RfG

Governor Response and Operating Reserves

 [Insert Unit Name]

[Insert Three Letter Code]

Version 0.1



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# Document VERSION History

|  |
| --- |
| **Document Revsion History** |
| **Revision**  | **Date** | **Comment** | **Name** | **Company** |
| 0.1 | Xx/xx/xxxx | XX | User | User |
|  |  |  |  |  |
| 1.0 | Xx/xx/xxxx | Revised to Major version for onsite testing and signoff |  | SONI |

# Introduction

**The unit shall highlight any changes made to this document or approval will be void.**

The Unit must submit the latest version of this test procedure as published on the SONI website[[1]](#footnote-1).

All yellow sections must be filled in before the test procedure will be approved. All grey sections must 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@soni.ltd.uk

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 Castlereagh House Control Centre (CHCC) as required;
4. Mitigate issues arising during the test and report on system incidents.

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

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

On completion of this test, the following shall be submitted to Generator\_Testing@soni.ltd.uk

|  |  |
| --- | --- |
| **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 |

**Note:**

**The NI Power System is a live, dynamic, constantly changing system on which major changes or disturbances can occur without warning. All testing has the potential to impact the NI Power System and must be treated as such.**

**Prior to testing taking place SONI Control Room must be informed as soon as practically possible. SONI Control Room Staff reserve the right to suspend any testing if it may have a detrimental impact on the NI Power System and/or prevailing system conditions call for it.**

**Tests must be undertaken in accordance with this procedure however should a test in the procedure:**

* **have potential for a detrimental impact on the NI Power System,**
* **result in damage to the Generator’s and/or TO’s Plant and Apparatus,**
* **does not adequately demonstrate Generator Plant performance,**

**an equivalent test procedure and/or demonstration of Generating Unit capability[[2]](#footnote-2) agreed between SONI and the Generator may be undertaken to validate Grid Code compliance.**

# Abbreviations

CHCC Castlereagh House 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

ROCOF Rate of Change of Frequency

# Unit DATA

|  |  |
| --- | --- |
| Unit Test Coordinator | Unit to Specify Name, Company and contact details. |
| Unit name | Unit to Specify |
| Associated Station | Unit to Specify |
| Unit connection point | Unit to Specify |
| Unit connection voltage | Unit to Specify |
| Unit Fuel Type  | Primary Fuel / Secondary Fuel |
| Registered Capacity | Unit to Specify |
| Contracted MEC | Unit to Specify |
| House Load (estimated) | Unit to Specify |
| Governor Droop Setting (expected) | Unit to Specify |
| Is the frequency injected using software or external hardware? | Unit to specify |
| Frequency injected as an offset to the system frequency or is the governor/control system isolated from the system frequency? | Unit to specify |

# SONI Grid Code references

## Operating Reserve

OC3.4.2 **Operating Reserve**

OC3.4.2.1 **Operating Reserve** is additional output from **Generating Plant** in Northern Ireland, additional **Interconnector** transfer and/or reduction in **Demand** which must be realisable in real time operation to respond in order to contribute to containing and correcting any **System Frequency** deviation to an acceptable level, within the limits specified in the Electricity Supply Regulations (N.I.) 1991, in the event of a loss of generation or a loss of import from any **Interconnector** or mismatch between generation output and **Demand**.

OC3.4.2.2 The **Operating Reserve** from **Generating Plant** must be capable of providing response in four distinct time scales:

OC3.4.2.2.1 **Primary Operating Reserve**

The automatic response to **NI System Frequency** changes which is released increasingly from the time of **Frequency** change and fully available by 5 seconds, and, subject to the **Unit Load Controller** adjustment determined pursuant to the CC where applicable, must be sustainable, for at least 15 seconds.

OC3.4.2.2.2 **Secondary Operating Reserve**

The additional **MW** output compared to the pre-incident output, which is fully available and sustainable over the period from 15 to 90 seconds following an **Event**.

OC3.4.2.2.3 **Tertiary Operating Reserve band 1**

The additional **MW** output required compared to the pre-**Event** output which is fully available and sustainable from 90 seconds to 5 minutes following an **Event**.

