EIRGRID_2015 Functional Document Template (21

WFPS Frequency Response

Test Procedure

[Insert Windfarm Name]

Version 0.1

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# Document Version History

EirGrid template version 0.7, drafted 27 June 2019.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Document Version History** | | | | |
| **Version** | **Date** | **Comment** | **Name** | **Company** |
| 0.1 | dd/mm/yyyy | First submission for review/approval |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

# Introduction

## WFPS Submissions

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

The WFPS shall submit the latest version of this test procedure template as published on the EirGrid website[[1]](#footnote-2).

All yellow sections shall be filled in before the test procedure shall 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).

Where a site consists of two separate controllable WFPS with a single connection point, this may impact on the test procedure outlined below.

Following testing, the following shall be submitted to [generator\_testing@eirgrid.com](mailto:generator_testing@eirgrid.com):

|  |  |
| --- | --- |
| **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 | 20 working days |

## Test Execution

The availability of personnel at NCC will be necessary in order to initiate the necessary instructions for the test. NCC shall determine if network conditions allow the testing to proceed.

The WFPS representative shall coordinate testing. On the day of testing, suitably qualified technical personnel may be needed at the wind farm to assist in undertaking the tests. Such personnel shall have the ability to fully understand the function of the wind farm and its relationship to the network to which the wind farm is connected. Furthermore, such personnel shall have the ability to set up the control system of the wind farm so as to enable Grid Code compliance test to be correctly undertaken. In addition, the function of the technical personnel is to liaise with NCC.

All wind turbines shall be available. If on the day of the testing all wind turbines are not available, then the test may proceed where one wind turbine is unavailable for a wind farm of registered capacity of up to 75 MW, if that turbine makes up <20% of Registered Capacity, or two wind turbines are unavailable for a wind farm of registered capacity in excess of 75 MW. Wind conditions need to be sufficient and at a relatively constant level in order adequately perform the test. The required wind capacity for this test is detailed in section 7.4.

## Timing of Test Steps

The wait period between test steps has been reduced from previous versions of this document. For all of these test steps, if the change in Target MW is <15 MW, the wait time shall be 1 minute. If the change in Target MW is > 15 MW, the wait time shall be at least 2 minutes. As these larger changes in MW will have bigger impact on the transmission system, the WFPS may be required to wait for longer than this before carrying out a frequency injection *e.g.* in steps marked “**In coordination with NCC\***”. During the test, if the WFPS output is fluctuating or has not stabilised at the “Target MW”, the injection period shall be extended as appropriate. WFPS shall adjust the timing of the steps as required in order to align with this requirement.

## Notes

Automated Test Scripts generated by the WFPS shall meet the following requirements:

* It must be possible to pause the script at any point.
* The MW Test Profile has been submitted and agreed in advance (assuming 100% AAP)
* The MW Test Profile mustaccounts for timing of each step (note 1 minute is not appropriate for all steps).

# Abbreviations

AAP Available Active Power

APC Active Power Control

DMOL Designed Minimum Operating Level

HV High Voltage

MEC Maximum Export Capacity

MW Mega Watt

NCC National Control Centre

TSO Transmission System Operator

WFCS Wind Farm Control System

WFPS Wind Farm Power Station

WTG Wind Turbine Generator

# WFPS DATA

|  |  |
| --- | --- |
| WFPS Name | WFPS to Specify  (name per connection agreement) |
| WFPS Test Coordinator and contact number: | WFPS to Specify |
| WFPS Address | WFPS to Specify |
| Associated 110 kV Station | WFPS to Specify |
| WFPS connection point | WFPS to Specify  (*i.e.* T121 in XXX Distribution or Transmission Station) |
| WFPS connection voltage | WFPS to Specify |
| WFPS Connection Type | WFPS to Specify  (TSO, DSO Type A, DSO Type B, etc.) |
| Installed Turbine type, MW size and quantity | WFPS to Specify |
| Contracted MEC | WFPS to Specify |
| Registered Capacity | WFPS to Specify |
| Limiter applied to Exported MW | WFPS to Specify |
| Limiter applied to AAP | WFPS to Specify |
| DMOL | WFPS to Specify |
| RoCoF Capability | WFPS to Specify |

# Grid Code References

|  |  |
| --- | --- |
| Grid Code Version: | WFPS to specify |

|  |  |
| --- | --- |
| **Design Minimum Operating Level (DMOL):** | The minimum **Active Power** output of **Controllable PPM** where all **Generation Units** are generating electricity and capable of ramping upwards at any of the specified ramp rates (given available resource), and shall not be greater than 12% of **Registered Capacity** |
| **Governor Droop** | The percentage drop in the **Frequency** that would cause the **Generation Unit** under free governor action to change its output from zero to its full **Capacity**. In the case of a **Controllable PPM**, it is the percentage drop in the **Frequency** that would cause the **Controllable PPM** to increase its output from zero to its full **Registered Capacity.** |

**PPM 1.5.1** No additional **Generation Unit** shall be started while the **Transmission System Frequency** is above 50.2 Hz.

### PPM 1.5.2 ACTIVE POWER MANAGEMENT

A **PPM Control System** shall be installed by the **Controllable PPM** to allow for the provision of **Active Power Control** and **Frequency** **Response** from the **Controllable PPM**. The **PPM Control System** and **Frequency Response System** shall provide the functionality as specified in this section PPM1.5.2.

