System Services

Reserve Test Report

Fast Frequency Response (FFR), Primary, Secondary and Tertiary Reserve (POR, SOR, TOR1, TOR2)

Interconnector

Site Name

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# Document Version History

Revision 3.0 published 12th November 2019

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Version** | **Date** | **Comment** | **Name** | **Company** |
| 0.1 | Insert Date | Minor version (v0.1) - First submission for review and approval | Insert Name | Unit Company Name |
| 1.0 | Insert Date | Revised to version 1.0 following approval by EirGrid, SONI. | Insert Name | Unit Company Name |

# Introduction

The Unit shall submit the latest version of this test report template as published on the EirGrid, SONI websites[[1]](#footnote-2).

The report shall be developed for technical and non-technical readers and shall follow the agreed test programme. The report is submitted to [generator\_testing@eirgrid.com](mailto:generator_testing@eirgrid.com) or [generation\_testing @soni.ltd.uk](mailto:generation_testing@soni.ltd.uk) as appropriate.

Submission of this document is required if a Unit does not have and existing FFR, POR, SOR or TOR1 Contract or is making changes or updates to any of the affected parameters.

To complete the report, the Unit shall have either:

1. Recorded frequency response data as per the test procedure agreed with EirGrid, SONI; or
2. Performance Data showing frequency response capability.

Any issue with meeting any requirements or completing this report, please contact [generator\_testing@eirgrid.com](mailto:generator_testing@eirgrid.com) or [generation\_testing @soni.ltd.uk](mailto:generation_testing@soni.ltd.uk) as appropriate.

# Abbreviations

CHCC Castlereagh House Control Centre

NCC National Control Centre

MVAr Mega Volt Ampere – reactive

MW Mega Watt

TSO Transmission System Operator

MEC Maximum Export Capacity

MIC Maximum Import Capacity

RPM Revolutions Per Minute

kV kilovolt

EDIL Electronic Dispatch Instruction Logger

POR Primary Operating Reserve

SOR Secondary Operating Reserve

TOR Tertiary Operating Reserve

FFR Fast Frequency Response

HVDC High Voltage Direct Current

# Unit DATA

|  |  |
| --- | --- |
| Unit Test Coordinator | Unit to Specify Name, Company and contact details. |
| Unit name | Unit to Specify |
| Unit connection point | HV Bushings of T101 in XX 110kV station |
| Unit connection voltage | Unit to Specify |
| Registered Import Capacity | Unit to Specify |
| Registered Export Capacity | Unit to Specify |
| Contracted MEC | Unit to Specify |
| Contracted MIC | Unit to Specify |
| Installed Plant | Unit to Specify |
| Control system Droop Setting (expected) | Unit to Specify |

# System Services definitions

## Fast frequency response

FFR is defined as the additional increase in MW output from a unit or a reduction in demand following a frequency event that is available within two seconds of the start of the event and sustainable for at least eight seconds afterwards

The extra energy provided by the MW increase, in the timeframe from the FFR response time to 10 seconds **shall be greater** than any loss of energy in the ten-to-twenty second timeframe afterwards due to a reduction in MW output. The energy provided and drawn should be compared to the pre-event output.



Figure 1: FFR being delivered after a frequency event

As shown in the diagram above, in order to be eligible for FFR the amount indicated by the blue hatched area (Power provided) must be greater than the green hatched area (Power drawn). If the amount of power drawn exceeds (or is equal to) the amount of power given (within the time frame) then the unit will not be eligible for an FFR contract.

* 1. **FFR Response Time**

A Providing Unit’s contracted FFR Response Time is the time from when the frequency falls through its contracted Reserve Trigger (T=0) to the time at which the Providing Unit must have achieved its contracted FFR volume, as dictated by its contracted FFR response curve.

The FFR response time provided in Section 7.4 shall be based on test data.

Please note that the FFR Response Time, as recorded on the Providing Unit’s installed performance measurement equipment, will be evaluated as part of the FFR performance monitoring process.

The product scalar for faster response of FFR will be based on the FFR response time of the Providing Unit.

