to ensure the following tests will not have an adverse impact upon the **Network Operator's System** as per OC.7.5. In situations where the tests have an adverse impact upon the **Network Operator's System**, **The Company** will only require demonstration within the acceptable limits of the **Network Operator**. For the avoidance of doubt, these tests do not negate the requirement to produce a complete **Power Park Module** performance chart as specified in OC2.4.2.1

OC5.A.3.4.4 In the case where the **Reactive Power** metering point is not at the same location as the **Reactive Power** capability requirement, then an equivalent **Reactive Power** capability for the metering point shall be agreed between the **Generator** and **The Company**.

OC5.A.3.4.5 The following tests shall be completed:

(i) Operation in excess of 50% **Rated MW** and maximum continuous lagging **Reactive Power** for 60 minutes. For the avoidance of doubt this test must start with **Active Power** output in excess of 85% of **Registered Capacity** of the **Power Park Module** as OC5.A.3.4.1 and must not fall below 50% of **Registered Capacity** of the **Power Park Module** during the 60 minutes.

(ii) Operation in excess of 50% **Rated MW** and maximum continuous leading **Reactive Power** for 60 minutes. For the avoidance of doubt this test must start with **Active Power** output in excess of 85% of **Registered Capacity** of the **Power Park Module** as OC5.A.3.4.1 and must not fall below 50% of **Registered Capacity** of the **Power Park Module** during the 60 minutes.

(iii) Operation at 50% **Rated MW** and maximum continuous leading **Reactive Power** for 5 minutes.

(iv) Operation at 20% **Rated MW** and maximum continuous leading **Reactive Power** for 5 minutes.

(v) Operation at 20% **Rated MW** and maximum continuous lagging **Reactive Power** for 5 minutes.

(vi) Operation at less than 20% **Rated MW** and unity **Power Factor** for 5 minutes. This test only applies to systems which do not offer voltage control below 20% of **Rated MW**.

(vii) Operation at 0% **Rated MW** and maximum continuous leading **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

(viii) Operation at 0% **Rated MW** and maximum continuous lagging **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

OC5.A.3.4.6 Within this **OC5** lagging **Reactive Power** is the export of **Reactive Power** from the **Power Park Module** to the **Total System** and leading **Reactive Power** is the import of **Reactive Power** from the **Total System** to the **Power Park Module** or **OTSUA**.

OC5.A.3.5 Voltage Control Tests

OC5.A.3.5.1 This section details the procedure for conducting voltage control tests on **Onshore Power Park Modules** or **OTSUA** or an **Offshore Power Park Module** which provides all or a portion of the voltage control capability as described in CC.6.3.8(b)(ii) (for the avoidance of doubt, **Offshore Power Park Modules** which do not provide part of the **Offshore Transmission Licensee** voltage control capability as described in CC6.3.8(b)(i) should complete the reactive power transfer / voltage control tests as per section OC5.A.3.8). These tests should be scheduled at a time when there are at least 95% of the **Power Park Units** within the **Power Park Module** in service. There should be sufficient MW resource forecasted in order to generate at least 65% of **Registered Capacity** of the **Onshore Power Park Module**. An **Embedded Generator** should also liaise with the relevant **Network Operator** to ensure all requirements covered in this section will not have a detrimental effect on the **Network Operator's System**.

OC5.A.3.5.2 The voltage control system shall be perturbed with a series of step injections to the **Power Park Module** voltage reference, and where possible, multiple up-stream transformer taps. In the case of an **Offshore Power Park Module** providing part of the **Offshore Transmission Licensee** voltage control capability, this may require a series of step injections to the voltage reference of the **Offshore Transmission Licensee** control system.

OC5.A.3.5.3 For steps initiated using network tap changers, the **Generator** will need to coordinate with **The Company** or the relevant **Network Operator** as appropriate. The time between transformer taps shall be at least 10 seconds as per OC5.A.3.5 Figure 1.

OC5.A.3.5.4 For step injections into the **Power Park Module** or **OTSUA** voltage reference, steps of ±1%, ±2% and ±4% shall be applied to the voltage control system reference summing junction. The injection shall be maintained for a minimum of 10 seconds as per OC5.A.3.5 Figure 2.

OC5.A.3.5.5 Where the voltage control system comprises of discretely switched **Plant** and **Apparatus** (eg. mechanically switched shunt reactors or capacitors) additional tests will be required to demonstrate that the overall performance of the voltage control system when switching these devices as part of the response is in accordance with Grid Code and **Bilateral Agreement** requirements.