OC3.4.2.2.4 **Tertiary Operating Reserve band 2**

The additional **MW** output required compared to the pre-**Event** output which is fully available and sustainable from 5 minutes to 20 minutes following an **Event**.

## Calculation of MW response and Governor Droop

$$ΔMW=\frac{\left(Δf\right)\left(Registered Capacity\right)}{\left(f\_{n} \right)\left(droop\right)}$$

ΔMW=Expected MW

Δf = frequency change in Hz

Registered Capacity = XXX MW (expected value)

Fn = 50 Hz

Droop = 0.04 (expected value)

**Governor:**

CC8.8.7.3 In addition to the requirements of CC8.8.6.1 and CC8.8.6.2 each **Generator** at its **Generating Plant** will be required to ensure that each of its **CDGUs** and **Controllable PPMs** must be fitted with a fast acting proportional **Frequency** control device (or turbine speed governor) and unit load controller or equivalent control device to provide **Frequency** response under normal operational conditions in accordance with CC5.3.

CC8.8.7.3.1 The **Frequency** control device (or speed governor) in co-ordination with other control devices must control each **CDGUs** and/or **Controllable PPMs Active Power** output with stability over the entire operating range of the **CDGUs** and/or **Controllable PPMs**; and

CC8.8.7.3.2 **CDGUs** and **Controllable PPMs** shall also meet the following minimum requirements:

1. **Frequency** control devices (or speed governors) must be capable of providing **Active Power Frequency** response with a nominal droop characteristic of 4%. in accordance with the performance characteristic shown below



**Frequency** control devices (or speed governors) must be capable of operating to the parameters for **Active Power Frequency** response in **Frequency Sensitive Mode** as shown in the table below.

|  |  |
| --- | --- |
| Parameter | Setting |
| Nominal **System Frequency** | 50 Hz |
| **Frequency Response Insensitivity** in mHz (ǀ$Δf\_{i}ǀ$) | ±15m Hz |
| **Frequency Response Insensitivity** as a percentage of nominal frequency ($\frac{ǀΔf\_{i}ǀ}{f\_{n}}$) | ±0.03 % |
| **Frequency Response Deadband** in mHz | ±15m Hz |
| **Droop** (%) | 4 % |

1. In satisfying the performance requirements specified in CC8.8.7.3.2 (i), **Generators** and their **Generating Plant** should be aware:-
* in the case of overfrequency, the **Active Power Frequency** response is limited by the **Minimum Generation** ,
* in the case of underfrequency, the **Active Power Frequency** response is limited by the **Registered Capacity**,
* the actual delivery of **Active Power** frequency response depends on the operating and ambient conditions of the **CDGUs** and/or **Controllable PPMs** when this response is triggered, in particular limitations on operation near **Registered Capacity** at low **Frequencies** as specified in CC8.8.7.4 and available primary energy sources.

Each **Generator** at its **Generating Plant** will be required to ensure that each of its **CDGUs** and **Controllable PPMs** proportional governor should be equipped with controls which allow the droop to be set independently in the range 2% to 12%. The frequency control device (or speed governor) must also be capable of being set so that it operates with an overall default speed **Droop** of 4%. The **Frequency Response Deadband** and **Droop** must be able to be reselected repeatedly.

CC.S1.1.5.5 The **TSO** may specify in the relevant **Connection Agreement** that a **Generating Unit** must be fitted with a **Unit Load Controller**. Where so specified, the **Generator** mustensure that the **Unit Load Controller** is in operation at all times and in accordancewith the settings for **Frequency** trigger and reset point, time delay and droop asspecified in the relevant **Connection Agreement** or such other settings as the **TSO** may notify to the **Generator** in writing on not less than two **Business Days'** notice,unless directed otherwise by the **TSO**.

