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

System Services Test Procedure

Thermal and Hydro

Unit Name

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# Document Revision 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 | Insert company |
| 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 procedure as published on the EirGrid or SONI website[[1]](#footnote-2).

All yellow sections shall be filled in before the test procedure will be approved. All grey sections shall be filled in during testing. If any test requirements or steps are unclear, or if there is an issue with meeting any requirements or carrying out any steps, please contact [generator\_testing@eirgrid.com](mailto:generator_testing@eirgrid.com) or  [generator\_testing@soni.ltd.uk](mailto:%20%20generator_testing@soni.ltd.uk%20)  as appropriate

On the day of testing, suitably qualified technical personnel are required on site to assist in undertaking the tests. The personnel shall have the ability to:

1. Set up and disconnect the control system and instrumentation as required;
2. Ability to fully understand the Unit’s function and its relationship to the System;
3. Liaise with NCC, CHCC as required;
4. Mitigate issues arising during the test and report on system incidents.

The availability of personnel at NCC, CHCC will be necessary in order to initiate the necessary instructions for the test. NCC, CHCC will determine:

1. If network conditions allow the testing to proceed.
2. Which tests will be carried out
3. When the tests will be carried out.

On completion of this test, the following shall be submitted to [generator\_testing@eirgrid.com](mailto:generator_testing@eirgrid.com) or  [generator\_testing@soni.ltd.uk](mailto:%20generator_testing@soni.ltd.uk%20)

|  |  |
| --- | --- |
| **Submission** | **Timeline** |
| A scanned copy of the test procedure, as completed and signed on site on the day of testing | 1 working day |
| Test data in CSV or Excel format | 1 working day |
| Test report | 10 working days |

# 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

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

# Unit DATA and Calculations

## 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 |
| Unit fuel type | Primary Fuel / Secondary Fuel, Gas / Distillate. |
| Operating modes | *e.g.* OCGT, CCGT, Sync Comp *etc*. |
| Registered capacity / (NI) maximum continuous rating | Unit to Specify |
| Contracted MEC | Unit to Specify |
| Installed plant | Unit to Specify |
| House load (estimated) | Unit to Specify |
| Governor control system droop setting (expected) | Unit to Specify |
| Minimum load | Unit to Specify |
| Minimum generation | Unit to Specify |
| Expected response time to frequency event | Unit to specify |

## Calculation

|  |  |
| --- | --- |
| **% of Registered Capacity** | **MW Calculation** |
| 5% | \_\_\_\_\_\_\_\_\_\_MW |
| 8% | \_\_\_\_\_\_\_\_\_\_MW |
| 10% | \_\_\_\_\_\_\_\_\_\_MW |
| 25% | \_\_\_\_\_\_\_\_\_\_MW |

# System Services

The definitions referenced in this document are for indicative purposes only. In the event of inconsistency between the definitions in this document and those in the DS3 System Services Agreement, the definitions in the DS3 System Services Agreement shall prevail.

## Fast frequency response (FFR)

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 over the period from FFR Response Time to 10 seconds.

The extra energy provided, in the two-to-ten second timeframe, by the MW increase **shall be greater** than any loss of energy in the ten-to-twenty second timeframe afterwards due to a reduction in MW output.



Figure 1: Example graph showing the additional power provided to and drawn from the grid

As shown in the diagram above, in order to be eligible for FFR the amount indicated by the blue hatched area (Power provided) shall 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.

## 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.

## Operating Reserve (POR, SOR and TOR1)

### 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 shall 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 at the frequency nadir (minimum), 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 (TOR1) is the additional MW output (and/or reduction in Demand) required at the frequency nadir (minimum), 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.

### Tertiary Operating Reserve band 2 (TOR2)

Tertiary Operating Reserve (TOR2) is the additional MW output (and/or reduction in Demand) required at the frequency nadir (minimum), compared to the pre-incident output (or Demand) which is fully available and sustainable over the period from 5 minutes to 20 minutes following an event.