OC5.A.3.5.6 Tests to be completed:

(i)

OC5.A.3.5 Figure 1 – Transformer tap sequence for voltage control tests

(ii)

OC5.A.3.5 Figure 2 – Step injection sequence for voltage control tests

OC5.A.3.5.7 In the case of **OTSUA** where the **Bilateral Agreement** specifies additional damping facilities, additional testing to demonstrate these damping facilities may be required.

OC.A.3.5.8 In the case of **Power Park Modules** that do not provide voltage control down to zero **Active Power** a test to demonstrate the smooth transition from voltage control mode to unity **Power Factor** shall be carried out. The **Power Park Module** voltage setpoint should be altered to

produce lagging **Reactive Power** or absorbing leading **Reactive Power** at a low **Active Power** level where voltage control is provided. The **Power Park Module Active Power** should then be reduced to zero **Active Power** as a ramp over a short period (60 seconds is suggested).

OC5.A.3.6 Frequency Response Tests

OC5.A.3.6.1 This section describes the procedure for performing frequency response testing on a **Power Park Module**. These tests should be scheduled at a time where there are at least 95% of the **Power Park Units** within the **Power Park Module** in service. There should be sufficient MW resource forecasted in order to generate at least 65% of **Registered Capacity** of the **Power Park Module**.

OC5.A.3.6.2 The frequency controller shall be in **Frequency Sensitive Mode** or **Limited Frequency Sensitive Mode** as appropriate for each test. Simulated frequency deviation signals shall be injected into the frequency controller reference/feedback summing junction. If the injected frequency signal replaces rather than sums with the real **System Frequency** signal then the additional tests outlined in OC5.A.3.6.6 shall be performed with the **Power Park Module** or **Power Park Unit** in normal **Frequency Sensitive Mode** monitoring actual **System Frequency**, over a period of at least 10 minutes. The aim of this additional test is to verify that the control system correctly measures the real **System Frequency** for normal variations over a period of time.

OC5.A.3.6.3 In addition to the frequency response requirements, it is necessary to demonstrate the **Power Park Module** ability to deliver a requested steady state power output which is not impacted by power source variation as per CC.6.3.9 or ECC.6.3.9. This test shall be conducted in **Limited Frequency Sensitive Mode** at a part-loaded output for a period of 10 minutes as per OC5.A.3.6.6.

Preliminary Frequency Response Testing

OC5.A.3.6.4 Prior to conducting the full set of tests as per OC5.A.3.6.6, **Generators** are required to conduct the preliminary set of tests below to confirm the frequency injection method is correct and the plant control performance is within expectation. The test numbers refer to Figure 1 below. The test should be conducted when sufficient MW resource is forecasted in order to generate at least 65% of **Registered Capacity** of the **Power Park Module**. The following frequency injections shall be applied when operating at module load point 4.

| Test No (Figure 1) | Frequency Injection | Notes |
|---|---|---|
| 8 | • Inject - 0.5Hz frequency fall over 10 sec<br>• Hold until conditions stabilise<br>• Remove the injected signal | |
| 14 | • Inject +0.5Hz frequency rise over 10 sec<br>• Hold until conditions stabilise<br>• Remove the injected signal | |
| 13 | • Inject -0.5Hz frequency fall over 10 sec<br>• Hold for a further 20 sec<br>• At 30 sec from the start of the test, Inject a +0.3Hz frequency rise over 30 sec.<br>• Hold until conditions stabilise<br>• Remove the injected signal | |

OC5.A.3.6.5 The recorded results (e.g. Finj, MW and control signals) should be sampled at a minimum rate of 1 Hz to allow **The Company** to assess the plant performance from the initial transients (seconds) to the final steady state conditions (5-15 minutes depending on the plant design). This is not witnessed by **The Company**. The **Generator** shall supply the recordings including data to **The Company** in an electronic spreadsheet format. Results shall be legible, identifiable by labelling, and shall have appropriate scaling.

Full Frequency Response Testing Schedule Witnessed by The Company

OC5.A.3.6.6 The tests are to be conducted at a number of different Module Load Points (MLP). In the case of a **Power Park Module** the module load points are conducted as shown below unless agreed otherwise by **The Company**.

| | |
|---|---|
| Module Load Point 6<br>(**Maximum Export Limit**) | 100% MEL |
| Module Load Point 5 | 90% MEL |
| Module Load Point 4<br>(Mid point of Operating Range) | 80% MEL |
| Module Load Point 3 | DMOL + 0.6 x (80% MEL – DMOL) |
| Module Load Point 2<br>(**Minimum Generation**) | DMOL + 0.3 x (80% MEL – DMOL) |
| Module Load Point 1<br>(**Designed Minimum Operating Level**) | DMOL |

OC5.A.3.6.7 The tests are divided into the following two types;

(i) Frequency response volume tests as per OC5.A.3.6. Figure 1. These tests consist of frequency profile and ramp tests.