## POR, SOR & TOR1[[2]](#footnote-3)

### Operating Reserve

Operating Reserve is defined as the additional MW output provided from Generation plant, reduction of Active power transfer to an external system or increase of Active power transfer to the Transmission system by interconnectors, or reduction in Customer demand, which must be realisable in real time operation to contain and correct any potential Transmission system deviation to an acceptable level.

### Primary Operating Reserve (POR)

Primary Operating Reserve (POR) is the additional MW output (and/or reduction in Demand) required at the frequency nadir (minimum), compared to the pre-incident output (or Demand) where the nadir occurs between 5 and 15 seconds after an Event.

### Secondary Operating Reserve (SOR)

Secondary Operating Reserve (SOR) is the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand), which is fully available and sustainable over the period from 15 to 90 seconds following an Event.

### Tertiary Operating Reserve band 1 (TOR1)

Tertiary Operating Reserve band 1 (TOR1) is the additional MW output (and/or reduction in Demand) required compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 90 seconds to 5 minutes following an Event.

## Dynamic & Static Response

### FFR Dynamic Capability requirements

Dynamic response is when a Unit tracks the system frequency and adjust its response accordingly. A Unit providing a dynamic response shall meet the following criteria:

1. The unit shall track changes in frequency dynamically.
2. Contain **at least** 10 discrete steps or sources which can dynamically adjust load contributions in response to frequency. No individual step shall be larger than 5MW and the response shall be provided in a linear, monotonically increasing manner. All step sizes shall be no more than +/- 1MW of the average step size[[3]](#footnote-4).
3. The unit shall have the capability to commit to a frequency trigger set point greater than or equal to 49.8 Hz and less than or equal to 49.985 Hz.
4. Have frequency measurement installed locally.
5. The unit shall be able to operate with a minimum trajectory[[4]](#footnote-5) of 2Hz in response to a Reserve Trigger.
6. While the basic energy recovery requirement of the FFR product is to apply[[5]](#footnote-6), to qualify as a dynamic provider, the unit shall be able to operate without recovering its resource[[6]](#footnote-7) until the system frequency has recovered to within 5% of the pre-event frequency in steady-state for a period of up to 5 mins (the exact timeframe will be instructed by the TSOs);
7. The unit’s provision of POR, SOR and TOR1, if contracted for any of these Services, shall mirror its FFR response characteristics, i.e. the unit shall have the capability of continuing along the trajectory of the applicable frequency response curve for the extended timeframes obligated of POR, SOR and TOR1, as required of the TSOs in response to a Reserve Trigger.
8. The unit shall have a PMU in situ. PMU shall meet the current metering standards.

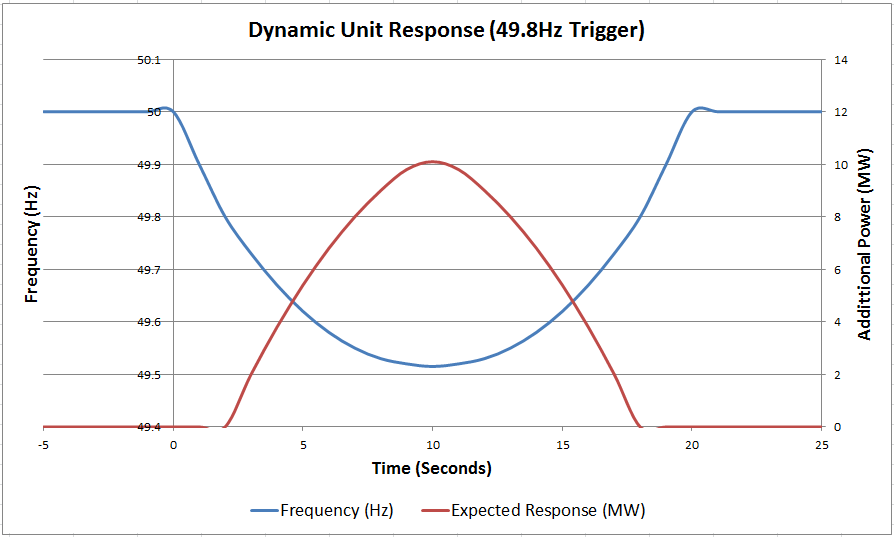


Figure 2: Example of a Dynamic unit response with a trigger point of 49.8Hz

As shown in figure 2, above, as the frequency drops the unit does not respond until the trigger point is reached (in this example the trigger point is set at 49.8Hz). When this point is reached the unit output begins ramping up in discrete steps (steps in accordance with the requirements stated in section 5.3.1), staying as close as possible to the expected output. The output steps down also as the frequency returns to nominal (50Hz). This is what is expected of a dynamic response.