# Site Safety requirements

The following is required for the EirGrid, SONI witness to attend site:

|  |  |
| --- | --- |
| Personal Protective Equipment Requirements   1. Site Safety boots 2. Hard Hat with chin strap 3. Hi Vis 4. Arc Resistive clothing 5. Safety Glasses 6. Gloves 7. Safe Pass | 1. Yes / No 2. Yes / No 3. Yes / No 4. Yes / No 5. Yes / No 6. Yes / No 7. Yes / No |
| Site Induction requirements | Yes / No  (If Yes, Unit to specify how and when the induction shall carried out) |
| Any further information | Unit to specify |

# Test Description and Pre-Conditions

## Purpose

The purpose of this test is to demonstrate the following:

1. For FFR:
   1. The unit response within two seconds of frequency passing through the FFR trigger frequency.
   2. The units MW output up to 10 seconds following the event.
   3. The unit does not draw in more energy in the 10 – 20 seconds timeframe after the event.
2. For POR, SOR and TOR1,TOR2
   1. The levels of Primary, Secondary and Tertiary Operating Reserves provided by the unit for the following load values.

by carrying out the following frequency injections. Note that additional injections may be included as required to establish the unit’s decrement rate:

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Cast No.** | **Load Level** | **Frequency Injection** | **Hold Step for a minimum of duration of the services being sought** |
| 1 | 95% | -0.5Hz | 20 minutes |
| 2 | 90% | -0.5Hz | 20 minutes |
| 3 | 75% | -0.5Hz | 20 minutes |
| 4 | 50% | -0.5Hz | 20 minutes |
| 5 | Minimum | -0.5Hz | 20 minutes |

## Initial Conditions

Should “No” be answered to any of the following, contact [the](mailto:generator_testing@eirgrid.com) EirGrid, SONI test coordinator and agree next steps in advance of making any corrective actions.

|  |  |  |
| --- | --- | --- |
| **No.** | **Conditions** | **Check on day of test** |
| 1 | Test Profiles have been submitted and approved by EirGrid, SONI | Yes/No |
| 2 | Unit Fuel Type: Primary Fuel / Secondary Fuel, Gas / Distillate. | Yes/No |
| 3 | Normal start up support auxiliary systems in service. | Yes/No |
| 4 | Required signals, as described in section 8 are available | Yes/No |
| 5 | High Speed data recorder has been installed in line with the DS3 Performance Measurement Device Standards for Fast Acting Services[[2]](#footnote-3) | Yes/No |

## Simulated Injection Details

The following test shall be conducted using a simulated -500 mHz frequency step being injected into the governor control system. It is recommended that the governor control system is isolated from the system frequency in order to perform this test as the natural variation in system frequency will not be a factor in the Units measured response. In order to accurately determine output the unit will run at base load for a period of time before the frequency injection testing begins.

|  |  |
| --- | --- |
| **Simulation Details** | **Comment** |
| Describe how the frequency simulation is injected i.e.   1. is the frequency injected using software or external hardware? 2. Frequency injected as an offset to the system frequency or is the governor control system isolated from the system frequency | 1. Unit to specify 2. Unit to specify |
| Are there any limitations to how the frequency injection is applied? i.e. can the frequency be injected as a ramp or as a step? | Unit to specify |

# Instrumentation and Onsite Data Trending

All of the following trends and screenshots shall be recorded by the Unit during the test. Failure to provide any of these trends will result in test cancellation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No.** | **Signal Name** | **Sample Rate** | **Source** | **Check on day of test** |
| 1 | Active Power at Connection Point (MW) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 3 | Active Power at Generator (MW) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 4 | Reactive Power at Generator (MVAr) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 5 | Simulated Frequency (Hz) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 6 | Generator Voltage (kV) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 7 | Turbine Speed (RPM) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 8 | Shaft Vibration (*µ*mp-p) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 9 | Blade Path Temperature (°C) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 10 | Bearing Metal Temperature (°C) | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 11 | Process variables e.g. Inlet Guide Vane position, Fuel Control Valve position etc. | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 12 | Other signals as required by the unit or by the TSO | Unit to specify, 100ms or as agreed with TSO (20ms for FFR scalar product) | Unit to specify | Yes/No |
| 13 | Alarm/Event page | Screenshot of alarms / events for duration of the test. | | Yes/No |
| 14 | Generator Overview Screen | Screenshots may be required where test data/milestone/event is not available through the trends listed above. | | Yes/No |
| 15 | EDIL instructions | Screenshot as logged during the test. | | Yes/No |

# Test Steps

The order of this test can be rearranged in agreement with EirGrid, SONI.