(ii) **System** islanding and step response tests as shown by OC5.A.3.6 Figure 2

OC5.A.3.6.8 There should be sufficient time allowed between tests for control systems to reach steady state (depending on available power resource). Where the diagram states 'HOLD' the current injection should be maintained until the **Active Power** (MW) output of the **Power Park Module** has stabilised or 90 seconds, which ever is the longer. All frequency response tests should be removed over the same timescale for which they were applied. **The Company** may require repeat tests should the response volume be affected by the available power, or if tests give unexpected results. When witnessed by **The Company** each test should be carried out as a separate injection; when not witnessed by **The Company** there must be sufficient time allowed between tests for the **Active Power** (MW) output of the **Power Park Module** to have stabilised or 90 seconds, whichever is the longer.

| Load Point | LF Event Profile 1 | LF Ramp -0.1Hz | HF Ramp +0.1Hz | LF Ramp -0.2Hz | HF Ramp +0.2Hz | LF Ramp -0.5Hz | HF Ramp +0.5Hz | LF Event Profile 2 |
|---|---|---|---|---|---|---|---|---|
| **MLP6** | | | 1 | 2 | 3 | | 4 | |
| **MLP5** | 5 | | | 6 | | | 7 | |
| **MLP4** | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| **MLP3** | 15 | | | | | | 16 | 17 |
| **MLP2** | 18 | | | 19 | 20 | 21 | | 22 |
| **MLP1** | 23 | | | 24 | 25 | | | 26 |

OC5.A.3.6. Figure 1 – Frequency response volume tests

| Load Point | +2.0* | ±0.02 | -0.2 | +0.2 | -0.5 | +0.5 | +0.6 | -0.5 | -2.0 | ± 0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **MLP6** | BC1 | | | | | | BC2 | | | L |
| **MLP6 LFSM** | BC3 | | | | | | BC4 | | | |
| **MLP5** | | | | | | | | A | | |
| **MLP4** | | D/E | F | G | H | I | | J | | M |
| **MLP4 LFSM** | | | | | | | | | | N |
| **MLP3** | | | | | | | | | | |
| **MLP2** | | | | | | | | | | |
| **MLP1** | | | | | | | | K | | |

OC5.A.3.6. Figure 2 – System islanding and step response tests

* This will generally be +2.0Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Designed Minimum Operating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example 0.9Hz is needed to take an initial output 65% to a final output of 20%. If the initial output was not 65% and the **Designed Minimum Operating Level** is not 20% then the injected step should be adjusted accordingly as shown in the example given below

| | |
|---|---|
| Initial Output | 65% |
| **Designed Minimum Operating Level** | 20% |
| Frequency Controller Droop | 4% |
| Frequency to be injected = | (0.65 - 0.20) x 0.04 x 50 = 0.9Hz |

** Tests L and M in Figure 2 shall be conducted if in this range of tests the **System Frequency** feedback signal is replaced by the injection signal rather than the injection signal being added to the **System Frequency** signal. The tests will consist of monitoring the **Power Park Module** in **Frequency Sensitive Mode** during normal **System Frequency** variations without applying any injection. Test N in Figure 2 shall be conducted in all cases. All three tests should be conducted for a period of at least 10 minutes.

OC5.A.3.6.9 The **Target Frequency** adjustment facility should be demonstrated from the normal control point within the range of 49.9Hz to 50.1Hz by step changes to the **Target Frequency** setpoint as indicated in OC5.A.3.6 Figure 3.

OC5.A.3.6. Figure 3 – Target Frequency setting changes

OC5.A.3.7 <u>Fault Ride Through Testing</u>

OC5.A.3.7.1 This section describes the procedure for conducting fault ride through tests on a single **Power Park Unit**.

OC5.A.3.7.2 The test circuit will utilise the full **Power Park Unit** (e.g. in the case of a wind turbine it would include the full wind turbine nacelle structure, all inverters and converters along with step up transformer to medium voltage, all control systems including pitch control emulation) and shall be conducted with sufficient power input resource available to produce at least 95% of the **Registered Capacity** of the **Power Park Unit**. The test will comprise of a number of controlled short circuits applied to a test network to which the **Power Park Unit** is connected, typically comprising of the **Power Park Unit** transformer and a test impedance or other decoupling equipment to shield the connected network from voltage dips at the **Power Park Unit** terminals.