### Static response capability requirements

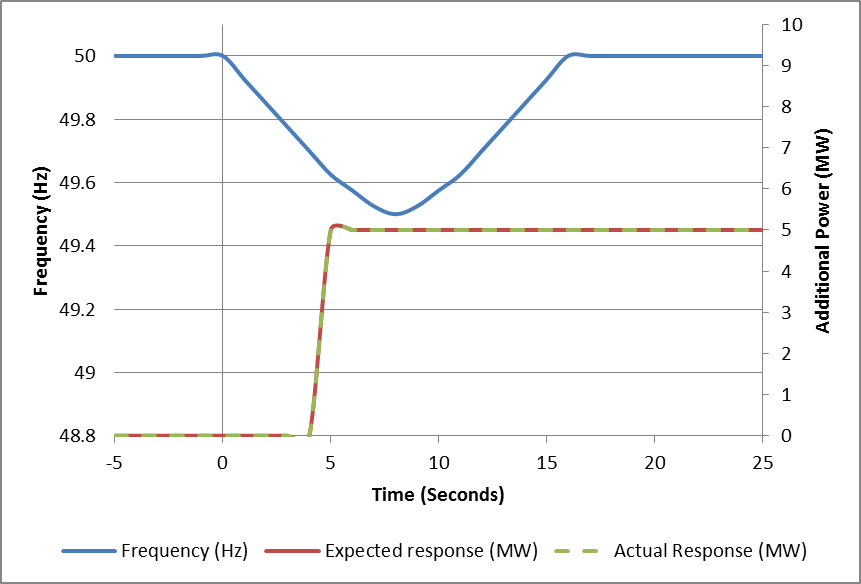
A Static response is where the Unit provides its entire response at one single trigger point.

Figure 4: Example of a Static response from a unit with a trigger point of 49.8Hz

# Assessment

The MW amount is based on the absolute lowest sustainable value the unit is capable of delivering in the given timeframe for the service.

The following are examples of how the different operating reserve services are graphed and assessed:

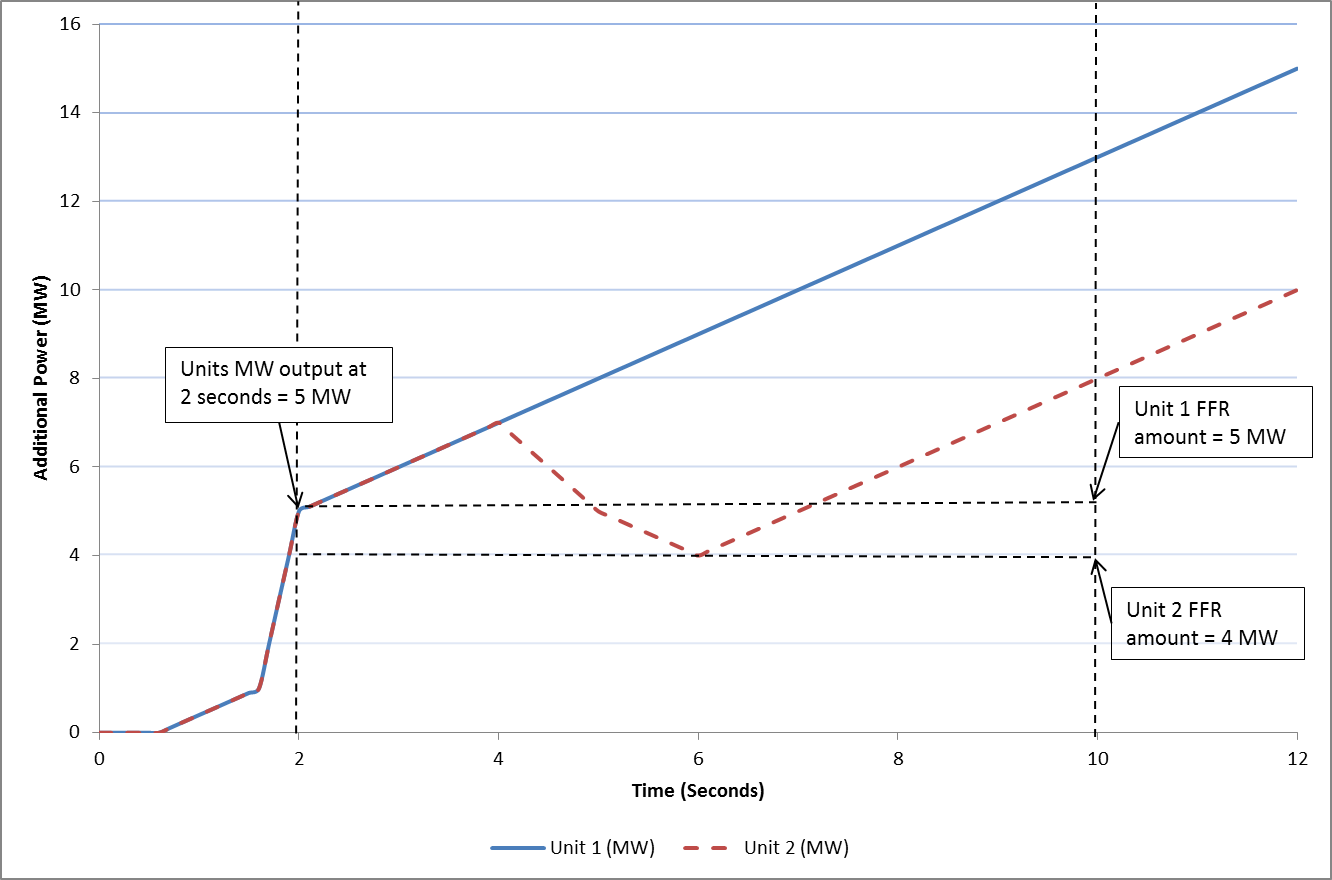


Figure 5: Example of how to measure the FFR MW amount

As shown in figure 5, above, both units begin ramping up and both reach 5MW at two seconds. Both begin ramping up over the course of the time period, however unit 2 (red dashed line) output drops to 4MW at one point where as Unit 1 (blue solid line) continues to ramp up. This shows that Unit 1 has a lowest sustainable MW output over the time period of 5MW and Unit 2 has a lowest sustainable MW output of 4MW. These are the units’ FFR MW capacities[[7]](#footnote-8).