## Verification of Base Load

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Time** | **Comment** |
| 1 | Begin data recording of signals as set out in section 8 |  |  |
| 2 | Request NCC, CHCC permission to   1. Turn frequency response off 2. Issue an EDIL Dispatch Instruction to bring the unit to full output. |  | Frequency Response Status: On / Off  Base Load: \_\_\_\_\_\_\_MW |
| 3 | When the Unit reaches full load record the Active Power Output at the connection point and maintain this output until the Unit has stabilised |  | Stable Full Load level = \_\_\_\_\_MW at connection point. |
| 4 | Request NCC, CHCC permission to turn Frequency Response on |  |  |

## 95% -0.5 Hz Step

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Time** | **Comment** |
| 1 | Generator control room contacts NCC, CHCC and:   1. Requests an EDIL Dispatch Instruction to bring the unit to **\_\_\_\_MW (Base load – 5% of Reg Cap)** 2. Confirms the MW swing that will occur during the frequency injection |  | **Base load – 5% of Reg Cap**: \_\_\_MW |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject **Step change of -0.5 Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time |  | Completion time \_\_\_\_\_\_. |
| 5 | Remove the frequency simulation and allow the unit to return its pre injection load under governor control system action |  |  |
| 6 | Stop recording |  |  |
| 7 | Step completed |  |  |

## 90% -0.5 Hz Step

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Time** | **Comment** |
| 1 | Generator control room contacts NCC, CHCC and:   1. Requests an EDIL Dispatch Instruction to bring the unit to **\_\_\_ MW (Base load – 10% of Reg Cap)** 2. Confirms the MW swing that will occur during the frequency injection |  | **Base load – 10% of Reg Cap**: \_\_\_MW |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject **Step change of -0.5 Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time |  | Completion time \_\_\_\_\_\_. |
| 5 | Remove the frequency simulation and allow the unit to return its pre injection load under governor control system action |  |  |
| 6 | Stop data recording |  |  |
| 7 | Test completed |  |  |

## 75% -0.5 Hz Step

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Time** | **Comment** |
| 1 | Generator control room contacts NCC, CHCC and:   1. Requests EDIL Dispatch Instruction to bring the unit to **\_\_\_ MW (Base load – 25% of Reg Cap)** 2. Confirms the MW swing that will occur during the frequency injection |  | **Base load – 25% of Reg Cap**: \_\_\_MW |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject **Step change of -0.5 Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time |  | Completion time \_\_\_\_\_\_. |
| 4 | Remove the frequency simulation and allow the unit to return its pre injection load under governor control system action |  |  |
| 5 | Stop data recording |  |  |
| 6 | Step completed |  |  |

## 50% -0.5 Hz Step

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Time** | **Comment** |
| 1 | Generator control room contacts NCC, CHCC and:   1. Requests an EDIL Dispatch Instruction to bring the unit to Minimum Load **\_\_\_ MW (Base load – 50% of Reg Cap)** 2. Confirms the MW swing that will occur during the frequency injection |  | **Base load – 50% of Reg Cap**: \_\_\_MW: |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject **Step change of -0.5 Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time |  | Completion time \_\_\_\_\_\_. |
| 4 | Remove the frequency simulation and allow the unit to return its pre injection load under governor control system action |  |  |
| 5 | Stop data recording |  |  |
| 6 | Step completed |  |  |

## Min load -0.5 Hz Step

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Time** | **Comment** |
| 1 | Generator control room contacts NCC, CHCC and:   1. Requests an EDIL Dispatch Instruction to bring the unit to Minimum Load of **\_\_\_ MW** 2. Confirms the MW swing that will occur during the frequency injection |  | Minimum Load: \_\_\_MW. |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject **Step change of -0.5 Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time |  | Completion time \_\_\_\_\_\_. |
| 4 | Remove the frequency simulation and allow the unit to return its pre injection load under governor control system action |  |  |
| 5 | Stop data recording |  |  |
| 6 | Step completed |  |  |

# Comments and sign-off

|  |
| --- |
| **Comments:** |
| Unit Witness signoff that this test has been carried out according to the test procedure above.  Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date / Time: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| EirGrid, SONI Witness signoff that this test has been carried out according to the test procedure above.  Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date / Time: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. <http://www.eirgrid.com/operations/gridcode/compliancetesting/cdgutestprocedures/#d.en.17699> [↑](#footnote-ref-2)
2. <http://www.eirgridgroup.com/site-files/library/EirGrid/DS3-Performance-Measurement-Device-Standards-for-Fast-Acting-Services.pdf> [↑](#footnote-ref-3)