## Frequency Step Change

CC8.8.7.3.3 **Frequency** Step Change

1. In the event of a **Frequency** step change, each **CDGU** shall be capable of activating full and stable **Active Power Frequency** response (without undue power oscillations), in accordance with the performance characteristic and parameters shown below.



|  |  |
| --- | --- |
| Parameter | Setting |
| **Active Power** as a percentage of **Registered Capacity** () | 10% |
| Maximum admissible initial delay t1  | 0 seconds |
| Activation time t2  | 5 seconds |

1. For each **CDGU** and **Controllable PPM,** the initial activation of **Active Power Primary Frequency** response is 0 seconds and shall not be unduly delayed. If the **Generator** cannot meet this requirement they shall provide technical evidence to **TSO** demonstrating why a longer time is needed for the initial activation of **Active Power Frequency** response.
2. Each **CDGU** and **Controllable PPM** shall be capableof providing full **Active Power** frequency responsefor a period of 20 minutes.
3. With regard to CC8.8.7.3.3 (iv), Active Power control must not have any adverse impact on the **Active Power** frequency response of **Generating Units**.
4. With regard to frequency restoration control, **CDGUs** and **Controllable PPMs** shall provide functionalities complying with specifications specified by the **TSO**, aimed at restoring **Frequency** to its nominal value or maintaining power flows between control areas at their scheduled values.
5. With regard to disconnection due to underfrequency, **Generating Units** capable of acting as load, including hydro pump-storage power-generating facilities, shall be capable of disconnecting their load in case of underfrequency. The requirement referred to in this point does not extend to auxiliary supply.

## Rate of Change of Frequency

CC5.3.3 In exceptional circumstances, **System Frequency** could vary causing a considerable **Rate of Change of Frequency**.Under such conditions, **Users** must ensure that their **Plant** and **Apparatus** remains **synchronised** to the **NI System** for a **Rate of Change of Frequency** up to and including 1 Hz per second as measured over a rolling 500 milliseconds period within the frequency range mentioned in CC5.3.2. For the avoidance of doubt, this requirement relates to the capabilities of **Generating Units** only and does not impose the need for **Rate of Change of Frequency** protection nor does it impose a specific setting for anti-islanding or loss-of-mains protection relays. Voltage dips may cause localised **Rate of Change of Frequency** values in excess of 1 Hz per second for short periods, and in these cases, the relevant condition for each type of generation contained in the schedule of these **Connection Conditions** supersedes this CC5.3.3 (the relevant conditions being: CC.S1.1.5.6 for any **User** other than a **PPM** connected to the **Transmission System**; CC.S2.1.4 or a **PPM** connected to the **Transmission System**; CC.S2.2.3.4 for a **PPM** connected to the **Distribution System** and CC.S1.2.4.4 for any **User** other than a **PPM** connected to the **Distribution System**.)

# site Safety requirements

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

|  |  |
| --- | --- |
| Personal Protective Equipment Requirements1. Site Safety boots
2. Hard Hat with chin strap
3. Hi Vis
4. Arc Resistive clothing
5. Safety Glasses
6. Gloves
 | 1. Yes / No
2. Yes / No
3. Yes / No
4. Yes / No
5. Yes / No
6. Yes / No
 |
| Site Induction requirements | Yes / No (If Yes, Unit to specify how and when the induction must carried out) |
| Any further information | Unit to specify |

# Test Description and Pre Conditions

## Purpose

The tests, for compliance purposes, should; demonstrate the capability of each generating unit to

continuously modulate active power to contribute to frequency control; validate the governor

model submitted to SONI, assess dead-band, overall and incremental droop, steadystate/

dynamic stability of the governor and demonstrate the robustness of the

control system.

Where a load controller is fitted (CC.S1.5.5) the unit governor and load controller should be in

Frequency Sensitive Mode. Simulated frequency deviation signals must be injected

simultaneously at both speed governor and load controller references.

These tests should verify that:

* the governor decrement rate is correctly implemented.
* the governor is continuously acting and responds with the required droop characteristic
* the governor reacts in a correct manner to a simulated ROCOF event.
* the minimum required levels of Primary, Secondary and Tertiary Operating Reserves are provided by the unit.

This is achieved by injecting a simulated frequency into the governor and recording the Units response.

It is recommended that the governor 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.

This test is to be performed separately on each fuel or fuel mix that the Unit is capable of running on.