### PPM 1.5.3 FREQUENCY RESPONSE

**PPM 1.5.3.1** In **Resource Following Mode**, the **Frequency Response System** shall have the capabilities as displayed in the *Power-Frequency Response Curve* in *Figures* PPM*1.2,* where the power and frequency ranges required for points A, B, C, D, E are defined below in *Table* PPM*1.1 and Table* PPM*1.2.* The **Frequency Response System** shall adjust the **Active Power** output of the **Controllable PPM** according to a **Governor Droop**, settable by the **TSO** in a range from 2% to 10% and defaulting to 4%, when operating in the ranges outside the deadband range FB-FC in the Power-Frequency Response Curve. **Controllable PPM****Frequency Response**and **Governor Droop** shall be calculated with respect to **Registered Capacity.**

**PPM 1.5.3.2** When in **Active Power Control Mode,** the **Controllable PPM** shall always operate in **Frequency Sensitive Mode** with a **Governor Droop** as set out in PPM1.5.3.1 and with a deadband of +/-15mHz or as otherwise agreed with the **TSO.**



*Figure* PPM*1.2 –Example of Power-Frequency Response Curve for Resource Following Mode*

**PPM 1.5.3.3** When acting to control **Transmission System Frequency**, the **Controllable PPM** shall provide at least 60% of its expected additional **Active Power** response within 5 seconds, and 100% of its expected additional **Active Power** response within 15 seconds of the start of the **Transmission System Frequency** excursion outside the range FB-FC, or in the case of a **Controllable PPM** in **Active Power Control Mode**, when the **Transmission System Frequency** goes outside the deadband set out in PPM1.5.3.2.

**PPM 1.5.3.4** When the **Transmission System Frequency** is in the range FC-FD, the **Controllable PPM** shall ensure that its **Active Power Output** does not increase beyond the **Active Power** value of the **Controllable PPM** when the **Transmission System Frequency** first exceeded FC, due to an increase in **Available Active Power** in that period.

**PPM 1.5.3.5** If the **Frequency** drops below FA, then the **Frequency Response System** shall act to maximise the **Active Power** output of the **Controllable PPM**, irrespective of the **Governor Droop Setting**. If the **Frequency** rises above FD, then the **Frequency Response System** shall act to reduce the **Active Power** output of the **Controllable PPM** to its **DMOL** value. If the **Frequency** rises above FE, then the **Frequency Response System** shall act to reduce the **Active Power** output of the **Controllable PPM** to zero. Any **Generation Unit** which has disconnected shall be brought back on load as fast as technically feasible, provided the **Transmission System Frequency** has fallen below 50.2 Hz.

**PPM 1.5.3.6** Points ‘A’, ‘B’, ‘C’, ‘D’ and ‘E’ shall depend on a combination of the **Transmission System Frequency**, **Active** **Power** and **Active Power Control Set-point** settings. These settings may be different for each **Controllable PPM** depending on system conditions and **Controllable PPM** location. These settings are defined in *Table PPM1.1* below.

|  |  |  |
| --- | --- | --- |
| Point | ***Transmission System Frequency***  *(Hz)* | ***Controllable PPM Active Power*** *Output*  *(****%*** *of* ***Available******Active Power****)* |
| A | ***FA*** | ***PA*** |
| B | ***FB*** | Minimum of : ***PB*** or  **Active Power Control Set-point** (converted to a % of **Available** **Active Power**) |
| C | ***FC*** | Minimum of: ***PC*** or  **Active Power Control Set-point** (converted to a % of **Available** **Active Power**) |
| D | ***FD*** | Minimum of: ***PD*or**  **Active Power Control Set-point** (converted to a % of **Available** **Active Power**) |
| E | ***FE*** | ***PE*** = 0 % |

*Table* PPM*1.1:* ***Transmission System Frequency*** *and %* ***Available Active Power*** *Settings for the Points ‘A’, ‘B’, ‘C’, ‘D’ and ‘E’ illustrated in Figure* PPM*1.2*

Two settings for each of ***FA, FB, FC, FD, FE, PA, PB, PC, PD*** and ***PE*** shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable PPM’s** scheduled **Operational Date** (refer to *PPM* 1.5.3.11 below).The **Controllable PPM** shall be responsible for implementing the appropriate settings during **Commissioning**.

**PPM 1.5.3.7** The table below, *Table* PPM*1.2,* shows the **Transmission System Frequency** and **Active** **Power** ranges for ***FA, FB, FC, FD, FE, PA, PB, PC, PD*** and ***PE****.*

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Transmission System Frequency*** *(Hz)* |  | ***Available Active Power*** *(%)* |
|  |  |  | ***Registered Capacity ≥ 5 MW*** |
| ***FA*** | *47.0-49.5* | ***PA*** | *50-100* |
| ***FB*** | *49.5-50* | ***PB*** | *15-100* |
| ***FC*** | *50-50.5* | ***PC*** |
| ***FD*** | *50.5-52.0* | ***PD*** | *15-100 but not less than* ***DMOL*** |
| ***FE*** | ***PE*** | *0* |

*Table PPM 1.2:* ***Transmission System Frequency*** *&* ***Active******Power*** *ranges*

*appropriate to Figure* PPM*1.2.*

For the **Transmission System Frequency** values in *Table* PPM*1.2* above, *FA* ≤ *FB* ≤ *FC* ≤ *FD* ≤ *FE*.

**PPM 1.5.3.8** Alterations to the **Controllable PPM’s Active Power** output, triggered by **Transmission System Frequency** changes, shall be achieved by proportionately altering the **Active Power** output of all available **Generation Units** as opposed to switching individual **Generation Units** on or off, insofar as possible.

**PPM 1.5.3.9** No time delays, such as moving average frequency filters, other than those necessarily inherent in the design of the **Frequency Response System** shall be introduced. The **Frequency Response System** shall continuously monitor the **Transmission System Frequency** in order to continuously determine the **Controllable PPM’s** appropriate **Active Power** output by taking account of the **Controllable PPM’s Available** **Active Power** or **Controlled** **Active Power**.