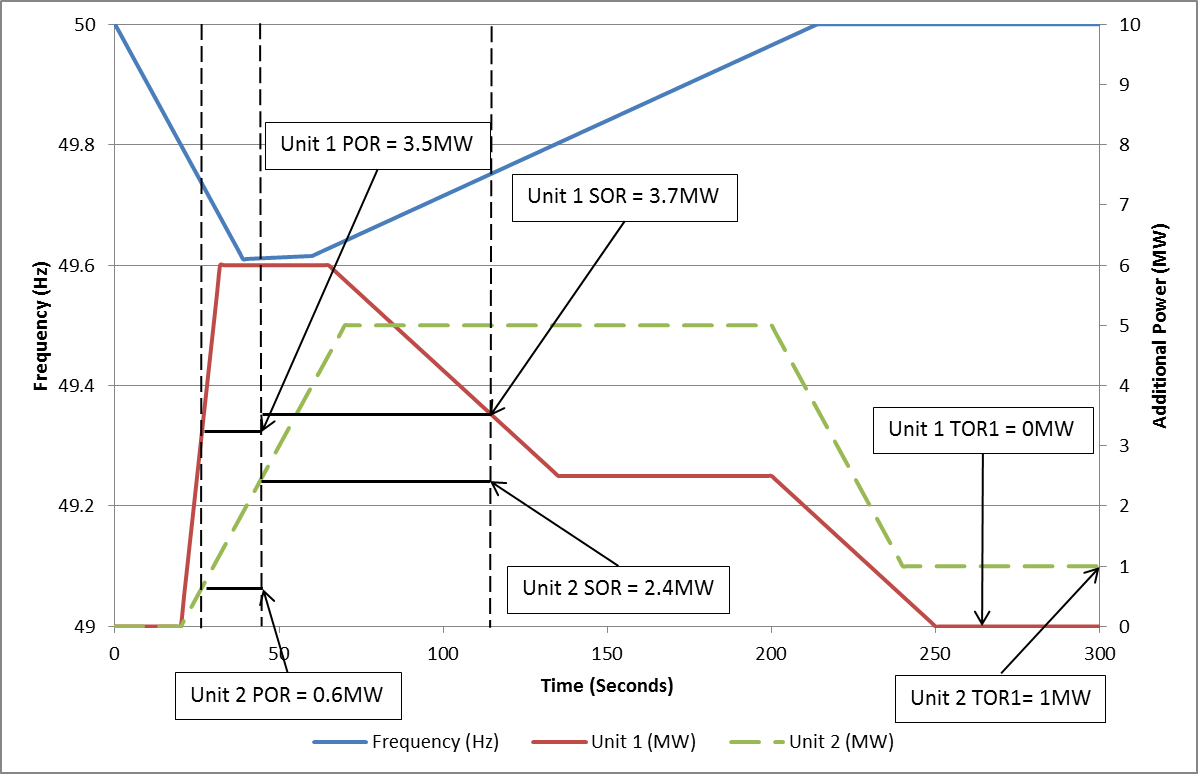


Figure 6: Example of how to measure the POR, SOR and TOR1 MW amounts

## FFR scalar

A product scalar incentivising advance FFR provision is available if the FFR can be provided prior to the two second threshold. If a unit wished to avail of this scalar then it is necessary to demonstrate this capability in the graphs in this report and specify the exact time this provision can be reached and sustained for. For this scalar a 20ms (or quicker) sampling rate shall be used for the measurements with agreement from EirGrid, SONI where applicable.