OC5.A.3.7.3 In each case, the tests should demonstrate the minimum voltage at the **Power Park Unit** terminals or **High Voltage** side of the **Power Park Unit** transformer which the **Power Park Unit** can withstand for the length of time specified in OC5.A.3.7.5. Any test results provided to **The Company** should contain sufficient data pre and post fault in order to determine steady state values of all signals, and the power recovery timescales.

OC5.A.3.7.4 In addition to the signals outlined in OC5.A.1.2. the following signals from either the **Power Park Unit** terminals or **High Voltage** side of the **Power Park Unit** transformer should be provided for this test only:

(i) Phase voltages

(ii) Positive phase sequence and negative phase sequence voltages

(iii) Phase currents

(iv) Positive phase sequence and negative phase sequence currents

(v) Estimate of **Power Park Unit** negative phase sequence impedance

(vi) MW – **Active Power** at the generating unit.

(vii) MVAr – **Reactive Power** at the generating unit.

(viii) Mechanical Rotor Speed

(ix) Real / reactive, current / power reference as appropriate

(x) Fault ride through protection operation (e.g. a crowbar in the case of a doubly fed induction generator)

(xi) Any other signals relevant to the control action of the fault ride through control deemed applicable for model validation.

At a suitable frequency rate for fault ride through tests as agreed with **The Company**.

OC5.A.3.7.5 The tests should be conducted for the times and fault types indicated in OC5.A.3.7 Table 1.

| 3 Phase | Phase to Phase | 2 Phase to Earth | 1 Phase to Earth | Grid Code Ref |
|---|---|---|---|---|
| 0.14s | 0.14s | 0.14s | 0.14s | CC.6.3.15a |
| 0.384s | | | | CC.6.3.15b |
| 0.710s | | | | |
| 2.5s | | | | |
| 180.0s | | | | |

OC5.A.3.7 Table 1 – Types of fault for fault ride through **testing**

OC5.A.3.8 Reactive Power Transfer / Voltage Control Tests for Offshore Power Park Modules

OC5.A.3.8.1 In the case of an **Offshore Power Park Module** which provides all or a portion of the **Reactive Power** capability as described in CC.6.3.2(e)(iii) and / or voltage control requirements as described in CC.6.3.8(b)(ii) to enable an **Offshore Transmission Licensee** to meet the requirements of **STC** Section K, the testing, will comprise of the entire control system responding to changes at the onshore **Interface Point**. Therefore the tests in this section OC5.A.3.8 will not apply. The **Generator** shall cooperate with the relevant **Offshore Transmission Licensee** to facilitate these tests as required by **The Company**. The testing may be combined with testing of the corresponding **Offshore Transmission Licensee** requirements under the **STC**. The results in relation to the **Offshore Power Park Module** will be assessed against the requirements in the **Bilateral Agreement**.

OC5.A.3.8.2 In the case of an **Offshore Power Park Module** which does not provide part of the **Offshore Transmission Licensee Reactive Power** capability the following procedure for conducting reactive power transfer control tests on **Offshore Power Park Modules** and / or voltage control system as per CC6.3.2(e)(i) and CC6.3.2(e)(ii) apply. These tests should be carried out prior to 20% of the **Power Park Units** within the **Offshore Power Park Module** being synchronised, and again when at least 95% of the **Power Park Units** within the **Offshore Power Park Module** in service. There should be sufficient power resource forecast to generate at least 85% of the **Registered Capacity** of the **Offshore Power Park Module**.

OC5.A.3.8.3 The **Reactive Power** control system shall be perturbed by a series of system voltage changes and changes to the **Active Power** output of the **Offshore Power Park Module**.

OC5.A.3.8.4 **System** voltage changes should be created by a series of multiple upstream transformer taps. The **Generator** should coordinate with **The Company** or the relevant **Network Operator** in order to conduct the required tests. The time between transformer taps should be at least 10 seconds as per OC5.A.3.8 Figure 1.

OC5.A.3.8.5 The **Active Power** output of the **Offshore Power Park Module** should be varied by applying a sufficiently large step to the frequency controller reference/feedback summing junction to cause a 10% change in output of the **Registered Capacity** of the **Offshore Power Park Module** in a time not exceeding 10 seconds. This test does not need to be conducted provided that the frequency response tests as outlined in OC5.A.3.6 are completed.