## Pre-conditions

[Unit to specify any pre-conditions here]

# Pass Criteria

**Criteria of Assessment:**

The Unit must demonstrate that:

* stable operation from Designed Minimum Operating Level to maximum (100% Loading Level).
* the governor decrement rate is correctly implemented.
* the governor is continuously acting and responds with the required droop characteristic
* the governor provides continuous frequency modulation capability across full generator operating range.
* The governor is capable of experiencing large frequency disturbances and high rates of change without the unit trippingthe governor reacts in a correct manner to a simulated ROCOF event.
* the minimum required levels of Primary, Secondary and Tertiary Operating Reserves are provided by the unit (Table 1).

for the following test cases at 4%:

A sub set of these will be required at 2% and 12%. Engagment with TSO require to agree appopiate test cases.

****

Table 1: minimum required levels of Primary, Secondary and Tertiary Operating Reserves

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Load Level** | **Frequency Injection** | **POR****(5-15sec) Requirement** | **SOR****(15-90sec) Requirement** | **TOR1****(90-300sec) Requirement** | **TOR2****(5-20min) Requirement** | **Estimated response with a 4 % droop** | **Estimated response with a 2 % droop** | **Estimated response with a 12 % droop** | **Hold Step for a minimum of** |
| 1 | DMOL | -0.5Hz(Step) | 10% | maintain droop response | maintain droop response | maintain droop response | +25% | +50% | +8.33% | 20 minutes |
| 2 | 50% | -0.5Hz(Step) | 10% | maintain droop response | maintain droop response | maintain droop response | +25% | +50% | +8.33% | 20 minutes |
| 3 | 75% | -0.5Hz(Step) | 10% | maintain droop response | maintain droop response | maintain droop response | +25% | +50% | +8.33% | 20 minutes |
| 4 | 95% | -0.5Hz(Step) | 5% | maintain droop response | maintain droop response | maintain droop response | +25% | +50% | +8.33% | 20 minutes |
| 5 | 100% | +0.5Hz(ramp of 1Hz/sec) | maintain droop response | maintain droop response | maintain droop response | maintain droop response | -25% | -50% | -8.33% | 10 minutes |

**Note:** the figures above indicate miminimum requirements if technically feasible to provide additional response Generators shall not unreasonably withhold that capability.

# Instrumentation and Onsite Data Trending

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

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Signal Name** | **Sample Rate** | **Source** |
| 1 | Active Power at Connection Point (MW)  | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 2 | Reactive Power at Connection Point (Mvar) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 3 | Active Power at Generator (MW) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 4 | Reactive Power at Generator (Mvar) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 5 | Generator Circuit Breaker position (Open / Closed) | Unit to specify,  | Unit to specify |
| 6 | Generator Voltage (kV) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 7 | Turbine Speed (RPM) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 8 | Simulated Frequency | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 9 | Shaft Vibration (*µ*mp-p) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 10 | Blade Path Temperature (°C) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 11 | Bearing Metal Temperature (°C) | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 12 | Process variables e.g. Inlet Guide Vane position, Fuel Control Valve position etc. | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 13 | Other signals as required by the unit or by the TSO | Unit to specify, 100ms or as agreed with TSO | Unit to specify |
| 14 | Alarm/Event page | Screenshot of alarms / events for duration of the test. |
| 15 | Generator Overview Screen | Screenshots may be required where test data/milestone/event is not available through the trends listed above. |
| 16 | EDIL instructions  | Screenshot as logged during the test. |

## Initial Conditions

Should “No” be answered to any of the following, contact the 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 neartime@soni.ltd.uk. | Yes/No |
| 2 | Unit Fuel Type: Primary Fuel / Secondary Fuel | Yes/No |
| 3 | Normal start up support auxiliary systems in service. | Yes/No |
| 4 | Required signals, as described in section 8.3 are available | Yes / No |

# Test Steps

Past experience has demonstrated that significant delays can occur during testing because of

problems associated with the governor/load controller set-up or frequency injection method. In

order to avoid the risk of re-testing, it is important that the injection method and the plant control

be proved well in advance of the main tests by the station or site contractor. A preliminary test is

therefore required with details given in section 10.1 below.

For all tests, the target frequency selected on the generating plant is that instructed by the SONI

Control Centre (CHCC). This should normally be 50.00 Hz.

Test program and test steps for Northern Ireland plant to be agreed with SONI as early as posible in the project timeframe and as an absolute minimum prior to testing.

## Preliminary Governor Frequency Response Testing

With the plant running at approximately 75% Load Level the following frequency injections should be applied.