**PPM 1.5.3.10** If the **Transmission System Frequency** rises to a level above ‘D’-’E’, as defined by the *Power-Frequency Response Curve in Figure* PPM*1.2*, the **TSO** accepts that **Generation Units** may disconnect. Any **Generation Unit** which has disconnected shall be brought back on load as fast as technically feasible (provided the **Transmission System Frequency** has fallen below 50.2 Hz).

**PPM** **1.5.3.11 Procedure for Setting and Changing the *Power-Frequency Response Curves***

Two *Power-Frequency Response Curves* (Curve 1 and Curve 2) shall be specified by the **TSO** at least 120 **Business Days** prior to the **Controllable PPM’s** scheduled **Operational Date.** The **Controllable PPM** shall be responsible for implementing the appropriate settings during **Commissioning**. The **Frequency Response System** shall be required to change between the two curves within one minute from receipt of the appropriate signal from the **TSO**. The **TSO** shall give the **Controllable PPM** a minimum of two weeks’ notice if changes to either of the curve’s parameters ***(i.e. FA, FB, FC, FD, FE, PA, PB, PC, PD*** or ***PE)***, are required. The **Controllable PPM** shall formally confirm that any requested changes have been implemented within two weeks of receiving the **TSO’s** formal request.

### PPM 1.5.4 RAMP RATES

**PPM** **1.5.4.1** The **PPM** **Control System** shall be capable of controlling the ramp rate of its **Active Power** output. There shall be three ramp rate capabilities, designated **Resource Following Ramp Rate**, **Active** **Power Control Set-Point Ramp Rate**, and **Frequency Response Ramp Rate**. The **PPM** **Control System** shall operate the ramp rates with the following order of priority (high to low): **Frequency Response Ramp Rate**; **Active** **Power Control Set-Point Ramp Rate**; **Resource Following Ramp Rate**. The **Resource Following Ramp Rate** shall be used during **Start-Up**, normal operation, and **Shutdown**. The **TSO** shall specify the **Resource Following Ramp Rate** and the **Active** **Power Control Set-Point Ramp Rate** in percentage of **Registered Capacity** per minute. The **Frequency Response Ramp Rate** shall be the maximum possible ramp rate of the **Controllable PPM** agreed with the **TSO** and with the characteristics as set out in *PPM* 1.5.3.1**.** The **TSO** acknowledges that rapidly changing resource availability may cause temporary deviations from the ramp rate settings of the **Controllable PPM**, but these deviations should not be allowed to exceed 3% of **Registered Capacity**.

**PPM** **1.5.4.2** It shall be possible to vary the **Resource Following Ramp Rate** and the **Active** **Power Control Set-Point Ramp Rate** each independently over a range between 1% and 100% of **Registered Capacity** per minute.

**PPM 1.7.2.3** **Frequency Response**

This signal shall be sent by the **TSO** to the **Controllable PPM** in the event that a change from *Power-Frequency Response Curve 1* to *Power Frequency Response Curve 2*, or vice versa, is required.

The **Controllable PPM** is required to make it possible for the **TSO** to remotely enable/ disable the **Frequency Response System**. The associated status indication is described in WFPS1.7.1.5.

The **Controllable PPM** shall make it possible for the **TSO** to set the **Governor Droop** value of the **Frequency Response System** in values from 2% to 10%.

# Site Safety requirements

The following is required for the EirGrid 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, WFPS to specify how and when the induction shall be carried out) |
| Any further information | WFPS to specify |

# Test desciption and pre conditions

## Purpose of the Test

The purpose of this test is to confirm the ability of the WFPS to respond to changes in system frequency. The WFPS shall be capable of operating with a “Governor Droop” – e.g. able to continuously adjust its active power output in response to changes in frequency. As the grid frequency cannot be changed at will, the test will require frequency to be simulated by means of injection of a frequency signal into the WFCS.

## Pass Criteria

The following is the pass criteria for the test. Any subsequent report for this test will be assessed against each of these criteria.

| **Criteria** |
| --- |
| **Governor Droop** |
| Governor droop is calculated with respect to Registered Capacity. |
| Governor droop is calculated with respect to 50 Hz. |
| Governor droop is settable in a range from 2% to 10%, online, from NCC. |
| When Frequency Response is OFF, no response shall be provided. |
| The WFCS continuously recalculates its expected response during the frequency excursion. |
| **Rate of Response** |
| WFPS provides ≥60% of its expected response within 5 seconds and 100% of its expected response within 15 seconds. (Expected Response is limited to AAP) |
| Ramp Rates shall be prioritised with Frequency Response Ramp Rate given the highest priority. |
| **Frequency Response Curve** |
| For frequency < FA, MW output ramps directly to 100% of AAP. |
| For frequency between FA and FB, MW output is based on frequency droop setting |
| For frequency ≥ FB and ≤ FC, no response shall be provided |
| For frequency between FC and FD, MW output is based on frequency droop setting. |
| For frequency > FD, MW output ramps directly to DMOL |
| For frequency > FE, MW output ramps directly to 0 MW |
| Deadband of +/-15 mHz is applied in Active Power Control Mode and in Curve 2 |
| **Latching etc.** |
| For frequency > FC, MW output does not increase above its value at the time frequency exceeded FC, due to AAP increasing. (Only applicable when APC is Off) |
| Any WTG which has disconnected due to frequency ≥ FE, shall be brought back on load when frequency falls less than 50.2 Hz. |
| No additional WTG can be started while frequency is above 50.2 Hz. |
| Frequency response is achieved by altering the output of all WTGs as opposed to switching WTGs on or off, insofar as possible. |
| For active power output levels ≥ DMOL, all WTGs shall be generating electricity. |
| WFPS regulates its active power output to within the greater of ±0.5 MW or ±3% of Registered Capacity of the Active Power Control Set-point adjusted for frequency response. |

## Instrumentation and Onsite Data Trending

Signals 1-11 shall be recorded by the WFPS during the test. Failure to provide any of these trends will result in test cancellation. Signal 12 is optional.