OC5.A.3.8.6 The following diagrams illustrate the tests to be completed:

OC5.A.3.8 Figure 1 – Transformer tap sequence for reactive transfer tests

OC5.A.3.8 Figure 2 – Active Power ramp for reactive transfer tests

# APPENDIX 4 - COMPLIANCE TESTING FOR DC CONVERTERS AT A DC CONVERTER STATION

OC5.A.4.1 Scope

OC5.A.4.1.1 This Appendix outlines the general testing requirements for **DC Converter Station** owners to demonstrate compliance with the relevant aspects of the **Grid Code**, **Ancillary Services Agreement** and **Bilateral Agreement** and apply only to **DC Converter Station** owners. The testing requirements applicable to **HVDC System Owners** are specified in ECP.A.7. The tests specified in this Appendix will normally be sufficient to demonstrate compliance however **The Company** may:

(i) agree an alternative set of tests provided **The Company** deem the alternative set of tests sufficient to demonstrate compliance with the **Grid Code**, **Ancillary Services Agreement** and **Bilateral Agreement**; and/or

(ii) require additional or alternative tests if information supplied to **The Company** during the compliance process suggests that the tests in this Appendix will not fully demonstrate compliance with the relevant section of the **Grid Code**, **Ancillary Services Agreement** or **Bilateral Agreement**; and/or

(iii) require additional tests if control functions to improve damping of power system oscillations and/or subsynchronous resonance torsional oscillations required by the **Bilateral Agreement** or included in the control scheme and active; and/or

(iv) agree a reduced set of tests for subsequent **DC Converters** following successful completion of the first **DC Converter** tests in the case of a **Power Station** comprised of two or more **DC Converters** which **The Company** reasonably considers to be identical.

If:

(a) the tests performed pursuant to OC5.A.4.1.1(iv) in respect of subsequent **DC Converters** do not replicate the full tests for the first **DC Converter**, or

(b) any of the tests performed pursuant to OC5.A.4.1.1(iv) do not fully demonstrate compliance with the relevant aspects of the **Grid Code**, **Ancillary Services Agreement** and / or **Bilateral Agreement**,

then notwithstanding the provisions above, the full testing requirements set out in this Appendix will be applied.

OC5.A.4.1.2 The **DC Converter Station** owner is responsible for carrying out the tests set out in and in accordance with this Appendix and the **DC Converter Station** owner retains the responsibility for the safety of personnel and plant during the test. The **DC Converter Station** owner is responsible for ensuring that suitable arrangements are in place with the **Externally Interconnected System Operator** to facilitate testing. **The Company** will witness all of the tests outlined or agreed in relation to this Appendix unless **The Company** decides and notifies the **DC Converter Station** owner otherwise. Reactive Capability tests if required, may be witnessed by **The Company** remotely from the **The Company** control centre. For all on site **The Company** witnessed tests the **DC Converter Station** owner must ensure suitable representatives from the **DC Converter Station** owner and / or **DC Converter** manufacturer (if appropriate) are available on site for the entire testing period. In all cases and in addition to any recording of signals conducted by **The Company** the **DC Converter Station** owner shall record all relevant test signals as outlined in OC5.A.1.

OC5.A.4.1.3 In addition to the dynamic signals supplied in OC5.A.1 the **DC Converter Station** owner shall inform **The Company** of the following information prior to the commencement of the tests and any changes to the following, if any values change during the tests:

(i) All relevant transformer tap numbers.

OC5.A.4.1.4 The **DC Converter Station** owner shall submit a detailed schedule of tests to **The Company** in accordance with CP.6.3.1, and this Appendix.

OC5.A.4.1.5 Prior to the testing of a **DC Converter** the **DC Converter Station** owner shall complete the **Integral Equipment Tests** procedure in accordance with OC.7.5

OC5.A.4.1.6 Full **DC Converter** testing as required by CP.7.2 is to be completed as defined in OC5.A.4.2 through to OC5.A.4.5

OC5.A.4.1.7 **The Company** may agree a reduction from the requirements set out in CP.A.7.2 to CP.A.7.5 for on-site testing where suitable factory acceptance testing on a representative installation with the same equipment and settings of the **HVDC Equipment** that can, in **The Company's** opinion, reasonably represent the performance of the installed **HVDC Equipment** at that site. This is also conditional on **The Company** and the **DC Converter Station** owner agreeing sufficient on site testing of the fully commissioned **DC Converter Station** to demonstrate that the factory acceptance tests are valid. If in the reasonable opinion of **The Company**, the on-site testing does not demonstrate the factory acceptance tests are valid then the full set of on-site tests should be carried out.