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Event Time** | **Comment** |
| 1 | Begin data recording of signals as set out in section 9 |  |  |
| 2 | Inject –0.5Hz frequency fall over 10 secHold until conditions stabiliseRemove the injected signal and re-stabilise at 75% Load Level |  |  |
| 3 | Inject +0.5Hz frequency rise over 10 secHold until conditions stabiliseRemove the injected signal and re-stabilise at 75% Load Level |  |  |
| 4 | Inject –0.5Hz frequency fall over 10 secHold for a further 20 secAt 30 sec from the start of the test, Inject a +0.3Hz frequencyrise over 30 sec.Hold until conditions stabiliseRemove the injected signal and re-stabilise at 75% Load Level |  |  |
| 5 | Inject -0.01Hz frequency fall as a step changeHold until conditions stabiliseRemove the injection signal and re- stabilise at 75% Load Level |  | **To assess governor deadband insensitivity** |
| 6 | Inject +0.01Hz frequency rise as a step changeHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level |  | **To assess governor deadband insensitivity** |
| 7 | Inject -0.02Hz frequency fall as a step changeHold until conditions stabiliseRemove injection signal and re-stabilise at 75% Load Level |  | **To assess governor deadband** |
| 8 | Inject +0.02Hz frequency rise as a step changeHold until conditions stabiliseRemove injection signal and re-stabilise at 75% Load Level |  | **To assess governor deadband** |

The recorded results (eg Frequency injected, MW and control signals) should be sampled at a

minimum rate as specified in Section 9 to allow SONI to assess the plant performance from the initial transients (seconds) to the final steady state conditions (5-15 minutes depending on the plant design).

The preliminary test results should be sent to SONI for assessment at least two weeks prior to the final witnessed tests. **SONI reserve the right to attend the preliminary Governor Frequency Response Testing.**

## Soni Witnessed Frequency Response Testing Sequence

The test sequence is outlined below with the initial test establishing the maximum steady state

output condition of the plant (ie 100% Load Level).

### **Establish Maximum Plant Capacity**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Event Time** | **Comment** |
| 1 | Switch Unit governors to manual and raise load demand to confirm the maximum plant capacity output level at the base settings. |  | 100% Load Level: \_\_\_\_ MW |
| 2 | Record plant and ambient conditions when plant is thermally stabilised. |  |  |

### **Note:** Should this test procedure be suspended then establishing Maximum Plant Capacity will need to be carried out once testing is resumed prior to any remaining tests continuing.

### **Response Tests at Maximum Plant Capacity (100% Load Level)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Event Time** | **Comment** |
| 1 | Confirm data recording of signals as set out in section 9 |  |  |
| 2 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | 100% Load Level: \_\_\_\_ MW |
| 3 | Inject +0.10Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 100% Load Level and hold for 1 minute |  |  |
| 4 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 5 | Inject +0.20Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise 100% Load Level and hold for 1 minute |  |  |
| 6 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 7 | Inject 0.50Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 100% Load Level and hold for 1 minute |  |  |
| 8 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 9 | Inject -0.50Hz **frequency fall** over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 100% Load Level and hold for 1 minute |  |  |
| 10 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 11 | Inject **Ramp change of +0.5Hz at a rate of 1 Hz per second** and maintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 12 | Remove the injection signal and re-stabilise at 100% Load and hold for 1 minute |  |  |
| 13 | Generater to ammned **droop setting to 2%** and confirm with CHCC |  |  |
| 14 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 15 | Inject **Ramp change of +0.5Hz at a rate of 1 Hz per second** and maintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 16 | Remove the injection signal and re-stabilise at 100% Load Level and hold for 1 minute |  |  |
| 17 | Generater to ammned **droop setting to 12%** and confirm with CHCC |  |  |
| 18 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 19 | Inject **Ramp change of +0.5Hz at a rate of 1 Hz per second** and maintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 20 | Remove the injection signal and re-stabilise at 100% Load Level and hold for 1 minute |  |  |
| 21 | Stop recording data |  |  |
| 22 | Test Completed |  |  |