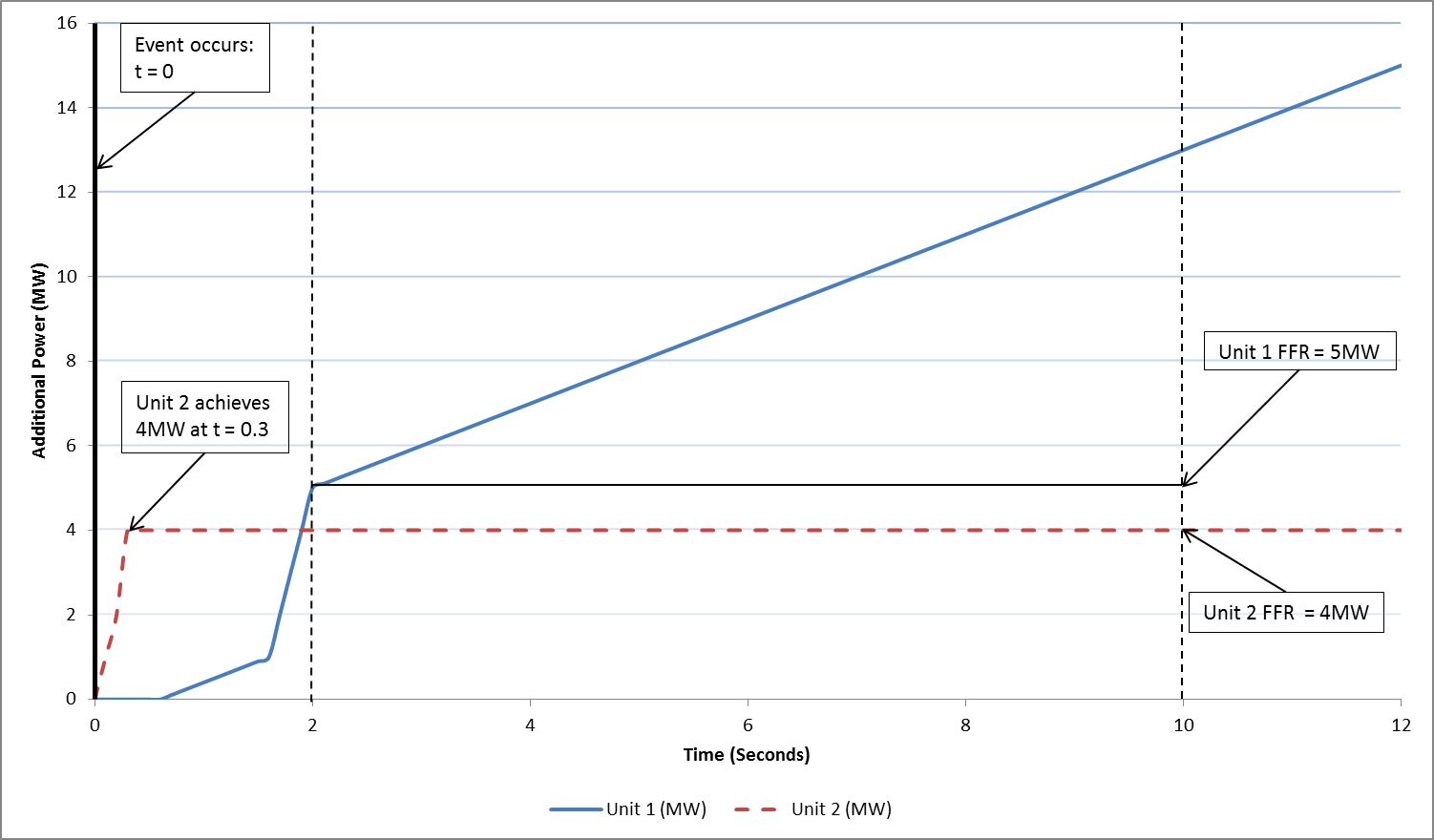


Figure 7: Example showing a unit achieving its’ FFR at 0.3 seconds, qualifying it for the FFR Scalar

# Results

## Summary of testing

Testing was completed on [DATE].

*[Insert comment on the results, highlighting any issues encountered in performing the test or in analysing the results].*

*[Include outline of operation of frequency control as set out under IOP with Other TSO].*

*[Insert Report summary]*

*[Include any relevant test notes here, relating to how the test was carried out or to any specific conditions encountered during the test.]*

*[Any abnormal behaviour during the test (spikes, dips, unusual vibrations, etc.) shall be noted and documented. The reasons behind these shall be detailed along with any corrective actions taken and what its effects are on the unit and/or the result. If possible a clear graph of the issue shall also be presented.]*

*[The following values are as a result of testing information analysed below]*

## FFR, POR, SOR, TOR1 Results

The following table shows the **minimum sustained** FFR, POR, SOR and TOR values achieved for each load range during testing.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Load Level** | | **(a) FFR Energy Provided (2 – 10 Sec)** | **(b) FFR Energy drawn (10 – 20 Sec)** | **FFR Eligibility: is (a) MW > (b) MW?** | **FFR** | **POR**  **(5 -15 Sec)** | **SOR**  **(15 – 90 Sec)** | **TOR1**  **(90 – 300 Sec)** |
| 1 |  | | \_\_\_\_\_\_MWs | \_\_\_\_\_\_MWs | Yes/No | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW |
| 2 |  | | \_\_\_\_\_\_MWs | \_\_\_\_\_\_MWs | Yes/No | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW |
| 3 |  | | \_\_\_\_\_\_MWs | \_\_\_\_\_\_MWs | Yes/No | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW |
| 4 |  | | \_\_\_\_\_\_MWs | \_\_\_\_\_\_MWs | Yes/No | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW |
|  | | Assess each of the load points above, for FFR, POR, SOR and TOR and identify the maximum value achieved. | | | | | | | |
| Maximum Value | | | MW range over which the unit can provide FFR  \_\_\_\_\_MW to \_\_\_\_\_MW | | | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW | \_\_\_\_\_\_MW |