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Data Trending and Recording** | **Resolution** | **Check On Day Of Test** |
| 1 | Available active power from the prevailing wind in MW, derived by algorithm in the WFCS (*Figure WFPS1.3, Point Y – preferably point Z if available*) | WFPS to Specify (≥ 10 Hz) | Yes / No |
| 2 | Actual active power from the WFPS in MW (*Figure WFPS1.3, Point Y – preferably point Z if available*) | WFPS to Specify (≥ 10 Hz) | Yes / No |
| 3 | APC ON/OFF | WFPS to Specify (≥ 10 Hz) | Yes / No |
| 4 | APC set-point from NCC | WFPS to Specify (≥10 Hz) | Yes / No |
| 5 | Frequency Response ON/OFF | WFPS to Specify (≥10 Hz) | Yes / No |
| 6 | Frequency Response Curve1/Curve2 | WFPS to Specify (≥10 Hz) | Yes / No |
| 7 | Frequency Droop Setting | WFPS to Specify (≥10 Hz) | Yes/No |
| 8 | Simulated Test Frequency | WFPS to Specify (≥10 Hz) | Yes / No |
| 9 | Grid Frequency | WFPS to Specify (≥10 Hz) | Yes / No |
| 10 | Number of turbines online | WFPS to Specify (≥10 Hz) | Yes / No |
| 11 | Wind Farm Availability % | WFPS to Specify (≥10 Hz) | Yes / No |
| 12 | Frequency Response Power Reference (Optional)  (Target MW Export during Frequency Response) | WFPS to Specify (≥10 Hz) | Yes / No |

## Initial Conditions

If “No” is answered to any of the following, contact NCC and agree next steps in advance of making any corrective actions.

| **Conditions** | **Check on day of test** |
| --- | --- |
| All WTGs are available | # turbines installed: \_\_\_\_  # turbines generating: \_\_\_\_ |
| Generated MW > 60% of Registered Capacity | Generated MW: \_\_\_\_ |
| Where NCC has control of the reactive power, ensure WFPS is exporting close to 0 Mvar at the connection point by bringing kV set-point = system voltage in 1 kV steps | Yes / No |
| MW Profile has been submitted if Test Script is automated | Yes / No / N/A |
| Automated Test Script can be paused. | Yes / No / N/A |
| If the WFPS has Emulated Inertia, note Emulated Inertia Status  Turn Emulated Inertia OFF | Pre-test status: ON / OFF / N/A  Emulated Inertia Status: \_\_\_\_ |

## Frequency Response Calculations

|  |  |
| --- | --- |
| **Calculation** | **Value** |
| Theoretical change in MW for frequency increase of 0.25 Hz with Frequency Droop of 4% | \_\_\_\_ MW  (WFPS to specify calculation and formula used) |
| Theoretical change in MW for frequency increase of 0.25 Hz with Frequency Droop of 2% | \_\_\_\_ MW  (WFPS to specify calculation and formula used) |
| Theoretical change in MW for frequency decrease of 0.5 Hz with Frequency Droop of 10% | \_\_\_\_ MW  (WFPS to specify calculation and formula used) |
| Ramp rate that is applied in frequency response mode | \_\_\_\_ MW/minute |

## Frequency and Ramp Rate Settings to be implemented in Wind Farm Control System



**Frequency Response Mode On**

Table Curve 1 Wind Following Mode

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Transmission System Frequency*** *f (Hz)* |  | ***Required Active Power Output*** |
|  | *f < 48* |  | *100% of AAP* |
| ***FA*** | *48* | ***PA*** | *100% of AAP* |
| ***Under Frequency Response*** | *48 < f < 49.8* |  | *100% of AAP* |
| ***FB*** | *f = 49.8* | ***PB*** | *100% of AAP* |
| ***+/-0.2Hz Deadband*** | *49.8 < f < 50.2* |  | *100% of AAP* |
| ***FC*** | *f = 50.2* | ***PC*** | *100% of AAP* |
| ***Over Frequency Response*** | *50.2 < f < 51.9* |  | *AAP + ∆MW2* |
| ***FD*** | *f = 51.9* | ***PD*** | *Minimum of: AAP and DMOL* |
| ***FE*** | *f = 52* | ***PE*** | *0%3* |
|  | *f > 52* |  | *0%3* |

Table Curve 1 Active Power Control Mode

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Transmission System Frequency*** *f (Hz)* |  | ***Required Active Power Output*** |
|  | *f < 48* |  | *100% of AAP* |
| ***FA*** | *f = 48* | ***PA*** | *100% of AAP* |
| ***Under Frequency Response*** | *48 < f < 49.985* |  | *Minimum of: APC Setpoint + ∆MW and AAP* |
| ***FB*** | *f = 49.985* | ***PB*** | *Minimum of: APC Setpoint and AAP* |
| ***+/-0.015Hz Deadband*** | *49.985 < f < 50.015* |  | *Minimum of: APC Setpoint and AAP* |
| ***FC*** | *f = 50.015* | ***PC*** | *Minimum of: APC Setpoint and AAP* |
| ***Over Frequency Response*** | *50.015 < f < 51.9* |  | *Minimum of: APC Setpoint + ∆MW and AAP + ∆MW1, 2* |
| ***FD*** | *f = 51.9* | ***PD*** | *Minimum of: APC Setpoint and AAP and DMOL* |
| ***FE*** | *f = 52* | ***PE*** | *0%3* |
|  | *f > 52* |  | *0%3* |