OC5.A.4.2 Reactive Capability Test

OC5.A.4.2.1 This section details the procedure for demonstrating the reactive capability of an **Onshore DC Converter**. These tests should be scheduled at a time where there are sufficient MW resource forecasted in order to import and export full **Registered Capacity** of the **DC Converter**.

OC5.A.4.2.2 The tests shall be performed by modifying the voltage set-point of the voltage control scheme of the **DC Converter** by the amount necessary to demonstrate the required reactive range. This is to be conducted for the operating points and durations specified in OC5.A.4.2.5.

OC5.A.4.2.3 **Embedded DC Converter Station** owner should liaise with the relevant **Network Operator** to ensure the following tests will not have an adverse impact upon the **Network Operator's System** as per OC.7.5. In situations where the tests have an adverse impact upon the **Network Operator's System**, **The Company** will only require demonstration within the acceptable limits of the **Network Operator**. For the avoidance of doubt, these tests do not negate the requirement to produce a complete **DC Converter** performance chart as specified in OC2.4.2.1.

OC5.A.4.2.4 In the case where the **Reactive Power** metering point is not at the same location as the **Reactive Power** capability requirement, then an equivalent **Reactive Power** capability for the metering point shall be agreed between the **DC Converter Station** owner and **The Company**.

OC5.A.4.2.5 The following tests shall be completed for both importing and exporting of **Active Power** for a **DC Converter** (excluding current source technology):

(i) Operation at **Rated MW** and maximum continuous lagging **Reactive Power** for 60 minutes.

(ii) Operation at **Rated MW** and maximum continuous leading **Reactive Power** for 60 minutes.

(iii) Operation at 50% **Rated MW** and maximum continuous leading **Reactive Power** for 5 minutes.

(iv) Operation at 20% **Rated MW** and maximum continuous leading **Reactive Power** for 5 minutes.

(v) Operation at 20% **Rated MW** and maximum continuous lagging **Reactive Power** for 5 minutes.

(vi) Operation at less than 20% **Rated MW** and unity **Power Factor** for 5 minutes. This test only applies to systems which do not offer voltage control below 20% of **Rated MW**.

(vii) Operation at 0% **Rated MW** and maximum continuous leading **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

(viii) Operation at 0% **Rated MW** and maximum continuous lagging **Reactive Power** for 5 minutes. This test only applies to systems which offer voltage control below 20% and hence establishes actual capability rather than required capability.

OC5.A.4.2.6 For the avoidance of doubt, lagging **Reactive Power** is the export of **Reactive Power** from the **DC Converter** to the **Total System** and leading **Reactive Power** is the import of **Reactive Power** from the **Total System** to the **DC Converter**.

OC5.A.4.3 Reactive Control Testing For DC Converters (Current Source Technology)

OC5.A.4.3.1 The Reactive control testing for **DC Converters** employing current source technology shall be for both importing and exporting of **Active Power** and shall demonstrate that the **Reactive Power** transfer limits specified in the **Bilateral Agreement** are not exceeded. The **Reactive Power** control system shall be perturbed by a series of system voltage changes to the **Active Power** output of the **DC Converter** and changes of system voltage where possible. The **DC Converter Station** owner is responsible for ensuring that suitable arrangements are in place with the **Externally Interconnected System Operator** to facilitate the **Active Power** changes required by these tests

OC5.A.4.3.2 The **Active Power** output of the **DC Converter** should be varied by applying a sufficiently large step to the frequency controller reference/feedback summing junction to cause at least a 10% change in output of the **Registered Capacity** of the **DC Converter** in a time not exceeding 10 seconds. This test does not need to be conducted provided that the frequency response tests as outlined in OC5.A.4.3 are completed.

OC5.A.4.3.3 Where possible, **System** voltage changes should be created by a series of multiple upstream transformer taps. The **DC Converter station** owner should coordinate with **The Company** or the relevant **Network Operator** in order to conduct the required tests. The time between transformer taps should be at least 10 seconds as per OC5.A.4.3 Figure 1.

OC5.A.4.3.4 The following diagrams illustrate the tests to be completed:

OC5.A.4.3 Figure 1 – Transformer tap sequence for reactive transfer tests

OC5.A.4.3 Figure 2 – Active Power ramp for reactive transfer tests

OC5.A.4.4 Voltage Control Tests

OC5.A.4.4.1 This section details the procedure for conducting voltage control tests on **DC Converters** (excluding current source technology). These tests should be scheduled at a time where there is sufficient MW resource in order to import and export full **Registered Capacity** of the **DC Converter**. An **Embedded DC Converter Station** owner should also liaise with the relevant **Network Operator** to ensure all requirements covered in this section will not have a detrimental effect on the **Network Operator's System**.