## Deadband test

### Parameter Settings

|  |  |
| --- | --- |
| **Test Details** | |
| Deadband Settable range | From +/-\_\_\_Hz to +/-\_\_\_\_Hz |
| Deadband setting for test | +/-\_\_\_Hz |
| Droop | \_\_\_% |
| Trajectory | \_\_\_\_\_\_MW/Hz  From edge of deadband |
| Dynamic Frequency Response Mode | ON / OFF |
| Static Frequency Response | ON / OFF |
| PMax Limit (Under-frequency response) | \_\_\_\_\_MW |
| PMax Limit (Over-frequency response) | \_\_\_\_\_\_MW |
| Simulated Frequency Description | * Reference frequency at To\_\_\_\_\_Hz * Simulated Frequency \_\_\_\_\_\_Hz * Simulated Frequency Ramp Rate \_\_\_\_ms |

### Graph of results

[State sample rate for the tests i.e. if it is 20ms or 100ms]

[Insert graph with analysis of results in next section, include data points and clear labelling on the graph for points of interest i.e. at 5 seconds, MW was…..]

### Analysis

[Insert comment on dynamic provision]

## Test 1

### Parameter Settings

|  |  |
| --- | --- |
| **Test Details** | |
| Deadband Settable range | From +/-\_\_\_Hz to +/-\_\_\_\_Hz |
| Deadband setting for test | +/-\_\_\_Hz |
| Droop | \_\_\_% |
| Trajectory | \_\_\_\_\_\_MW/Hz  From edge of deadband |
| Dynamic Frequency Response Mode | ON / OFF |
| Static Frequency Response | ON / OFF |
| PMax Limit (Under-frequency response) | \_\_\_\_\_MW |
| PMax Limit (Over-frequency response) | \_\_\_\_\_\_MW |
| Simulated Frequency Description | * Reference frequency at To\_\_\_\_\_Hz * Simulated Frequency \_\_\_\_\_\_Hz * Simulated Frequency Ramp Rate \_\_\_\_ms |

### Graph of Results

[State sample rate for the tests]

[Insert graph with analysis of results, include data points and clear labelling on the graph for points of interest i.e. at 5 seconds, MW was….]

### Analysis

## Test 2 [update title as appropriate]

[Include analysis of proportional response]

## Test 3 [update as appropriate]

## Test 4 [update as appropriate]

## Static Frequency Settings and trigger points

[Use table to provide existing contract values which shows settable range and values and trigger points and time delays as applicable]

## Online signalling Commissioned and Data measurement

[Include table or online signalling that is available wrt system services Signalling requirements]

## Commissioned Values post test

|  |  |
| --- | --- |
| **Parameter** | **Setting** |
| Droop Setting | \_\_\_\_\_%  \_\_\_\_\_\_MW/Hz |
| Deadband | +/-\_\_\_Hz |
| Dynamic Frequency Response Mode | ON/OFF |
| Dynamic Frequency Trigger point when Frequency response is on | +/-\_\_\_Hz |
| Static Frequency Response Mode | ON/OFF |
| Dynamic Frequency Trigger point when Frequency response is on | +/-\_\_\_Hz |

[Include any time delays or limitations for provision of response.]

* 1. **FFR Response Characteristics**

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Details** | **Value** | **Comment** |
| **1** | **FFR Response Time** | **\_\_\_\_\_ms** |  |
| **2** | **Is the response Static or Dynamic?** |  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  *User to fill in sections below as applicable* |
|  | **Dynamic Response Characteristics** | | |
| **3** | **Reserve Trigger** | **\_\_\_\_Hz** |  |
| **4** | **Trajectory Capability** | **\_\_\_\_Hz** |  |
|  | **Static Response Characteristics** | | |
| **5** | **Reserve trigger** | **\_\_\_\_Hz** |  |
| **7** | **Number of discrete steps** |  |  |
| **8** | **Max discrete step value for static provision** | **MW** |  |