Table Curve 2 Wind Following Mode

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Transmission System Frequency*** *f (Hz)* |  | ***Required Active Power Output*** |
|  | *f <49.3* |  | *100% of AAP* |
| ***FA*** | *f = 49.3* | ***PA*** | *100% of AAP* |
| ***Under Frequency Response*** | *49.3 < f < 49.985* |  | *95% of Available Active Power + ∆MW* |
| ***FB*** | *f = 49.985* | ***PB*** | *95% of Available Active Power. This is = to 5% Reserve.* |
| ***+/-0.015Hz Deadband*** | *49.985 < f < 50.015* |  | *95% of Available Active Power. This is = to 5% Reserve.* |
| ***FC*** | *f = 50.015* | ***PC*** | *95% of Available Active Power. This is = to 5% Reserve.* |
| ***Over Frequency Response*** | *50.015 < f < 51.9* |  | *95% of AAP + ∆MW2* |
| ***FD*** | *f = 51.9* | ***PD*** | *Minimum of: AAP and DMOL* |
| ***FE*** | *f = 52* | ***PE*** | *0%3* |
|  | *f > 52* |  | *0%3* |

Table Curve 2 Active Power Control Mode

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Transmission System Frequency*** *f (Hz)* |  | ***Required Active Power Output*** |
|  | *f < 49.3* |  | *100% of AAP* |
| ***FA*** | *f = 49.3* | ***PA*** | *100% of AAP* |
| ***Under Frequency Response*** | *49.3 < f < 49.985* |  | *Minimum of: APC Setpoint + ∆MW and 95% of AAP + ∆MW* |
| ***FB*** | *f = 49.985* | ***PB*** | *Minimum of: APC Setpoint and 95% of AAP* |
| ***+/-0.015Hz Deadband*** | *49.985 < f < 50.015* |  | *Minimum of: APC Setpoint and 95% of AAP* |
| ***FC*** | *f = 50.015* | ***PC*** | *Minimum of: APC Setpoint and 95% of AAP* |
| ***Over Frequency Response*** | *50.015 < f < 51.9* |  | *Minimum of: APC Setpoint + ∆MW and 95% of AAP + ∆MW1, 2* |
| ***FD*** | *f = 51.9* | ***PD*** | *Minimum of: APC Setpoint and AAP and DMOL* |
| ***FE*** | *f = 52* | ***PE*** | *0%3* |
|  | *f > 52* |  | *0%3* |

Minimum reserve level in Curve 2 is 5% of Available Active power, not lower than DMOL (settable between DMOL and 100%).

|  |
| --- |
| 1 APC Setpoint + ∆MW shall have a lower limit of the minimum of: APC Setpoint and DMOL |
| 2 (95% of) AAP + ∆MW shall have a lower limit of the minimum of AAP and DMOL |
| 3 Any WTG which has disconnected due to high frequency shall be brought back on load as fast as technically feasible, provided the Frequency has fallen below 50.2Hz. |
| DMOL shall not be greater than 12% of Registered Capacity |
| If AAP < DMOL and f < FE, maximise output |

**Frequency Response Mode Off**

Table Curves 1 & 2 Wind Following Mode

|  |  |  |
| --- | --- | --- |
| ***Transmission System Frequency*** *(Hz)* |  | ***Required Active Power Output*** |
| ***47.5* ≤ *f* ≥ *52*** | *No governor action* | *100% of AAP* |

Table Curves 1 & 2 Wind Following Mode

|  |  |  |
| --- | --- | --- |
| ***Transmission System Frequency*** *(Hz)* |  | ***Required Active Power Output*** |
| ***47.5 ≤ f ≥ 52*** | *No governor action* | *Minimum of: AAP and APC Setpoint* |

**Frequency Droop**

|  |  |
| --- | --- |
| **Frequency Droop** | **Droop Calculation** |
| 4% of Registered Capacity |  |

**Ramp Rates**

|  |  |  |
| --- | --- | --- |
| **Mode** | **Rate** | **Priority** |
| Frequency Response | As fast as technically possible. 60% of its expected Active Power response within 5 seconds 100% of its expected Active Power response within 15 seconds. | 1 |
| Active Power Dispatch | 20% of Registered Capacity per Minute | 2 |
| Wind Following | 20% of Registered Capacity per Minute | 3 |

**Rate of Change of Frequency:**

ROCOF shall be disabled on Transmission System-connected Windfarms. If this is not possible, ROCOF shall be set to max that machine is capable of. Under no circumstances is ROCOF to be set to less than 0.5 Hz/s

# Test Steps

## Functional Check

This WFPS demonstrates that the basic functions of switching on and off frequency response, changing curves and changing droop settings are working prior to conducting the frequency response test.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response functional check and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is OFF 4. Frequency Response is ON 5. Frequency Response is in Curve 1 6. Frequency Droop Setting is 4% |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. Status \_\_\_\_ 5. Curve \_\_\_\_ 6. \_\_\_\_% |
| 3 | WFPS requests NCC to select Frequency Response Curve 2 and manually records the time between the command being issued from NCC and being implemented in the WFCS |  | Curve \_\_\_\_  Time delay \_\_\_\_ |
| 4 | WFPS requests NCC to select Frequency Response Curve 1 and manually records the time between the command being issued from NCC and being implemented in the WFCS |  | Curve \_\_\_\_  Time delay \_\_\_\_ |
| 5 | WFPS requests NCC to select Frequency Response OFF and manually records the time between the command being issued from NCC and being implemented in the WFCS |  | Status \_\_\_\_  Time delay \_\_\_\_ |
| 6 | WFPS requests NCC to select Frequency Response ON and manually records the time between the command being issued from NCC and being implemented in the WFCS |  | Status \_\_\_\_  Time delay \_\_\_\_ |
| 6 | WFPS requests NCC to issue a Frequency Droop Setting of 2% and manually records the Frequency Droop Setting implemented in the WFCS |  | \_\_\_\_% |
| 7 | WFPS requests NCC to issue a Frequency Droop Setting of 10% and manually records the Frequency Droop Setting implemented in the WFCS |  | \_\_\_\_% |
| 8 | WFPS requests NCC to issue a Frequency Droop Setting of 4% and manually records the Frequency Droop Setting implemented in the WFCS |  | \_\_\_\_% |
| 9 | WFPS informs NCC that the Functional check is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure.  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Droop Setting