### **Response Tests at 95% Load Level**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step**  | **Action** | **Event Time** | **Comment** |
| 1 | Generator control room contacts CHCC and requests the following: 1. Issue an EDIL Dispatch Instruction to bring the unit to **XX MW**
2. Confirmation of the MW swing that will occur during the frequency injection
 |  | 95% Load Level: \_\_\_\_ MW |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject -0.50Hz frequency fall over 10 secHold for 20 secInject +0.30Hz frequency rise over 30 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 95% Load Level and hold for 1 minute |  |  |
| 4 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load Level: \_\_\_\_ MW |
| 5 | Inject +0.50Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 95% Load Level and hold for 1 minute |  |  |
| 6 | Inject **Step change of -0.5Hz** and maintain the frequency injection for a minimum of **20 minutes** |  | Completion time (t+20mins): \_\_\_\_ |
| 7 | Remove the injection signal and re-stabilise at 95% Load Level and hold for 1 minute |  |  |
| 8 | Stop recording data |  |  |
| 9 | Test completed |  |  |

### **Response Tests at 75% Load Level**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step**  | **Action** | **Event Time** | **Comment** |
| 1 | Generator control room contacts CHCC and requests the following: 1. Issue an EDIL Dispatch Instruction to bring the unit to **XX MW**
2. Confirmation of the MW swing that will occur during the frequency injection
 |  | 75% Load Level: \_\_\_\_ MW |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject -0.50Hz frequency fall over 10 secHold for 20 secInject +0.30Hz frequency rise over 30 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 4 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 5 | Inject -0.10Hz frequency fall over 10 secHold until conditions stabiliseRemove the injection signal nd re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 6 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 7 | Inject +0.10Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 8 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 9 | Inject -0.20Hz frequency fall over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 10 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 11 | Inject +0.20Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 12 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 13 | Inject +0.50Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 14 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 15 | Inject -0.20Hz frequency falls as a step changeHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  | **To assess step response characteristic of plant** |
| 16 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 17 | Inject +0.20Hz frequency rise as a step changeHold until conditions stabiliseRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  | **To assess step response characteristic of plant** |
| 18 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 19 | Inject **Ramp change of -0.5 Hz Ramp at 1 Hz/Second, hold for 1 second then +1 Hz ramp of 1 Hz/Second** and maintain the frequency injection for up to **10 minutes** |  | Start time Completion time  |
| 20 | Remove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 21 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 22 | Inject **Ramp change of +0.5 Hz Ramp at 1 Hz/Second, hold for 1 second then -1 Hz ramp of 1 Hz/Second** and maintain the frequency injection for up to **10 minutes** |  | Start time Completion time  |
| 23 | Remove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 24 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 25 | Inject -1.0Hz/sec frequency fall over 2 secHold for 30 secRemove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  | **To assess plant performance under islanding and system split conditions** |
| 26 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 27 | Inject **Step change of -0.5Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time. |  | Completion time (t+20mins): \_\_\_\_. |
| 28 | Remove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 29 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 30 | Inject Ramp change of -0.5 Hz at a rate of 1 Hz per second and mmaintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 32 | Remove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 33 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 34 | Inject Ramp change of +0.5 Hz at a rate of 1 Hz per second and mmaintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 35 | Remove the injection signal and re-stabilise at 75% Load Level and hold for 1 minute |  |  |
| 36 | Stop recording data |  |  |
| 37 | Test completed |  |  |