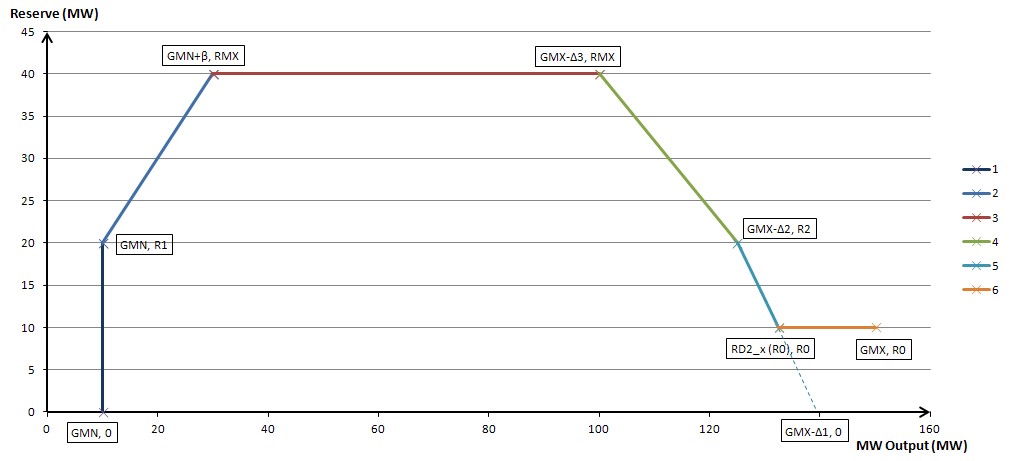
* 1. **Proposed Volumes**

Please provide the proposed contract values for each service as per test results.

|  |  |  |
| --- | --- | --- |
| **1** | Proposed Maximum FFR Available Volume | **\_\_\_\_MW** |
| **2** | Proposed Maximum POR Available Volume | **\_\_\_\_MW** |
| **3** | Proposed Maximum SOR Available Volume | **\_\_\_\_MW** |
| **4** | Proposed Maximum TOR1 Available Volume | **\_\_\_\_MW** |
| **5** | Proposed Maximum TOR2 Available Volume | **\_\_\_\_MW** |

* 1. **Reserve Curve Characteristics**

The Unit shall provide a proposed reserve curve for each service based on test data showing the levels of Operating Reserve at varying MW outputs.



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **FFR** | **POR** | **SOR** | **TOR1** | **TOR2** |
| **RMX (Max reserve volume)** |  |  |  |  |  |
| **GMN (Min Load / Min Gen)** |  |  |  |  |  |
| **R0** |  |  |  |  |  |
| **R1** |  |  |  |  |  |
| **R2** |  |  |  |  |  |
| **DELTA1** |  |  |  |  |  |
| **DELTA2** |  |  |  |  |  |
| **DELTA3** |  |  |  |  |  |
| **BETA** |  |  |  |  |  |

1. <http://www.eirgridgroup.com/> or <http://www.soni.ltd.uk/> [↑](#footnote-ref-2)
2. Definitions form DS3 System Services Decision Paper SEM-13-098: <https://www.semcommittee.com/sites/semcommittee.com/files/media-files/SEM-13-098%20%20DS3%20System%20Services%20Technical%20Definitions%20Decision%20Paper%20-%20FINAL_0.pdf>

   [↑](#footnote-ref-3)
3. Where average step size = (Available FFR volume / number of discrete steps) [↑](#footnote-ref-4)
4. Trajectory is defined in the DS3 System services contract paper Pg.39: <http://www.eirgridgroup.com/site-files/library/EirGrid/DS3-System-Services-Contracts-Recommendations_final.pdf> [↑](#footnote-ref-5)
5. DS3 System Services Technical Definitions Decision Paper SEM-13-098 20/12/2013, page 10

   <https://www.semcommittee.com/sites/semcommittee.com/files/media-files/SEM-13-098%20%20DS3%20System%20Services%20Technical%20Definitions%20Decision%20Paper%20-%20FINAL_0.pdf> [↑](#footnote-ref-6)
6. For example, a battery charging to its pre-event output [↑](#footnote-ref-7)
7. Assuming that the units meet the FFR requirements of not drawing more energy from the grid in the subsequent 10 – 20 second time period afterwards than it supplied. [↑](#footnote-ref-8)