OC5.A.4.4.2 The voltage control system shall be perturbed with a series of step injections to the **DC Converter** voltage reference, and where possible, multiple up-stream transformer taps.

OC5.A.4.4.3 For steps initiated using network tap changers, the **DC Converter Station** owner will need to coordinate with **The Company** or the relevant **Network Operator** as appropriate. The time between transformer taps shall be at least 10 seconds as per OC5.A.4.4 Figure 1.

OC5.A.4.4.4 For step injections into the **DC Converter** voltage reference, steps of ±1%, ±2% and ±4% shall be applied to the voltage control system reference summing junction. The injection shall be maintained for 10 seconds as per OC5.A.4.4 Figure 2.

OC5.A.4.4.5 Where the voltage control system comprises of discretely switched **Plant** and **Apparatus**, additional tests will be required to demonstrate that its performance is in accordance with **Grid Code** and **Bilateral Agreement** requirements.

OC5.A.4.4.6 Tests to be completed:

(i)

OC5.A.4.4 Figure 1 – Transformer tap sequence for voltage control tests

(ii)

OC5.A.4.4 Figure 2 – Step injection sequence for voltage control tests

OC5.A.4.5 Frequency Response Tests

OC5.A.4.5.1 This section describes the procedure for performing frequency response testing on a **DC Converter**. These tests should be scheduled at a time where there is sufficient MW resource in order to import and export full **Registered Capacity** of the **DC Converter**. The **DC Converter Station** owner is responsible for ensuring that suitable arrangements are in place with the **Externally Interconnected System Operator** to facilitate the **Active Power** changes required by these tests

OC5.A.4.5.2 The frequency controller shall be in **Frequency Sensitive Mode** or **Limited Frequency Sensitive Mode** as appropriate for each test. Simulated frequency deviation signals shall be injected into the frequency controller reference/feedback summing junction. If the injected frequency signal replaces rather than sums with the real **System Frequency** signal then the additional tests outlined in OC5.A.4.5.6 shall be performed with the **DC Converter** in normal **Frequency Sensitive Mode** monitoring actual system frequency, over a period of at least 10 minutes. The aim of this additional test is to verify that the control system correctly measures the real **System Frequency** for normal variations over a period of time.

OC5.A.4.5.3 In addition to the frequency response requirements it is necessary to demonstrate the **DC Converter** ability to deliver a requested steady state power output which is not impacted by power source variation as per CC.6.3.9. This test shall be conducted in **Limited Frequency Sensitive Mode** at a part-loaded output for a period of 10 minutes as per OC5.A.4.5.6.

Preliminary Frequency Response Testing

OC5.A.4.5.4 Prior to conducting the full set of tests as per OC5.A.4.5.6, **DC Converter Station** owners are required to conduct a preliminary set of tests below to confirm the frequency injection method is correct and the plant control performance is within expectation. The test numbers refer to Figure 1 below. These tests should be scheduled at a time where there is sufficient MW resource in order to export full **Registered Capacity** from the **DC Converter**. The following frequency injections shall be applied when operating at module load point 4.

| Test No (Figure 1) | Frequency Injection | Notes |
|---|---|---|
| 8 | • Inject - 0.5Hz frequency fall over 10 sec<br>• Hold until conditions stabilise<br>• Remove the injected signal | |
| 14 | • Inject +0.5Hz frequency rise over 10 sec<br>• Hold until conditions stabilise<br>• Remove the injected signal | |
| 13 | • Inject -0.5Hz frequency fall over 10 sec<br>• Hold for a further 20 sec<br>• At 30 sec from the start of the test, Inject a +0.3Hz frequency rise over 30 sec.<br>• Hold until conditions stabilise<br>• Remove the injected signal | |

OC5.A.4.5.5 The recorded results (e.g. Finj, MW and control signals) should be sampled at a minimum rate of 1 Hz to allow **The Company** to assess the plant performance from the initial transients (seconds) to the final steady state conditions (5-15 minutes depending on the plant design). This is not witnessed by **The Company**. The **DC Converter Station** owner shall supply the recordings including data to **The Company** in an electronic spreadsheet format. Results shall be legible, identifiable by labelling, and shall have appropriate scaling.