The WFPS demonstrates that TSO can set the frequency droop online between 2% and 10% and that the frequency droop functions accordingly.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Droop Setting test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC set-point is [insert 40% of Registered Capacity] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 1 7. Frequency Droop Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to the APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS requests NCC to issue a Frequency Droop Setting of 2% |  | \_\_\_\_% |
| 5 | WFPS injects a simulated frequency of 49.75 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency Reposonse ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50.25 Hz and waits 3 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency Reposonse ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 8 | WFPS requests NCC to issue a Frequency Droop Setting of 10% |  | \_\_\_\_ % |
| 9 | WFPS injects a simulated frequency of 49 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency Reposonse ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 51 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency Reposonse ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 11 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 12 | WFPS requests NCC to issue a Frequency Droop Setting of 4% |  |  |
| 13 | WFPS ends data recording |  |  |
| 14 | WFPS informs NCC that the Frequency Droop Setting test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure.  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response ON, Curve 1, APC ON

The WFPS demonstrates that the active power output is correctly altered for simulated frequencies, based on the settings issued by the TSO. The behaviour of the WFPS to frequency deviations while below DMOL is also examined.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response ON, Curve 1, APC ON test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC set-point is [insert 40% of Registered Capacity] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 1 7. Frequency Droop Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes.  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49.8 Hz and waits **5 minutes** after expected MW output is achieved  Expected MW Output = [Insert Target MW]  Please note the wait time for this step should not be changed as data from this injection may be used to as part of a report for System Services Operating Reserve. |  | AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 48 Hz and waits 2 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 49.75 Hz and waits 2 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 49.984 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 8 | WFPS injects a simulated frequency of 49.985 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to the APC Set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 9 | WFPS injects a simulated frequency of 50.015 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 50.016 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 11 | WFPS injects a simulated frequency of 50.25 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 12 | WFPS injects a simulated frequency of 51.9 Hz and waits 2 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall go to DMOL at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 13 | WFPS injects a simulated frequency of 52 Hz and waits 3 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall go to 0 MW at maximum possible rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 14 | WFPS injects a simulated frequency of 50.21 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WTGs shall not start up  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 15 | WFPS injects a simulated frequency of 50.19 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point +ΔMW at maximum possible rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 16 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 17 | WFPS requests NCC to issue an APC set-point of [insert 50% of DMOL] MW and waits until APC set-point has been achieved |  | AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 18 | WFPS injects a simulated frequency of 50.5 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall not turn off any additional WTG to provide frequency reponse  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 19 | WFPS injects a simulated frequency of 49.5 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall provide response at maximum possible rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 20 | WFPS requests NCC to issue an APC set-point of [insert 40% of Registered Capacity] MW and waits until APC set-point + ΔMW, has been achieved  Expected MW Output = [Insert Target MW] |  | AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 21 | WFPS injects a simulated frequency of 50 Hz and waits until the APC set-point has been achieved  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC set-point ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ |
| 22 | WFPS ends data recording |  |  |
| 23 | WFPS informs NCC that the Frequency Response ON, Curve 1, APC ON test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response OFF Curve 1 APC ON

The WFPS demonstrates that the active power output is independent of simulated frequency while in Curve 1 with APC ON.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response OFF, Curve 1, APC ON test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC set-point is [insert 40% of Registered Capacity] MW 5. Frequency Response is OFF 6. Frequency Response is in Curve 1 7. Frequency Droop Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 51 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS ends data recording |  |  |
| 8 | WFPS informs NCC that the Frequency Response OFF, Curve 1, APC ON test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response ON, Curve 1, APC OFF

The WFPS demonstrates that the active power output is correctly altered for simulated frequencies, based on the settings issued by the TSO.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response ON, Curve 1, APC OFF test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is OFF 4. Frequency Response is ON 5. Frequency Response is in Curve 1 6. Frequency Droop Setting is 4% 7. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. Status \_\_\_\_ 5. Curve \_\_\_\_ 6. \_\_\_\_% 7. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to AAP at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49.5 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall follow AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 50.2 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall follow AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50.21 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 50.8 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 8 | WFPS injects a simulated frequency of 51.9 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at Frequency response ramp rate  WFPS shall go to DMOL  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 9 | WFPS injects a simulated frequency of 52 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at maximum possible rate  WFPS shall go to 0 MW  Number of turbine online: \_\_\_\_  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 50.21 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WTGs shall not start up any additional turbines  Number of turbine online: \_\_\_\_  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 11 | WFPS injects a simulated frequency of 50.19 Hz and waits 1 minutes after achieving expected MW output  Expected MW Output = [Insert Target MW] |  | Output shall ramp to AAP at the Wind Following Ramp Rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 12 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS output shall follow AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 13 | WFPS ends data recording |  |  |
| 14 | WFPS informs NCC that the Frequency Response ON, Curve 1, APC OFF test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response OFF, Curve 1, APC OFF

The WFPS demonstrates that the active power output is independent of simulated frequency while in Curve 1 with APC OFF.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response OFF, Curve 1, APC OFF test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is OFF 4. Frequency Response is OFF 5. Frequency Response is in Curve 1 6. Frequency Droop Setting is 4% 7. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. Status \_\_\_\_ 5. Curve \_\_\_\_ 6. \_\_\_\_% 7. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall follow AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 51 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall follow AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall follow AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS ends data recording |  |  |
| 8 | WFPS informs NCC that the Frequency Response OFF, Curve 1, APC OFF test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response ON, Curve 2, APC ON