### **Response Tests at 50% Load Level**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step**  | **Action** | **Event Time** | **Comment** |
| 1 | Generator control room contacts CHCC and requests the following: 1. Issue an EDIL Dispatch Instruction to bring the unit to **XX MW**
2. Confirmation of the MW swing that will occur during the frequency injection
 |  | 50% Load Level: \_\_\_\_ MW |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject -0.50Hz frequency fall over 10 secHold for 20 secInject +0.30Hz frequency rise over 30 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 4 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 5 | Inject -0.10Hz frequency fall over 10 secHold until conditions stabiliseRemove the injection signal nd re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 6 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 7 | Inject +0.10Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 8 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 9 | Inject -0.20Hz frequency fall over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 10 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 11 | Inject +0.20Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 12 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 13 | Inject +0.50Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 14 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 15 | Inject -0.20Hz frequency falls as a step changeHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  | **To assess step response characteristic of plant** |
| 16 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 17 | Inject +0.20Hz frequency rise as a step changeHold until conditions stabiliseRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  | **To assess step response characteristic of plant** |
| 18 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 19 | Inject **Ramp change of -0.5 Hz Ramp at 1 Hz/Second, hold for 1 second then +1 Hz ramp of 1 Hz/Second** and maintain the frequency injection for up to **10 minutes** |  | Start time Completion time  |
| 20 | Remove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 21 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 22 | Inject **Ramp change of +0.5 Hz Ramp at 1 Hz/Second, hold for 1 second then -1 Hz ramp of 1 Hz/Second** and maintain the frequency injection for up to **10 minutes** |  | Start time Completion time  |
| 23 | Remove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 24 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 25 | Inject -1.0Hz/sec frequency fall over 2 secHold for 30 secRemove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  | **To assess plant performance under islanding and system split conditions** |
| 26 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 27 | Inject **Step change of -0.5Hz** and maintain the frequency injection for a minimum of **20 minutes** and note the completion time. |  | Completion time (t+20mins): \_\_\_\_. |
| 28 | Remove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 29 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 30 | Inject Ramp change of -0.5 Hz at a rate of 1 Hz per second and mmaintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 32 | Remove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 33 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 34 | Inject Ramp change of +0.5 Hz at a rate of 1 Hz per second and mmaintain the frequency injection for a minimum of **10 minutes** |  | Completion time (t+10mins): \_\_\_\_ |
| 35 | Remove the injection signal and re-stabilise at 50% Load Level and hold for 1 minute |  |  |
| 36 | Stop recording data |  |  |
| 37 | Test completed |  |  |

### **Response Tests at Designed Minimimum Operating Level (DMOL)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Step** | **Action** | **Event Time** | **Comment** |
| 1 | Generator control room contacts CHCC and requests the following: 1. Issue an EDIL Dispatch Instruction to bring the unit to DMOL of **XX MW**
2. Confirmation of the MW swing that will occur during the frequency injection
 |  | DMOL Load Level: \_\_\_\_ MW.  |
| 2 | Confirm data recording of signals as set out in section 9 |  |  |
| 3 | Inject +0.20Hz frequency rise over 10 secHold until conditions stabiliseRemove the injection signal and re-stabilise at DMOL and hold for 1 minute |  |  |
| 4 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 5 | Inject -0.80Hz frequency fall over 10 secHold for 20 secInject +0.30Hz frequency rise over 30 secHold until conditions stabiliseRemove the injection signal and re-stabilise at DMOL and hold for 1 minute |  |  |
| 6 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 7 | 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 (t+20mins) \_\_\_\_\_\_. |
| 8 | Remove the injection signal and re-stabilise at DMOL and hold for 1 minute |  |  |
| 9 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 10 | Inject **Ramp change of -0.5Hz at a rate of 1Hz per second** and maintain the frequency injection for a minimum of **10 minutes** and note the completion time. |  | Completion time (t+10mins): \_\_\_\_. |
| 11 | Remove the injection signal and re-stabilise at DMOL and hold for 1 minute |  |  |
| 12 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 13 | Inject **Ramp change of -0.5 Hz Ramp at 1 Hz/Second, hold for 1 second then +1 Hz ramp of 1 Hz/Second** and maintain the frequency injection for up to **10 minutes** |  | Start time Completion time |
| 14 | Remove the injection signal and re-stabilise at DMOL and hold for 1 minute |  |  |
| 15 | Generator control room contacts CHCC and confirms the MW swing that will occur during the frequency injection |  | Load: \_\_\_\_ MW |
| 16 | Inject **Ramp change of +0.5 Hz Ramp at 1 Hz/Second, hold for 1 second then -1 Hz ramp of 1 Hz/Second** and maintain the frequency injection for up to **10 minutes** |  | Start time Completion time |
| 17 | Remove the injection signal and re-stabilise at DMOL and hold for 1 minute |  |  |
| 18 | Stop data recording |  |  |
| 19 | Test completed |  |  |

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

1. https://www.soni.ltd.uk/how-the-grid-works/grid-codes/ [↑](#footnote-ref-1)
2. For example a simulation model of the Generator performance characteristics under the test procedure [↑](#footnote-ref-2)