Full Frequency Response Testing Schedule Witnessed by **The Company**

OC5.A.4.5.6 The tests are to be conducted at a number of different Module Load Points (MLP). In the case of a **DC Converter** the module load points are conducted as shown below unless agreed otherwise by **The Company**.

| | |
|---|---|
| Module Load Point 6 (**Maximum Export Limit**) | 100% MEL |
| Module Load Point 5 | 90% MEL |
| Module Load Point 4 | 80% MEL |
| Module Load Point 3 | DMOL + 0.6 x (80% MEL – DMOL) |
| Module Load Point 2 (**Minimum Generation**) | DMOL + 0.3 x (80% MEL – DMOL) |
| Module Load Point 1 (**Designed Minimum Operating Level**) | DMOL |

OC5.A.4.5.7 The tests are divided into the following two types;

(i) **Frequency** response volume tests as per OC5.A.4.5. Figure 1. These tests consist of frequency profile and ramp tests.

(ii) **System** islanding and step response tests as shown by OC5.A.4.5 Figure 2

OC5.A.4.5.8 There should be sufficient time allowed between tests for control systems to reach steady state (depending on available power resource). Where the diagram states 'HOLD' the current injection should be maintained until the **Active Power** (MW) output of the **DC Converter** has stabilised or 90 seconds whichever is the longer. All frequency response tests should be removed over the same timescale for which they were applied. **The Company** may require repeat tests should the response volume be affected by the available power, or if tests give unexpected results. When witnessed by **The Company** each test should be carried out as a separate injection, when not witnessed by **The Company** there must be sufficient time allowed between tests for the **Active Power** (MW) output of the **HVDC Equipment** to have stabilised or 90 seconds, whichever is the longer.

| Load Point | LF Event Profile 1 | LF Ramp -0.1Hz | HF Ramp +0.1Hz | LF Ramp -0.2Hz | HF Ramp +0.2Hz | LF Ramp -0.5Hz | HF Ramp +0.5Hz | LF Event Profile 2 |
|---|---|---|---|---|---|---|---|---|
| **MLP6** | | | 1 | 2 | 3 | | 4 | |
| **MLP5** | 5 | | | 6 | | | 7 | |
| **MLP4** | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| **MLP3** | 15 | | | | | | 16 | 17 |
| **MLP2** | 18 | | | 19 | 20 | 21 | | 22 |
| **MLP1** | 23 | | | 24 | 25 | | | 26 |

OC5.A.4.5. Figure 1 – Frequency response volume tests

| Load Point | +2.0* | ±0.02 | -0.2 | +0.2 | -0.5 | +0.5 | +0.6 | -0.5 | -2.0 | ± 0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **MLP6** | BC1 | | | | | | BC2 | | | L |
| **MLP6 LFSM** | BC3 | | | | | | BC4 | | | |
| **MLP5** | | | | | | | | A | | |
| **MLP4** | | D/E | F | G | H | I | | J | | M |
| **MLP4 LFSM** | | | | | | | | | | N |
| **MLP3** | | | | | | | | | | |
| **MLP2** | | | | | | | | | | |
| **MLP1** | | | | | | | | K | | |

OC5.A.4.5. Figure 2 – System islanding and step response tests

* This will generally be +2.0Hz unless an injection of this size causes a reduction in plant output that takes the operating point below the **Designed Minimum Operating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example 0.9Hz is needed to take an initial output of 65% to a final output of 20%. If the initial output was not 65% and the **Designed Minimum Operating Level** is not 20% then the injected step should be adjusted accordingly as shown in the example given below

| | |
|---|---|
| Initial Output | 65% |
| **Designed Minimum Operating Level** | 20% |
| Frequency Controller Droop | 4% |
| Frequency to be injected = | (0.65 - 0.20) x 0.04 x 50 = 0.9Hz |

** Tests L and M in Figure 2 shall be conducted if in this range of tests the **System Frequency** feedback signal is replaced by the injection signal rather than the injection signal being added to the **System Frequency** signal. The tests will consist of monitoring the **DC Converter** in **Frequency Sensitive Mode** during normal **System Frequency** variations without applying any injection. Test N in Figure 2 shall be conducted in all cases. All three tests should be conducted for a period of at least 10 minutes.

OC5.A.4.6.9 The **Target Frequency** adjustment facility should be demonstrated from the normal **Control Point** within the range of 49.9Hz to 50.1Hz by step changes to the **Target Frequency** setpoint as indicated in OC5.A.4.6 Figure 3.

OC5.A.4.6. Figure 3 – Target Frequency setting changes

**< END OF OPERATING CODE NO. 5 >**