The WFPS demonstrates that the active power output is correctly altered for simulated frequencies, based on the settings issued by the TSO.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response ON, Curve 2, APC ON test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC Set-point is [insert 40% of Registered Capacity] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 2 7. Frequency Response Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49.3 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate to AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 49.75 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 49.984 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 49.985 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 8 | WFPS injects a simulated frequency of 50.015 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 9 | WFPS injects a simulated frequency of 50.016 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 50.25 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 11 | WFPS injects a simulated frequency of 51.9 Hz and waits 3 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  WFPS shall go to DMOL  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 12 | WFPS injects a simulated frequency of 52 Hz and waits 3 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the maximum possible ramp rate  WFPS shall go to 0 MW  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 13 | WFPS injects a simulated frequency of 50.21 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WTGs shall not start up  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 14 | WFPS injects a simulated frequency of 50.19 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | Output shall ramp to APC set-point +ΔMW at the Frequency response ramp rate from the point above DMOL  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 15 | WFPS injects a simulated frequency of 50 Hz and waits until the APC set-point has been achieved  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 16 | WFPS ends data recording |  |  |
| 17 | WFPS informs NCC that the Frequency Response ON, Curve 2, APC ON test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response OFF Curve 2 APC ON

The WFPS demonstrates that the active power output is independent of simulated frequency while in Curve 2 with APC ON.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response OFF, Curve 2, APC ON test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC set-point is [insert 40% of Registered Capacity] MW 5. Frequency Response is OFF 6. Frequency Response is in Curve 2 7. Frequency Droop Setting 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 51 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS ends data recording |  |  |
| 8 | WFPS informs NCC that the Frequency Response OFF, Curve 2, APC ON test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |

## Frequency Response ON Curve 2 APC OFF

The WFPS demonstrates that the active power output is correctly altered for simulated frequencies, based on the settings issued by the TSO.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response ON, Curve 2, APC OFF test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is OFF 4. Frequency Response is ON 5. Frequency Response is in Curve 2 6. Frequency Response Setting is 4% 7. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. Status \_\_\_\_ 5. Curve \_\_\_\_ 6. \_\_\_\_% 7. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 3 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to 95% AAP at the Wind Following ramp rate  WFPS output = 95% AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49.3 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to 100% AAP at Frequency response ramp rate  WFPS ramps to 100% AAP  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 50.015 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS ramps to 95% AAP at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50.016 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 50.25 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 8 | WFPS injects a simulated frequency of 50.8 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 9 | **I**WFPS injects a simulated frequency of 51.9 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Frequency response ramp rate  WFPS shall go to DMOL  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 52 Hz and waits 3 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the maximum possible ramp rate  WFPS shall go to 0 MW  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 11 | WFPS injects a simulated frequency of 50.21 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WTGs shall not start up  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 12 | WFPS injects a simulated frequency of 50.19 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to 95% of AAP + ΔMW at the at the Frequency response ramp rate from the point above DMOL  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 13 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to 95% AAP at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 14 | WFPS ends data recording |  |  |
| 15 | WFPS informs NCC that the Frequency Response ON, Curve 2, APC OFF test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response OFF, Curve 2, APC OFF

The WFPS demonstrates that the active power output is independent of simulated frequency while in Curve 2 with APC OFF.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3. |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the Frequency Response OFF, Curve 2, APC OFF test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is OFF 4. Frequency Response is OFF 5. Frequency Response is in Curve 2 6. Frequency Droop Setting is 4% 7. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. Status \_\_\_\_ 5. Curve \_\_\_\_ 6. \_\_\_\_% 7. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 49 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 51 Hz and waits 1 minute  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS ends data recording |  |  |
| 8 | WFPS informs NCC that the Frequency Response OFF, Curve 2, APC Off test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## DMOL Test

The WFPS demonstrates that the WFPS responds correctly to frequency deviations at its declared DMOL.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS requests permission from NCC to proceed with the DMOL test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS is [insert DMOL] MW 3. APC is ON 4. APC Set-point is [insert DMOL] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 1 7. Frequency Response Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS injects a simulated frequency of 50.02 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS requests NCC to issue an APC set-point of [insert 100% of Registered Capacity] MW without turning APC off, and waits until exported power has increased to meet AAP.  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to AAP + ΔMW at the maximum possible rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at APC ramp rate |
| 7 | WFPS ends data recording |  |  |
| 8 | WFPS informs NCC that DMOL test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response Ramp Rate Priority in Curve 1

The WFPS demonstrates that ramp rates are prioritised and adhered to correctly during frequency response.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Sexction 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | Account for the timing if using an automated test script throughout this section.  WFPS requests permission from NCC to proceed with the Ramp Rates Settings Curve 1 test and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC set-point is [insert 100% of Registered Capacity] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 1 7. Frequency Response Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS requests NCC to issue an APC set-point of [insert DMOL] MW.While the WFPS is ramping, WFPS injects a simulated frequency of 50.02 Hz and waits until exported power has decreased to meet DMOL. [[2]](#footnote-3)  Expected MW Output = [Insert Target MW] |  | WFPS shall commence ramping at the APC ramp rate, and change to the Frequency Response ramp rate following injection  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 50 Hz.  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS requests NCC to issue an APC set-point of [insert 100% of Registered Capacity] MW, without turning APC off While the WFPS is ramping at the APC setpoint Ramp Rate, WFPS injects a simulated frequency of 50.02 Hz and waits until exported power has achieved AAP + ΔMW at the Frequency Response Ramp Rate.2  Expected MW Output = [Insert Target MW] |  | AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to 100% AAP at the APC ramp rate |
| 8 | WFPS requests NCC to issue an APC set-point of [insert DMOL] MW and waits until exported power has decreased to meet DMOL  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to APC set-point at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 9 | WFPS requests NCC to issue an APC set-point of [insert 100% of Registered Capacity] MW and turn APC OFF. While the WFPS is ramping at Wind Following Ramp Rate, WFPS injects a simulated frequency of 49.79 Hz and waits until exported power has increased to meet AAP.3  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to AAP at the Frequency response ramprate following injection  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall not respond |
| 11 | WFPS requests NCC to turn APC on, issue a set-point of [insert DMOL] MW and waits until exported power has decreased to meet DMOL[[3]](#footnote-4)  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp to DMOL at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 12 | WFPS requests NCC to issue an APC set-point of [insert 100% of Registered Capacity] MW and turn APC OFF. While the WFPS is ramping, WFPS injects a simulated frequency of 50.21 Hz and waits 1 minute.3  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at Frequency response ramp rate following injection  WFPS shall latch output per WFPS1.5.3.4. Output = min(latched value, AAP + ΔMW)  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 13 | WFPS injects a simulated frequency of 50 Hz.  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 14 | WFPS ends data recording |  |  |
| 15 | WFPS informs NCC that the Ramp Rate Settings Curve 1 test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Frequency Response Ramp Rate Priority in Curve 2

The WFPS demonstrates that ramp rates are prioritised and adhered to correctly during frequency response and also that response to set-points is not inhibited by latched Active Power Output.

| **Step No.** | **Action** | **Time** | **Comments** |
| --- | --- | --- | --- |
| 1 | WFPS begins data recording for all trends noted in Section 7.3, above |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | Account for the timing if using an automated test script throughout this section.  WFPS requests permission from NCC to proceed with the Ramp Rates Settings Curve 2 and confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is ON 4. APC set-point is [insert 100% of Registered Capacity] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 2 7. Frequency Response Setting is 4% 8. Emulated inertia status is OFF (remove if not applicable) |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Status \_\_\_\_ |
| 3 | WFPS replaces the system frequency with a simulated frequency of 50 Hz and waits 1 minutes  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 4 | WFPS requests NCC to issue an APC set-point of [insert DMOL] MW. While WFPS is ramping, WFPS injects a simulated frequency of 49.98 Hz and waits until exported power has decreased to DMOL + ΔMW. [[4]](#footnote-5)  Expected MW Output = [Insert Target MW] |  | WFPS shall commence ramping at the APC ramp rate, and change to the Frequency Response ramp rate following injection  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 5 | WFPS injects a simulated frequency of 50 Hz.  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the APC ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 6 | WFPS requests NCC to issue an APC set-point of [insert 100% of Registered Capacity] MW. While WFPS is ramping, WFPS injects a simulated frequency of 49.98 Hz and waits until exported power has achieved 95% of AAP + ΔMW.4  Expected MW Output = [Insert Target MW] |  | WFPS shall commence ramping at the APC ramp rate, and change to the Frequency Response ramp rate following injection  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 7 | WFPS injects a simulated frequency of 50 Hz  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the APC ramp rate |
| 8 | WFPS requests NCC to issue an APC set-point of [insert DMOL] MW and waits until exported power has decreased to meet DMOL |  | WFPS shall ramp at the APC ramp rate |
| 9 | WFPS requests NCC to issue an APC set-point of [insert 100% of Registered Capacity] MW and turn APC OFF. While WFPS is ramping, WFPS injects a simulated frequency of 49.98 Hz and waits until exported power has achieved 95% of AAP + ΔMW .4  Expected MW Output = [Insert Target MW] |  | WFPS shall commence ramping at the Wind following ramp rate, and change to the Frequency Response ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 10 | WFPS injects a simulated frequency of 50 Hz.  Expected MW Output = [Insert Target MW] |  | WFPS shall ramp at the Wind Following ramp rate  AAP = \_\_\_\_ MW  MW Output = \_\_\_\_ MW |
| 11 | WFPS ends data recording |  |  |
| 12 | WFPS informs NCC that the Ramp Rate Settings Curve 2 test is complete. If further testing is not being completed, go to Section 8.14 Return to Standard Settings |  |  |
| Note any issues or deviations from test procedure  For example changes in step size, duration, test operators, parameter changes on site.  Mark as “No Comment” if test proceeded as per procedure. | |  | |

## Return to Standard Settings

The WFPS settings are returned to standard following completion of the Frequency Response Test.

|  |  |  |  |
| --- | --- | --- | --- |
| **Step No.** | **Action** | **Time** | **Comments** |
| 1 | WFPS removes the simulated frequency, returning the WFCS reference to system frequency |  | Operator Name \_\_\_\_\_\_\_\_\_\_\_\_  Date \_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | WFPS confirms the following with NCC:   1. AAP of the WFPS 2. MW output of the WFPS 3. APC is OFF 4. APC Set-point = [insert 100% of Registered Capacity] MW 5. Frequency Response is ON 6. Frequency Response is in Curve 1 7. Frequency Droop Setting is 4% 8. WFCS frequency reference is system frequency |  | 1. \_\_\_\_ MW 2. \_\_\_\_ MW 3. Status \_\_\_\_ 4. \_\_\_\_ MW 5. Status \_\_\_\_ 6. Curve \_\_\_\_ 7. \_\_\_\_% 8. Frequency Reference \_\_\_\_\_\_\_\_\_\_ |
| 3 | WFPS informs NCC that Frequency Response testing is complete |  |  |

## Comments & Signatures

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

1. <http://www.eirgridgroup.com/library> [↑](#footnote-ref-2)
2. Account for the timing of this step if using an automated test script [↑](#footnote-ref-3)
3. Account for the timing of this step if using an automated test script [↑](#footnote-ref-4)
4. Account for the timing of this step if using an automated test script [↑](#footnote-ref-5)